Textbook of

PROSTHODONTICS

Deepak Nallaswamy

- Complete Dentures (CD)
- Removable Partial Dentures (RPD)
- Fixed Partial Dentures (FPD)
- Maxillofacial Prosthetics (MFP)
- Implant Dentistry (ID)
- Glossary of Prosthodontics Term

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Textbook of Prosthodontics

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To
My

Father—Dr NM Veeraiyan
Mother—Mrs Saraswathy
Sister—Dr V Saveetha
Niece—Miss Keerthanya
Professor of Anatomy—Prof Dr Saratha Kathiresan
Zoology Teacher—Mrs NS Karthikeyani

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Foreword

Even though many books are available on different sections in prosthodontics, there is no comprehensive textbook available in this subject. Dr. Deepak Nallaswamy *et al* have undertaken this venture as a challenge. I had the opportunity to evaluate this book right from the conceptual stage to the completed level. The unique feature of this book is the use of simple crisp explanations accompanied with over 3000 illustrations, which will aid the students to read and understand the subject in a better way. Three years of hard work have gone into this book and I believe that this unstinted effort will be fruitful to the students. I wish this book would become an essential companion for all dental graduates.

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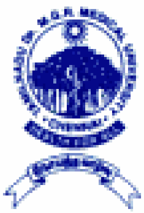
Foreword



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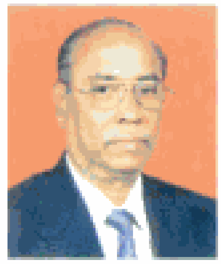

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As the Vice-Chancellor of the Tamil Nadu Dr MGR Medical University, I envisioned to make medical education a pleasurable and hassle-free experience. It is said that the root of education is bitter but the fruit is sweet. But as academicians, I believe every one should work to make even the roots of education sweet. The book *Textbook of Prosthodontics* authored by Dr Deepak et al takes a path similar to my vision. Writing a book is a work of art. But very few Indian dental academicians have excelled in this art. Prosthodontics is a vast and ever expanding specialty that requires a minimum of three books to cover the university undergraduate syllabus. The lack of a comprehensive textbook in this subject makes it difficult for an undergraduate student to cover the syllabus. A commendable and arduous task has been taken up by these authors in bringing out a comprehensive prosthodontic textbook that is unique in its contents, coverage, language and illustrations.

I wish them success in their noble but humble mission. I believe that this book 'tailor-made' to our university syllabus will aid to fulfill the needs of all prosthodontic students.

Dr CV Bhirmanandham

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Section One

Complete Dentures

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Chapter 1
Introduction to Complete Dentures

- Definition
- Component Parts of a Complete Denture
- Steps in the Fabrication of a Complete Denture

1

Introduction to Complete Dentures

DEFINITION

Complete denture prosthodontics or Full denture prosthetics is defined as *"The replacement of the natural teeth in the arch and their associated parts by artificial substitutes"*- GPT.

It can also be defined as *"The art and science of the restoration of an edentulous mouth"* - GPT.

Complete denture is defined as *" A dental prosthesis which replaces the entire dentition and associated structures of the maxilla and mandible"* - GPT.

It can be classified as,

- Removable complete dentures
- Fixed complete dentures

Generally complete dentures are fabricated for geriatric patients. Some young patients who are born with congenitally malformed teeth or edentulous arches require complete dentures. It is essential for the dentist to evaluate the patient before treatment.

This section discusses in detail the steps involved in the fabrication of a complete denture and the various modifications done to suit the needs of the patient, etc. This chapter will cover the contents of the entire section in a brief manner so as to give a clear idea about the prosthesis.

Functions of a Complete Denture

A complete denture functions to restore aesthetics, mastication and speech.

Aesthetics The complete denture should restore the lost facial contours, vertical dimension, etc. Artefacts like stains can be incorporated in order to improve the aesthetics.

Mastication A complete denture should have proper balanced occlusion in order to enhance the stability of the denture. Occlusion is discussed in detail in Chapter 10.

Phonetics One of the most important functions of a denture is to restore the speech of the patient (Refer Chapter 12).

COMPONENT PARTS OF A COMPLETE DENTURE

It is important to have a thorough knowledge about the various parts of a complete denture before we discuss about the various procedures. A denture has three surfaces and four component parts.

Surfaces of A Complete Denture

A complete denture has the following surfaces (Fig. 1.1):

Impression surface (Intaglio surface) It is defined as, *"That portion of the denture surface which has its contour determined by the impression"*- GPT.

This surface refers to the surface of the denture that will be in contact with the tissues (basal seat area and limiting structures) when the denture is

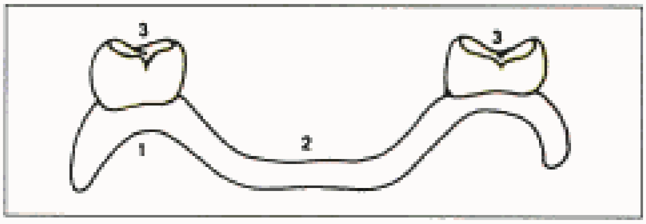


Fig. 1.1: Surfaces of a complete denture (1) Impression surface (2) Polished surface (3) Occlusal surface

seated in the mouth. This surface is a negative replica of the tissue surface of the patient. It should be free of voids and nodules to avoid injury to the tissues.

Polished surface (Cameo surface) It is defined as, *"That portion of a surface of a denture which extends in an occlusal direction from the border of the denture and includes the palatal surfaces. It is the part of the denture base which is usually polished, and it includes the buccal and lingual surfaces of the teeth"* – GPT.

This surface refers to the external surfaces of the lingual, buccal, labial flanges and the external palatal surface of the denture. This surface should be well polished and smooth to avoid collection of food debris.

Occlusal surface It is defined as, *"That portion of the surface of a denture or dentition which makes contact or near contact with the corresponding surface of the opposing denture or dentition"*—GPT.

This surface refers to the occlusal surface of the denture teeth. It resembles the natural teeth and usually contains cusps and sluice ways to aid in mastication.

Parts of a Complete Denture (Fig. 1.2)

The various parts of a complete denture are:
- Denture base.
- Denture flange.
- Denture border.
- Denture teeth.

Each of these parts have been explained in detail here.

Denture Base

It is defined as, *"That part of a denture which rests on the oral mucosa and to which teeth are attached"* – GPT.

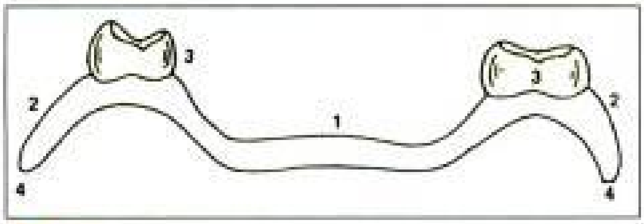


Fig. 1.2: Parts of a complete denture (1) Denture base (2) Denture flange (3) Denture teeth and (4) Denture border

It is usually made in acrylic resin. In some cases metal denture bases are prepared. The denture base forms the foundation of the denture. It helps to distribute and transmit all the forces acting on the denture teeth to the basal tissues. It has the maximum influence on the health of the oral tissues. It is the part of the denture, which is responsible for retention and support.

Acrylic Resin Denture Bases

It is the most commonly used denture base material (Fig. 1.3). It is easy to fabricate and economical. It is supplied as a powder (polymer) and a liquid (monomer).

Advantages
- Acrylic has a translucent pink colour, which closely resembles the gingiva, providing good aesthetics.
- These dentures can be easily rebased / relined as required in future.
- It is also available in various pigmented colours which can be used for characterization.
- The material is quite strong and can withstand normal occlusal forces.

Disadvantages
- It cannot be used in thin sections like a metal denture base. Hence, it affects the speech of the patient.
- It does not transmit any heat. So the patient's perception of the temperature of the food is decreased.
- Difficult to maintain.

Metal Denture Bases

Metal denture bases can be fabricated using Gold, Gold alloys, Chromium-Cobalt or Nickel-Chromium alloys (Fig. 1.4).

Fig. 1.3: Acrylic denture base

Fig. 1.4: Metal denture base

Advantages

- Mandibular dentures are heavier. So the retention and stability are improved.
- Improved thermal conductivity gives good sensory interpretation.
- They are strong even in thin sections. Thin sections are very comfortable for the patient.
- Easier to maintain.

Disadvantages

- More expensive.
- Require more time for fabrication.
- Require refractory cast material.
- Difficult to fabricate.
- Cannot be rebased.

Flange of a Denture

It is defined as, "*The essentially vertical extension from the body of the denture into one of the vestibules of the oral cavity. Also, on the mandibular denture, the essentially vertical extension along the lingual side of the alveololingual sulcus*"- GPT.

It has two surfaces, namely, the internal *basal seat surface* and the external *labial or lingual surface*. The functions of the flange include, providing peripheral seal and horizontal stability to the denture. The flanges are named based on the vestibule they extend into.

Labial Flange

It is defined as, "*The portion of the flange of the denture which occupies the labial vestibule of the mouth*"- GPT. Thickness of this flange provides aesthetic lip support. It has a "V" shaped notch to accommodate the labial frenum (Fig. 1.5).

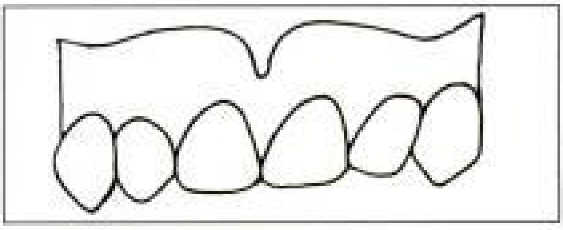


Fig. 1.5a: Frenum relief in the labial flange

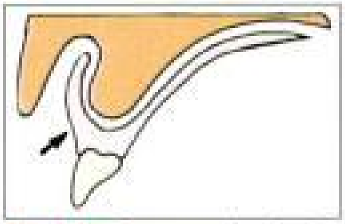


Fig. 1.5b: Cross-sectional view of a maxillary denture showing the labial flange

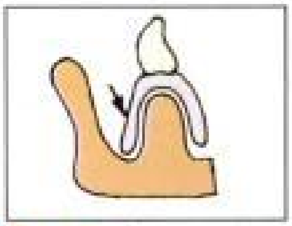


Fig. 1.5c: Cross-sectional view of a mandibular denture showing the labial flange

Buccal Flange

It is defined as, "*The portion of a flange of a denture which occupies the buccal vestibule of the mouth*"—GPT. It provides the required cheek fullness in aged edentulous patients. In the mandibular denture it also transmits the occlusal forces to the buccal shelf area. The buccal frenum is attached to *active muscle fibres*, hence, additional relief should be provided in the buccal flange (Fig. 1.6).

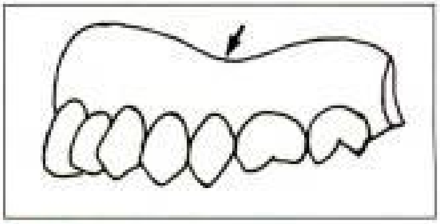


Fig. 1.6a: Buccal flange of a maxillary denture

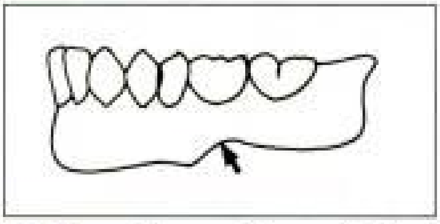


Fig. 1.6b: Buccal flange of the mandibular denture

Lingual Flange

It is defined as, *"The portion of the flange of a mandibular denture which occupies the space adjacent to the tongue"*-GPT. It should be in contact with the floor of the mouth to provide peripheral seal. However, overextended lingual flanges can lead to loss of retention due to displacement during the activation of the muscles of the floor of the mouth (Fig. 1.7a).

Denture Border

It is defined as, *"The margin of the denture base at the junction of the polished surface and the impression surface"*- GPT (Fig. 1.7b).

It is responsible for peripheral seal. The denture border should be devoid of sharp edges and nodules to avoid soft tissue injury. Over-extended denture borders can cause hyperplastic tissue changes like *epulis fissuratum*. On the other hand the border should not be under-extended as peripheral seal may be lost.

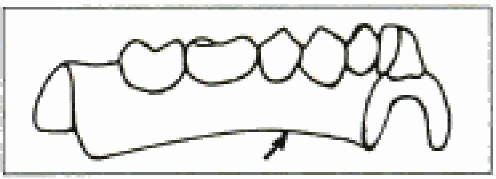


Fig. 1.7: Lingual flange of the mandibular denture

Denture Teeth

It is the most important part of the complete denture from the patient's point of view. The functions of the denture teeth are aesthetics, mastication and speech. They are usually made of acrylic resin or porcelain (Fig 1.8).

There are different types of denture teeth which are classified as follows:

Based on the material:

- Acrylic teeth.
- Porcelain teeth.
- Inter-penetrating polymer network resin teeth (IPN resin).
- Gold occlusals.
- Acrylic resin with amalgam stops.

Based on the morphology of the teeth:

- Anatomic teeth.
- Semi-anatomic teeth.
- Non-anatomic teeth. Or 0°/Cuspless teeth.
- Cross-bite teeth.
- Metal insert teeth.

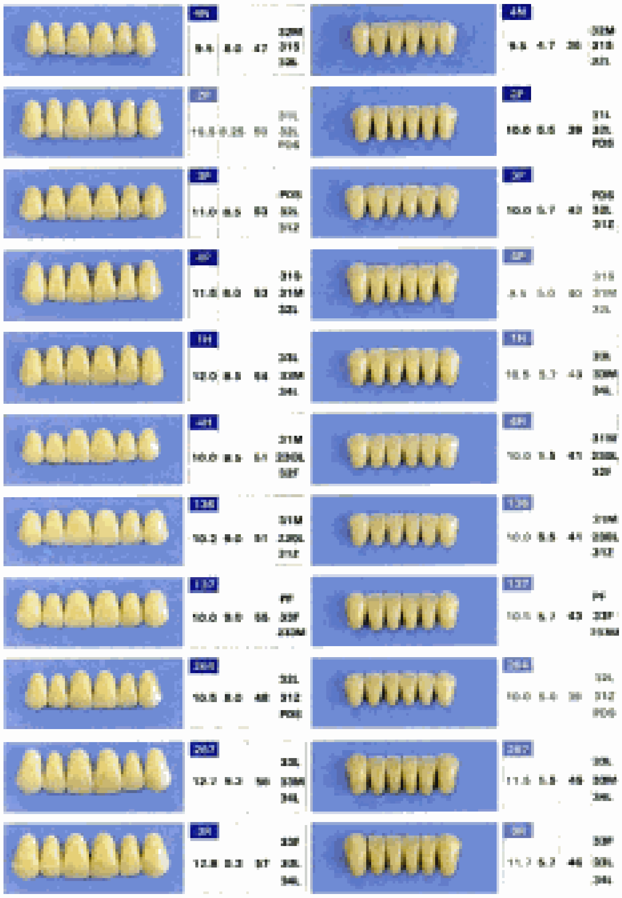


Fig. 1.8: Acrylic denture teeth

Types of Teeth

Acrylic and Porcelain Teeth

Acrylic and porcelain teeth

Property	*Acrylic*	*Porcelain*
Abrasion resistance	Low	High
Adjustability	Easy to adjust	Difficult to trim
Bonding	Chemical	Mechanical
Staining	Easily stained	Does not stain
Percolation	Absent if acrylic denture base is used	Present when acrylic denture base is used
Clicking sound	Absent	Present
Ease of fabrication	Easy	Difficult
Ease of rebasing	Difficult to remove acrylic teeth	Easy to remove porcelain teeth
Trauma to denture bearing area	Less	More

IPN Resin (inter-penetrating polymer network resin)

It has the advantages of acrylic and porcelain. This material has an unfilled, highly cross-linked polymer chains. It has more wear resistance than conventional acrylic.

Gold Occlusals

It is considered to be the best material to oppose a natural tooth. It is very expensive and requires a longer fabrication time, hence it is avoided.

Acrylic Resin with Amalgam Stops

Here, occlusal preparations are made on the acrylic teeth and amalgam is condensed into the preparation and occlusal correction is done in the articulator. It is simple and less expensive than the gold occlusal (Fig. 1.9).

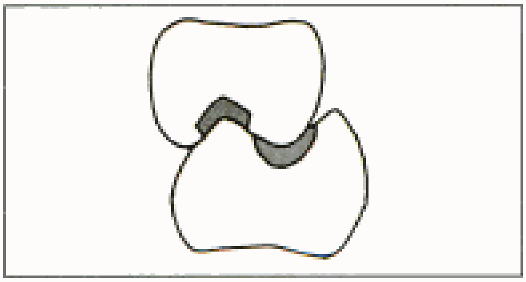


Fig. 1.9: Acrylic resin teeth with amalgam stops

Morphology of Teeth

Anatomic Teeth

It is defined as, "*Teeth which have prominent pointed or rounded cusps on the masticating surfaces and which are designed to occlude with the teeth of the opposing denture or natural dentition*" - GPT.

Anatomic teeth have a 33° cusp angle. Cusp angle can be defined as, "*the angle made by the slopes of the cusp with a perpendicular line bisecting the cusp, measured mesiodistally or buccolingually*" - GPT (Fig. 1.10).

They are the most commonly used of all the types available because they resemble the natural teeth and provide good aesthetics and the psychological benefit to the patient. While choosing the type of teeth for a patient, the incisal and condylar guidance of the patient, should be analyzed.

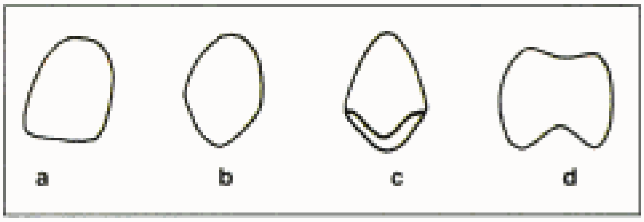


Fig. 1.10: Anatomic teeth (a) Incisor (b) Canine (c) Premolar (d) Molar

Advantages

- They are more efficient in cutting and grinding food, so, less masticatory effort and forces are needed.
- Balanced occlusion can be achieved in eccentric jaw positions (Protrusive, right lateral and left lateral movement).
- The cusp-fossa relationship helps to guide the mandible into centric occlusion.
- Aesthetically and psychologically acceptable.
- The physical contours closely resemble natural teeth and hence, they are more compatible to the oral environment.

The disadvantages of these teeth are that they magnify the horizontal forces acting on the ridge and the 'teeth setting' is very crucial to obtain proper occlusion (i.e. they should be placed in specified positions).

Semi-anatomic Teeth

These teeth have cusp angles ranging between 0° and 30°. The cusp angles are usually around 20°. They are also called *modified anatomic teeth*.

Victor Sears in 1922 designed the first semi-anatomic tooth, which was called the *channel tooth*. This consisted of a mesiodistal groove in all maxillary posterior teeth and a mesiodistal ridge in all mandibular posterior teeth. These teeth were designed for unlimited protrusive movement and limited lateral movements (Fig. 1.11).

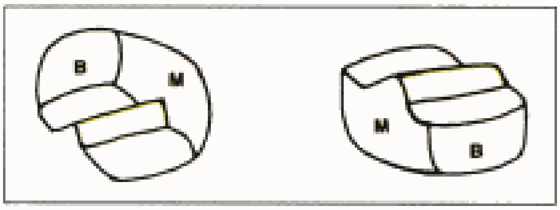


Fig. 1.11: Victor Sear's channel tooth (schematic representation)

In 1930 Avery Brothers modified the channel tooth to produce what was called the *scissor bite teeth*. This is exactly the opposite of the channel tooth. The grooves and ridges run buccolingually so that protrusive movement is limited and lateral movement is free. This was designed to shear food in the lateral direction (Fig. 1.12).

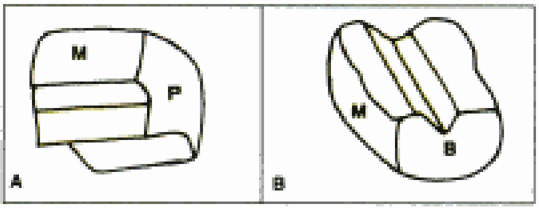


Fig. 1.12: Avery Brother's modified channel tooth (Schematic representation)

Non-anatomic or 0° or cuspless Teeth

Non-anatomical teeth are defined as, *"Artificial teeth with occlusal surfaces which are not anatomically formed but which are designed to improve the function of mastication"* - GPT.

Cuspless teeth are defined as, *"They are teeth designed without cuspal prominences on the occlusal surfaces"* - GPT. Zero degree teeth are defined as, *"Artificial posterior teeth having no cusp angles in relation to the horizontal occlusal surfaces"* - GPT.

These teeth have 0° cusp angles. These designs evolved to over-come the disadvantages of the normal anatomic teeth. These teeth do not provide balanced occlusion. Balanced occlusion in dentures with these teeth is obtained by balancing ramps and compensatory curves.

Hall in 1929 designed the first cuspless tooth and named it "inverted cusp tooth". The occlusal surfaces of these teeth were flat with concentric conical depressions producing sharp concentric ridges around a central depression (Fig. 1.13).

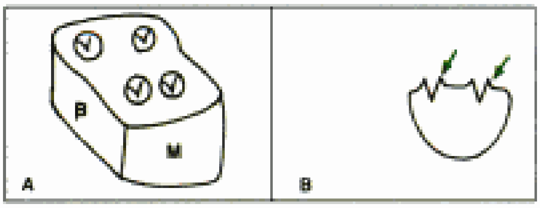


Fig. 1.13: (a) Hall's inverted cusp teeth (Schematic representation) (b) Cross-section of the tooth showing the concentric ridges around the conical depression (Green arrow)

Myerson introduced the *"trukusp"* teeth in 1929. These had a series of buccolingual ridges on the occlusal surfaces of both maxillary and mandibular teeth. Here the ridges of opposing teeth were parallel to each other (Fig. 1.14).

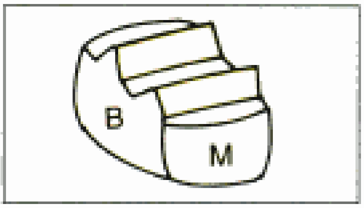


Fig. 1.14: Myerson's trukusp teeth (Schematic representation)

In 1934 Nelson described the *"chopping block"*. In this design the maxillary teeth had mesiodistal ridges and mandibular teeth had buccolingual ridges. These ridges occluded perpendicular to each other increasing masticatory efficiency (Fig. 1.15).

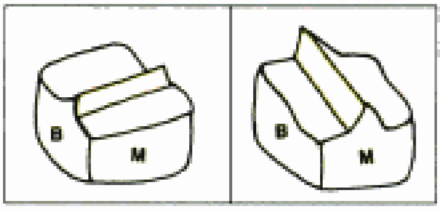


Fig. 1.15: Nelson's chopping block teeth (Schematic representation) (a) Mandibular (b) Maxillary

In 1939 Swenson designed the *"non-lock tooth"*. The occlusal surface was flat with *sluiceways* or pathways for food clearance. They also had a slight buccal and lingual incline (Fig 1.16).

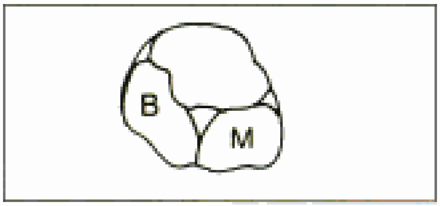


Fig. 1.16: Swenson's non-lock teeth (Schematic representation)

Advantages

- In patients with bruxism non-anatomic teeth decrease the forces acting on the basal tissues.
- Greater range of movements is possible.

- In patients with neuromuscular disorders where accurate jaw relation cannot be recorded, cuspless teeth are preferred.

- In cases with highly resorbed ridge, cuspless teeth are preferred as they do not get locked and displace the denture during lateral movements.

Disadvantages

- Flat occlusal surfaces and artificial contours give an unaesthetic appearance.
- Masticatory efficiency is less.
- Balanced occlusion cannot be obtained.
- Occlusion is in two dimensions, whereas the mandibular movement is in three dimensions.
- Any attempt to correct these teeth by occlusal grinding will decrease their efficiency.

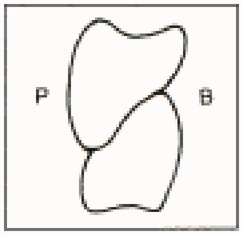


Fig. 1.17: Gysi's cross bite teeth (Schematic representation)

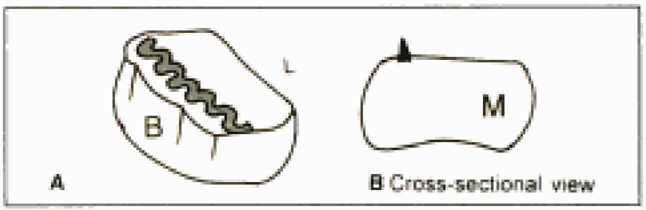


Fig. 1.18: Hardy's Vitallium occlusal (Schematic representation)

Cross Bite Teeth

These teeth are used in jaw discrepancy cases leading to a posterior cross bite relationship. Here the buccal cusps of the maxillary teeth are absent. Instead there is a large palatal cusp, which rests on the lower tooth. Gysi in 1927 designed the cross bite tooth (Fig. 1.17).

Metal Insert Teeth (VO Posteriors)

Hardy designed the first metal insert tooth and he called it the "*Vitallium occlusal*". Here each tooth will look like the fusion of two premolars and one molar. On the occlusal surface of these teeth, a Vitallium ribbon is embedded in a zigzag pattern. The Vitallium metal insert is not totally submerged into the tooth, instead it is slightly raised above the occlusal surface. On occlusion, the metal-to-metal contact produces greater cutting efficiency (Fig. 1.18).

STEPS IN THE FABRICATION OF A COMPLETE DENTURE

This topic is included to give a brief idea about the various procedures that are discussed in detail in the later chapters. Only a brief description about each procedure is given here. For a better understanding, the procedures have been separated as clinical and lab procedures.

The steps have been enlisted in the Table 1.1. The numbering denotes the order in which these procedures are carried out.

Table 1.1: Steps in the fabrication of a complete denture

No:	*Clinical procedures*	*No:*	*Lab procedures*
1.	Diagnosis and treatment planning. *Diagnosis:* • Patient evaluation (physical, psychological and socio-economic) • History taking (name, age, sex, address, occupation, religion, past medical history, past dental history, history of present illness, etc. • General clinical examination (CNS, CVS, RS, GIT) • Local clinical examination — Extra-oral (TMJ, mouth opening, lips, etc) — Intra-oral (residual alveolar ridge, mucosa, palate, etc).		

Contd.

Contd.

- Radiological examination
- Examination of previous dentures, Examination of pre-treatment records.

- Making the diagnostic impression with *alginate.* (rigid impression material are avoided as undercuts may be present).

2. Pouring the diagnostic cast using Dental Plaster.
   - Surveying the diagnostic cast using a surveyor.
   - — Identifying the presence of an undercut
   - — Measuring the depth of the undercut.
   - — Determining the amount of mouth preparation required.
   - — Determining the path of insertion.
3. *Treatment plan:*
   - Choosing the type of prosthesis. (Design and material)
   - Applying design considerations.
4. Pre-prosthetic surgery (excision of tori, frenectomy, frenotomy, alveoloplasty, vestibuloplasty, ridge augmentation procedures, removal of undercuts, etc.)
5. Making the primary impression using impression compound (material of choice) and refining the impression.
6. Pouring the primary cast using Dental plaster. Surveying the primary cast to determine the path of insertion.
   Tripoding the primary cast.
   Adapting a spacer and fabricating the special tray over the primary cast. Providing relief to certain areas
   Materials used: shellac, acrylic, polystyrene, etc.
7. Making the secondary impression.
   - Border moulding using green stick compound.
   - Recording the posterior palatal seal
   - Trimming the excess green stick compound.
   - Scraping out the wax spacer in the special tray.
   - Providing relief holes over areas where additional relief is required
   - Making the secondary impression using zinc oxide eugenol Impression paste.
8. Pouring the master cast.
   - Beading the secondary impression using Beading/ modelling wax.
   - Boxing the secondary impression using Boxing or modelling wax.
   - Pouring the master cast using Dental stone.
9. Fabricating the temporary denture base using shellac or acrylic.
   Fabricating occlusal rims using modelling wax.
10. Recording the tentative jaw relation
    - Vertical jaw relation
    - Centric or Horizontal jaw relation
11. Orientation relation using face-bow
12. Face bow transfer and Articulation
13. Attaching the tracers to the occlusal rims
14. Performing the gothic arch tracing to determine the true centric relation
15. Remounting the mandibular cast according to the true centric relation
16. Protrusive and lateral inter occlusal records are made in eccentric relations
17. The articulator is programmed according to the inter-occlusal records
18. Anterior teeth arrangement
19. Anterior Try-in
20. Posterior teeth arrangement in balanced occlusion.
21. Try-in Verification
22. Wax-up
23. Processing the denture
24. Finishing the denture
25. Insertion
    - Check for proper fit and function.
    - Give proper instructions
    - Recall after 24 hours to check immediate changes.
    - Refine occlusal discrepancies if any.
    - Call for review after a week.
    - Recall every 3 to 6 months for review.

Chapter 2
Diagnosis and Treatment Planning

- **Diagnosis**
- **Patient Evaluation**
- **Clinical History Taking**
- **Clinical Examination of the Patient**
- **Radiographic Examination**
- **Treatment Plan**
- **Adjunctive Care**
- **Prosthodontic Care**

2

Diagnosis and Treatment Planning

Diagnosis and treatment planning are the most important parameters in the successful management of a patient. Inadequate diagnosis and treatment planning are the major reasons behind the failure of a complete denture.

The following factors should be evaluated to arrive at a proper diagnosis and treatment planning.

DIAGNOSIS:

- Patient Evaluation
  - Gait
  - Age of the patient
  - Sex
  - Complexion
  - Cosmetic Index
  - Mental Attitude
- Clinical history taking:
  - Name
  - Age
  - Sex
  - Occupation
  - Race
  - Location
  - Religion
  - Dental History
    - — Chief Complaint
    - — Expectations
    - — Period of Edentulousness
    - — Pre-treatment Records:
    - • Previous Denture
    - • Current Denture
    - • Pre-extraction Records
    - • Diagnostic Casts
    - — Denture Success
  - Medical History
    - — Debilitating Diseases
    - — Diseases of the Joints
    - — Cardiovascular Diseases
    - — Diseases of the Skin
    - — Neurological Disorders
    - — Oral Malignancies
    - — Climacteric Conditions
- Clinical Examination of the Patient
  - Extraoral:
    - — Facial examination:
      - – Facial Form
      - – Facial Features
    - — Muscle Tone
    - — Muscle Development
    - — Complexion
    - — Lip Examination
    - — TMJ Examination
    - — Neuromuscular Examination
      - – Speech
      - – Co-ordination
  - Intraoral:
    - — Existing teeth (If any)
    - — Mucosa:
      - – Colour of the mucosa
      - – Condition of the Mucosa
      - – Thickness
    - — Saliva
    - — Residual Alveolar Ridge:
      - – Arch Size
      - – Arch Form
      - – Ridge Contour
      - – Ridge Relation
      - – Ridge Parallelism
      - – Inter-arch Space
    - — Ridge Defects
    - — Redundant Tissue
    - — Hyperplastic Tissue
    - — Hard palate
    - — Soft palate and Palatal Throat Form
    - — Lateral Throat Form
    - — Gag Reflex
    - — Bony Undercuts
    - — Tori
    - — Muscle and Frenum Attachments
      - – Border Attachments of the Mucosa
      - – Frenal Attachments
    - — Tongue
    - — Floor of the Mouth
- Radiographic Examination
  - Bone Quality
- Examination of the Existing Prosthesis

TREATMENT PLANNING:

- Adjunctive care:
  - Elimination of Infection
  - Elimination of Pathosis

- Pre-prosthetic Surgery
- Tissue Conditioning
- Nutritional Counselling
- Prosthodontics care

- Patients destined to be edentulous:
  — Immediate or Conventional Denture
  — Definitive or Interim Denture
  — Implant or Soft Tissue Supported Denture
- Patients already edentulous:
  — Soft Tissue Supported
  — Implant Supported (Fixed or Removable)
  — Material of Choice
  — Selection of Teeth
  — Anatomic Palate

DIAGNOSIS

Essential diagnostic data obtained from patient interview, definitive oral examination, consultation with medical and dental specialists, radiographs, mounted and surveyed diagnostic casts should be carefully evaluated during treatment planning.

PATIENT EVALUATION

Patient evaluation is the first step to be carried out in treating a patient. The dentist should begin evaluating the patient as soon as he/she enters the clinic. This is to obtain a clear idea of what type of treatment is necessary for the patient.

Gait

The dentist should note the way the patient walks into the clinic. People with neuromuscular disorders show a different gait. Such patients will have difficulty in adapting to the denture.

Age

The decade, which the patient belongs to, is important to predict the outcome of treatment. For example patients belonging to the fourth decade of life will have good healing abilities and patients above the sixth decade will have compromised healing.

Sex

Male patients are generally busy people who appear indifferent to the treatment. They are only bothered about comfort and nothing else. On the other hand, female patients are more critical about aesthetics and they usually appear to overrule the dentist in treatment planning.

Complexion and Personality

Evaluating the complexion helps to determine the shade of the teeth. Executives require smaller teeth. More details are discussed under selection of teeth in Chapter 10.

Cosmetic Index

It basically speaks about the aesthetic expectations of the patient. Based on the cosmetic index, patients can be classified as:

Class I: High cosmetic index. They are more concerned about the treatment and wonder if their expectations can be fulfilled.

Class II: Moderate cosmetic patients. They are patients with nominal expectations.

Class III: Low cosmetic index. These patients are not bothered about treatment and the aesthetics. It is very difficult for the dentist to know if the patient is satisfied with the treatment or not.

Mental Attitude of Patients

De Van stated, *"meet the mind of the patient before meeting the mouth of the patient"*. Hence, we understand that the patient's attitudes and opinions can influence the outcome of the treatment.

A doctor should evaluate the patient's hair colour, height, weight, gait, behaviour, socio-economic status, etc right from the moment he/she enters the clinic. A brief conversation will reveal his/her mental attitude. Actually patient evaluation is done along with history taking but since it is usually begun prior to history taking, we have discussed it in detail here.

Based on their mental attitude, patients can be grouped under two classifications. Dr. MM House proposed the first one in 1950, which is widely followed.

House's Classification

Dr.MM House in 1950 classified patient's psychology into four types:

Class I: Philosophical

a. Those who have presented themselves prior to the extraction of their teeth, have had no experience in wearing dentures, and do not anticipate any special difficulties in that regard.

b. Those who have worn satisfactory dentures, are in good health, are a well-balanced type, and are in need of further denture service.

Generally they can be described as easy-going, congenial, mentally well adjusted, cooperative and confident of the dentist. These patients have excellent prognosis.

Class II: Exacting

a. Those who, while suffering from ill health, are seriously concerned about appearance and efficiency of artificial dentures. They are reluctant to accept the advice of the physician and the dentist and are unwilling to submit to the removal of their artificial teeth.

b. Those wearing dentures unsatisfactory in appearance and usefulness, and who doubt the ability of the dentist to render a satisfactory treatment, and those who insist on a written guarantee or expect the dentist to make repeated attempts to please them.

These patients are precise, above average in intelligence, concerned in their dress and appearance, usually dissatisfied by their previous treatment, do not have confidence in the dentist. It is very difficult to satisfy them. But once satisfied they become the dentist's greatest supporter.

Class III: Hysterical

a. Those in bad health with long neglected pathological mouth conditions and who are positive in their minds that they can never wear dentures. They are emotionally unstable and tend to complain without justification.

b. Those who have attempted to wear dentures but failed. They are thoroughly discouraged. They are of a hysterical, nervous, very exacting temperament and will demand efficiency and appearance from the dentures equal to that of the most perfect natural teeth. Unless their mental attitude is changed it is difficult to give a successful treatment.

These patients do not want to have any treatment done. They come out of compulsion from their relatives and friends. They have a highly negative attitude to the dentist and the treatment. They have unrealistic expectations and want the dentures to be better than their natural teeth. They are the most difficult patients to manage. They show poor prognosis.

Class IV: Indifferent

Those who are unconcerned about their appearance and,feel very little or no necessity for teeth for mastication. They are, therefore uncooperative and will hardly try to become accustomed to dentures. They will not maintain the dentures properly and do not appreciate the efforts and skills of the dentist.

Classification II

Patients may also be classified under the following categories:

Cooperative These patients represent the optimum group. They may or may not recognize the need for dentures but they are open-minded and are amenable to suggestion. Procedures can be explained with very little effort and they become fully cooperative.

Apprehensive Even though these patients realize the need for dentures they have some irrational problem, which cannot be overcome by ordinary explanation. The approach to all of these patients is to talk with them and to make them speak out their thoughts about dentures.

Apprehensive patients are of different types namely:

Anxious These patients are anxious and upset about the uncertainities of wearing dentures. They often put themselves into a neurotic state. In extreme and rare cases they may be psychotic.

Frightened Some fear the development of cancer; others fear that they will not be able to wear the teeth; still others fear that the teeth will not look well. Extreme cases should be referred to a psychiatrist.

Obsessive or exacting These persons are naturally of an exacting nature and are accustomed to giving directions to others. They state their wants and are inclined to tell the dentist how to proceed. Patients of this type must be handled firmly. They should be told tactfully at the outset that they would not be allowed to direct the denture construction.

Chronic complainers They are a group of people who are habitually faultfinding and dissatisfied. Appreciating their cooperation and incorporating as many of their ideas as possible with good denture construction is the best way to handle them. It is best to have an understanding with such patients before work commences. In this way they are made to share responsibility for the outcome.

Self-conscious The apprehension here centres chiefly on appearance. It is wise to give overt reassurance to the self-conscious patient and permit participation in the reconstruction as far as feasible in order to establish some responsibility in the result.

Uncooperative

These patients present themselves usually upon being urged by relatives or friends. They do not feel a need for dentures, though the need exists. Their general attitude is negative. They constitute an extremely difficult group of potential denture wearers and tax the dentist's patience to the limit. In many cases, an attempt to make dentures for these individuals is a waste of time.

Along with analyzing the mental attitudes of the patient, the dentist must collect information about the patient's habits, diet, past dental history and the physical characteristics, etc. The expectations of the patient should be taken into consideration to achieve patient satisfaction.

CLINICAL HISTORY TAKING

History taking is a systematic procedure for collecting the details of the patient to do a proper treatment planning. Personal and medical particulars are gathered to rule out general diseases and to determine the best form of treatment for that patient.

Name

The name should be asked to enter it in the record. When the patient is addressed by his name, it brings him some confidence and psychological security. The name also gives an idea about the patient's family and community.

Age

The importance of knowing the age was discussed in patient evaluation. Some diseases are limited to certain age groups. Hence, age can be used to rule out certain systemic conditions apart from determining the prognosis.

Sex

The importance of knowing the sex was also discussed in patient evaluation. Generally the mentality of the patient is affected by the gender. Again certain diseases are confined to a particular sex. Hence, sex can also be used to rule out certain systemic conditions.

Occupation

Executives and sales representatives require more idealistic teeth. While other people who work in places with high physical exertion require rugged teeth. And people with higher income have greater expectations. People who are very busy will be more critical about comfort.

Race

It helps to select the shade of the teeth.

Location

Some endemic disorders like fluorosis are confined to certain localities. People from that locality may want characterization (pattern staining) in their teeth for a natural appearance.

Religion and Community

Gives an idea about the dietary habits and helps to design the denture accordingly.

Medical History

The following medical conditions should be ruled out before beginning the prosthetic treatment.

Debilitating Diseases

Complete denture patients, most of whom are geriatric, are bound to be suffering from debilitating diseases like diabetes, blood dyscrasias and tuberculosis. These patients require specific instructions on denture/tissue care. They also require special follow-up appointments to observe the response of the soft tissues to the denture.

Diabetic patients show excessive rate of bone resorption, hence, frequent relining may be necessary.

Diseases of the Joints

The most common disease of the joint in old age is osteoarthritis. Complete denture patients with osteoarthritis affecting the finger joints may find it difficult to insert and clean dentures.

Osteoarthritis plays an important role in complete denture construction when it affects the TMJ. With limited mouth opening and painful movements of the jaw, it becomes necessary to use special impression trays. It may also become necessary to repeat jaw relations and make post-insertion occlusal adjustments due to changes in the joint.

Cardiovascular Diseases

It is always advisable to consult the patient's cardiologist before commencing treatment. Cardiac patients will require shorter appointments.

Diseases of the Skin

Skin diseases like Pemphigus have oral manifestations, which vary, from ulcers to bullae. Such painful conditions, make the denture use impossible without medical treatment. Constant use of the prosthesis should be discouraged for these patients.

Neurological Disorders

Diseases such as Bell's palsy and Parkinson's disease can influence denture retention and jaw relation records. Patients should understand the difficulty in denture fabrication and usage.

Oral Malignancies

Some complete denture patients with oral malignancies may require radiation therapy before prosthetic treatment. A *waiting period* should elapse between the end of radiation therapy and the beginning of complete denture construction. Only the radiotherapist determines this waiting period. Tissues having bronze colour and loss of tonicity are not suitable for denture support. Once the dentures are constructed, the tissues should be examined frequently for radionecrosis.

Climacteric Conditions

Climacteric conditions like menopause can cause glandular changes, osteoporosis and psychiatric changes in the patient. These can influence treatment planning and the efficiency of the complete denture.

Dental History

Although other sections in history are important, dental history is the most important all of them.

Chief Complaint

It should be recorded in the patient's own words. It gives ideas about the patient's psychology.

Expectations

The patient should be asked about his/her expectations. The dentist should evaluate the patient's expectations and classify them as realistic or attainable and unrealistic.

Period of Edentulousness

This data gives information about the amount and pattern of bone resorption. The cause for the tooth loss should be enquired (caries, periodontitis, etc.)

Pre-treatment Records

The pre-treatment record is a very valuable information. Pre-treatment records include information about the previous denture, current denture, pre-extraction records and diagnostic casts.

Previous denture It denotes the dentures, which were worn before the current denture. The reason for the failure of the prosthesis should be enquired with the patient. The patients who keep changing dentures in a short period of time are difficult to satisfy and are risky to deal with.

Current denture The existing denture, which is worn by the patient at present, should be examined thoroughly. The reason for wanting a replacement should be evaluated. This denture gives us information about the denture experience, denture care, dental knowledge and parafunctional habits of the patient.

The following factors should be noted on the existing prosthesis:

- The period for which the patient has been wearing the denture should be determined. The amount of ridge resorption should be assessed to determine the amount of expected ridge resorption after placement of the new prosthesis.
- Anterior and posterior teeth shade, mould and material.
- Centric occlusion and also the patient profile in centric relation. (*Centric occlusion is "the centered contact position of the occlusal surfaces of the mandibular teeth against the occlusal surfaces of the maxillary teeth"* -GPT). It should be marked as *acceptable* or *unacceptable*.
- Vertical dimension at occlusion. It should be marked as *acceptable* or *unacceptable*.
- Plane of orientation of the occlusal plane. Improperly-oriented plane will have teeth arranged in a reverse smile line (Fig. 2.1).
- The tissue surface and the polished or *cameo surface* of the palate should be examined. Reproduction of rugae should be noted.
- The patient's speech pattern should be noted for any valving *nasal twang*.

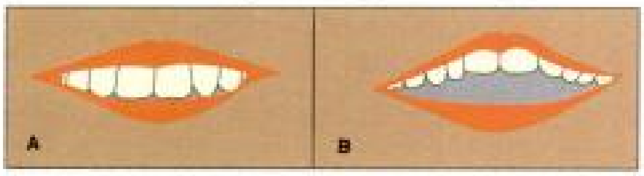


Fig. 2.1: (a) Normal smile line (b) Reverse smile line

- The posterior extension of the maxillary denture should be noted.
- The posterior palatal seal should be examined. It should be marked as *acceptable* or *unacceptable*.
- Proper basal seat coverage and adaptation should be noted. It should be marked as acceptable or unacceptable
- The midline of the denture should be checked. At-least the maxillary denture should coincide with the facial midline. If there is deviation, the distance should be recorded. It should be marked as *acceptable* (less than 2 mm deviation) or *unacceptable* (more than 2 mm deviation) (Fig. 2.2).

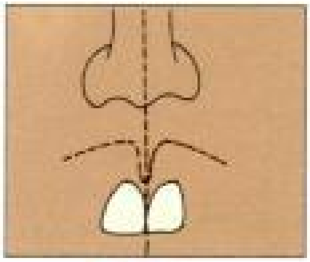


Fig. 2.2

- The amount of space in the buccal vestibule should be examined. It should be marked as *acceptable* or *unacceptable*.
- Presence of cross-bite should be checked. It should be recorded as *none, unilateral* and *bilateral*.
- Characterization or purposeful staining of the denture for esthetics should be recorded.
- Patient's comfort should be enquired. It should be marked as *acceptable* or *unacceptable*.
- The denture maintenance should be evaluated. It can be classified as:
  1. Good
  2. Fair
  3. Poor
- Wear or breakage. This may be an indication of bruxism. Denture wear can be classified as:
  1. Minimal
  2. Moderate
  3. Severe.

- Retention and stability of the denture should be examined.
- Attachments and other components in overdenture patients should be examined.

Pre-extraction records It includes pre-extraction radiographs, photographs, diagnostic casts, etc. They can be used to reproduce the anterior aesthetics. They can also be used to guide jaw relation (Chapter 9).

Diagnostic cast Sometimes, intraoral examination may be inaccurate because the patient keeps moving his jaws and altering ridge relationship. In such cases it may be necessary to prepare diagnostic casts and mount them in an articulator in a tentative jaw relation. This set-up serves to assess the inter-ridge space, ridge form and ridge shape.

Denture success The patients should be asked about the aesthetics and functioning of the existing denture. Based on the patient's comment, the denture success should be classified as *favourable* or *unfavourable*.

CLINICAL EXAMINATION OF THE PATIENT

It includes extraoral and intraoral examination.

Extraoral Examination

The patient's head and neck region should be examined for any pathological condition. Facial colour, tone, hair color and texture, symmetry and neuromuscular activity are noted. It includes facial examination, examination of muscle tone and development, lip examination, TMJ examination and neuromuscular examination.

Facial Examination

It includes the evaluation of facial features, facial form, facial profile and lower facial height.

Facial Features The following features on the face should be noted during diagnosis of the patient:

Perioral features:

- Length of the lips.
- Lip fullness.
- Apparent support of the lips.
- Philtrum.
- Nasolabial fold.
- Mentolabial sulcus or labiomental groove.
- Labial commissures and modiolus.
- Width of the vermillion border. It influences the degree of tooth display.
- Size of the oral opening. It also influences the degree of tooth display.
- Texture of the skin: (rough or smooth and light colour). Rough texture skin will require the placement of rugged teeth. Wrinkles on the cheeks show decrease in vertical dimension. All the above-mentioned factors aid to determine the shade, shape and arrangement of teeth (Fig. 2.3).

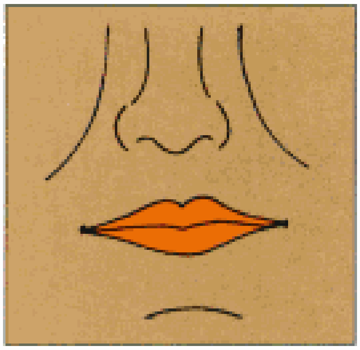


Fig. 2.3

Facial form House and Loop, Frush and Fisher, and Williams classified facial form based on the outline of the face as square, tapering, square tapering and ovoid. Examining the facial form helps in teeth selection (Figs 2.4 to 2.7).

Facial profile Examination of the facial profile is very important because it determines the jaw relation and occlusion. Angle classified facial profile as:

Class I: Normal or straight profile (Fig. 2.8).
Class II: Retrognathic profile (Fig. 2.9).
Class III: Prognathic profile (Fig. 2.10).

Lower facial height Determining the lower facial height is important to determine the vertical jaw relation (see jaw relation). For those patients who are already wearing a complete denture, the lower facial height is examined under occlusion. If the face appears collapsed, it indicates the loss of

Fig. 2.4: Square facial form

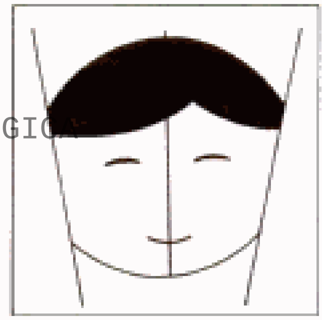


Fig. 2.5: Tapering facial form

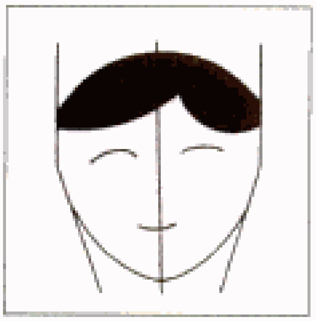


Fig. 2.6: Square tapering facial form

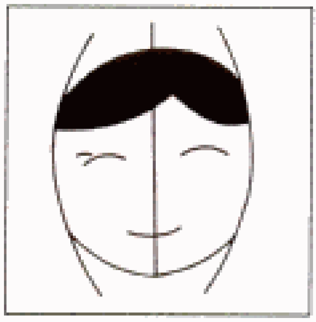


Fig. 2.7: Oval facial form

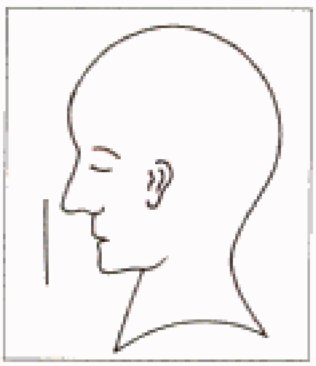


Fig. 2.8: Straight profile

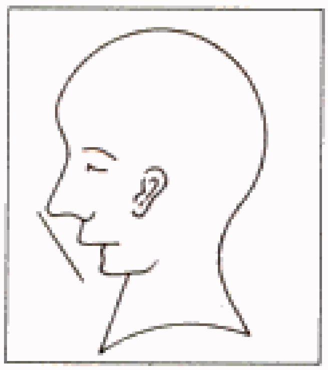


Fig. 2.9: Retrognathic profile

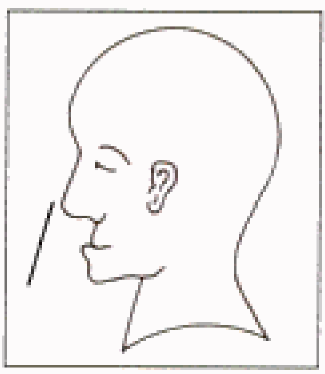


Fig. 2.10: Prognathic profile

vertical dimension (VD). Decreased VD produces wrinkles around the mouth. Excessive VD will cause the facial tissues to appear stretched (Figs 2.11 to 2.13).

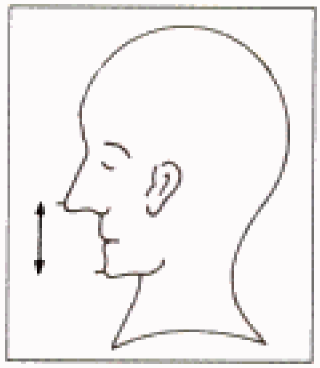


Fig. 2.11: Normal lower facial height

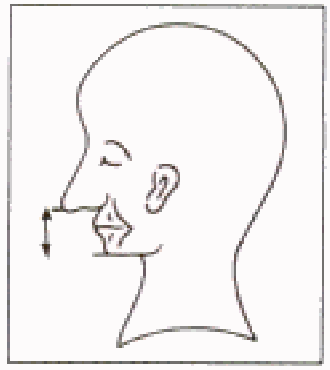


Fig. 2.12: Decreased lower facial height

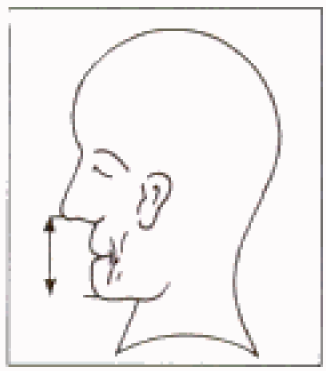


Fig. 2.13: Increased lower facial height

Muscle Tone

Muscle tone can affect the stability of the denture. House classified muscle tone as:

Class I: Normal tension, tone and placement of the muscle of mastication and facial expression. No degeneration. It is common in immediate denture patients because all other patients generally show degeneration.

Class II: Normal muscle function but slightly decreased muscle tone.

Class III: Decreased muscle tone and function. It is usually accompanied with ill-fitting dentures, decreased vertical dimension, decreased biting force, wrinkles in the cheeks and drooping of commissures.

Muscle Development

People with excessive muscle development have more biting force. House classified muscle development as:

Class I: Heavy
Class II: Medium
Class III: Light.

Complexion

The colour of the eye, hair and the skin guide the selection of artificial teeth. Pale skin colour is indicative of anaemia and should be treated.

Lip Examination

- *Lip support:* Based on the amount of lip support, lips can be classified as *adequately supported or unsupported.*
- *Lip mobility:* Based on the mobility, lips are classified as normal (class 1), reduced mobility (class 2) and paralysed (class 3).
- *Thickness of the lips:* Thick lips need lesser support from the artificial teeth and the labial flange. Thus, the operator is free to place the teeth to his wishes. On the other hand, thin lips rely on the appropriate labiolingual position of the teeth, for their fullness and support.
- *Length of the lips:* It is an important determinant in anterior teeth selection. Short lips will tend to reveal more of the tooth structure and also the denture base. Based on the length, lips are classified as long, normal or medium and short.
- *Health of the lips:* The lips are examined for fissures, cracks or ulcers at the corners of the mouth. If present these indicate vitamin B deficiency, candidiasis, or prolonged overclosure of the mouth due to decreased VD.

TMJ Examination

TMJ plays a major role in the fabrication of a CD. The joint should be examined for range of movements, pain, muscles of mastication, joint sounds upon opening and closing. Severe pain in the TMJ indicates increased or decreased VD.

Neuromuscular Examination

It includes the examination of speech and neuromuscular coordination.

Speech Speech is classified based on the ability of the patients to articulate and coordinate it.

Type 1: Normal. Patients who are capable of producing an articulated speech with their existing dentures can easily accommodate to the new dentures.

Type 2: Affected. Patients who have impaired articulation or coordination of speech with their existing dentures require special attention during anterior teeth arrangement (setting).

Patients whose speech was altered due to a poorly-designed denture require more time to adapt to a proper articulated speech in the new denture. They also fall under affected speech.

Neuromuscular coordination The patient is to be observed from the time he/she enters the clinic. The patient's gait, coordination of movements, the ease with which he moves and his steadiness are important points to be considered.

Any deviation from the normal will indicate that the patient is suffering from neuromuscular diseases like Parkinson's disease, hemiplegia, cerebellar disease or even the use of psychotropic drugs. These conditions also produce their manifestations on the face.

Facial movements have to be noted as much as bodily movements. Abnormal facial movements like lip smacking, tongue tremors, uncontrollable chewing movements can influence complete denture performance and may also lead to prosthetic failure.

Patients with good neuromuscular coordination can easily learn to manipulate dentures. Neuromuscular coordination of a patient can be classified as:

Class I: Excellent.
Class II: Fair.
Class III: Poor.

Intraoral Examination

Existing Teeth

The condition of the existing teeth is of importance for single complete dentures. The state of the remaining teeth influence the success of tooth-supported overdentures. The diagnosis and treatment planning for a overdenture is discussed in detail in Chapter 13.

Mucosa

The colour, condition and the thickness of the mucosa should be examined.

Colour of the mucosa The mucosa should have a healthy pink colour. Any amount of redness indicates an inflammatory change. This may be due to ill-fitting denture, smoking, infection or a systemic disease. Inflamed tissues provide a wrong recording while making an impression. Other colour changes such as white patches should be noted, as this might indicate an area of frictional keratosis.

Condition of the mucosa House classified the condition of the mucosa as:
Class I: Healthy mucosa.
Class II: Irritated mucosa.
Class III: Pathologic mucosa.

Thickness of the mucosa The quality of the mucoperiosteum may vary in different parts of the arch. Variations in the thickness of mucosa make it very difficult to equalize the pressure under the denture and to avoid soreness. House classified thickness of the mucosa as:

Class I: Normal uniform density of mucosal tissue (approximately 1 mm thick). Investing membrane is firm but not tense and forms the ideal cushion for the basal seat of the denture (Fig. 2.14).

Class II: (Fig. 2.15). It can be of two types:

a. Soft tissues have a thin investing membrane and are highly susceptible to irritation under pressure.
b. Soft tissues have mucous membranes that are twice the normal thickness.

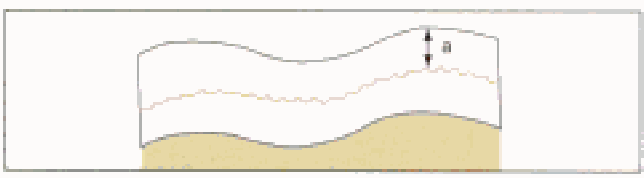


Fig. 2.14: Class I normal mucosa

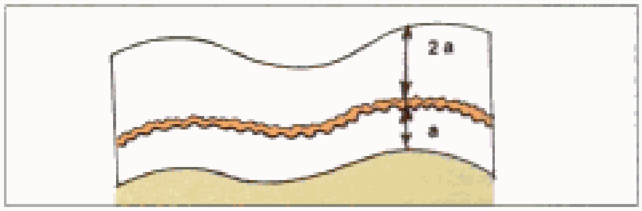


Fig. 2.15: Class II mucosa. Which is twice in thickness

Class III: Soft tissues have excessively thick investing membranes filled with redundant tissues. This requires tissue treatment (Fig. 2.16).

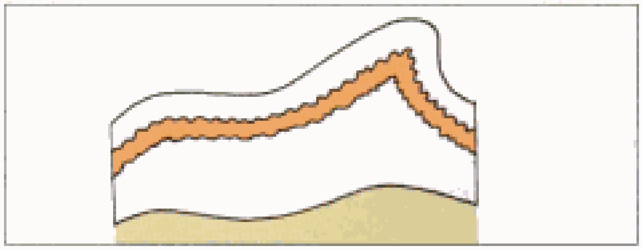


Fig. 2.16: Class III excessively thick mucosa where surgical treatment is mandatory

Saliva All major salivary gland orifices should be examined for patency. The viscosity of the saliva should be determined. Saliva can be classified as:

Class I: Normal quality and quantity of saliva. Cohesive and adhesive properties are ideal.

Class II: Excessive saliva. Contains much mucus.

Class III: Xerostomia. Remaining saliva is mucinous.

Thick ropy saliva alters the seat of the denture because of its tendency to accumulate between the tissue and the denture. Thin serous saliva does not produce such effects.

Xerostomic patients show poor retention and excessive tissue irritation wheras excessive salivation complicates the clinical procedures.

Residual Alveolar Ridge

While examining the residual alveolar ridge the arch size, shape, inter-arch space, ridge contour, ridge relation and ridge parallelism should be noted.

Arch size Arch should be observed for two main reasons:

- Denture bearing area increases with arch size and in turn increases the retention.
- Discrepancy between the mandibular and maxillary arch sizes can lead to difficulties in artificial teeth-arrangement and decrease the stability of the denture resting in the smaller one of the two arches.

Arch size can be classified as follows:

Class I: Large (ideal retention and stability) (Fig. 2.17).

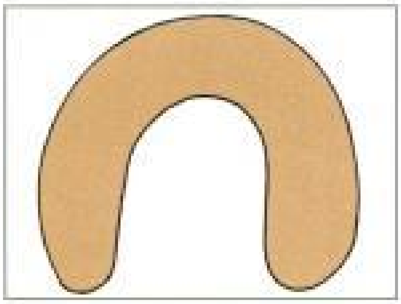


Fig. 2.17: Large size arch

Class II: Medium (good retention and stability) (Fig. 2.18).

Class III: Small (difficult to achieve good retention and stability) (Fig. 2.19).

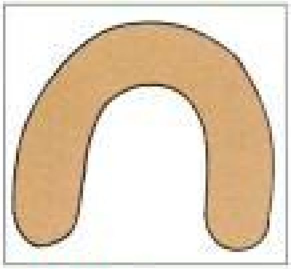


Fig. 2.18: Medium size arch

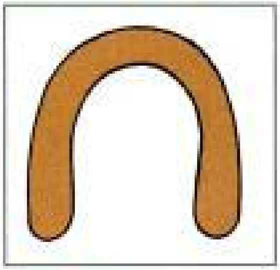


Fig. 2.19: Small size arch

Arch form This plays a role in support of a denture and in tooth selection. The various arch forms are *square ovoid* and *tapered*. Discrepancies between the maxillary and mandibular arch forms can create problems during teeth setting.

House classified arch form as:

Class I: Square (Fig. 2.20)

Class II: Tapering (Fig. 2.21)

Class III: Ovoid (Fig. 2.22).

Ridge contour Ridges should be both inspected and palpated. The ridge should be palpated for

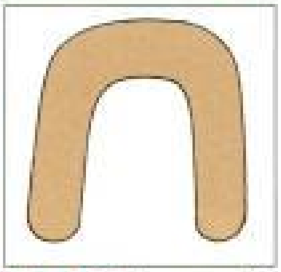


Fig. 2.20: Square arch form

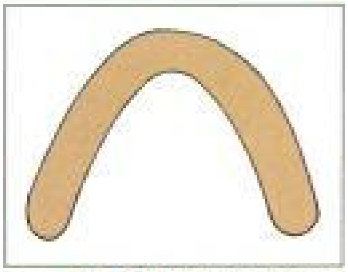


Fig. 2.21: Tapering arch form

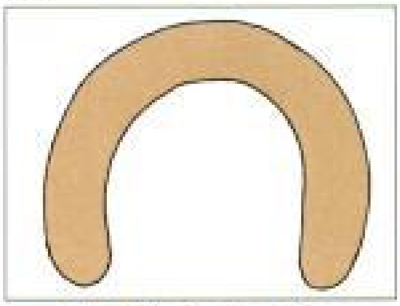


Fig. 2.22: Oval arch form

bony spicules which produce pain on palpation. Ridges can be classified as based on their contour as:

- *High ridge with flat crest and parallel sides* (most ideal) (Fig. 2.23).
- *Flat ridge* (Fig. 2.24).
- *Knife-edged ridge* (Fig. 2.25).

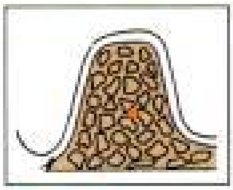


Fig. 2.23: High ridge

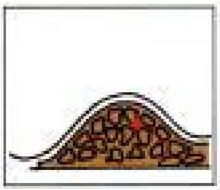


Fig. 2.24: Flat ridge

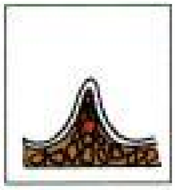


Fig. 2.25: Knife edge ridge

There is another classification for ridge contour. According to that classification, the maxillary and mandibular ridges are classified separately.

Classification of maxillary ridge contour:

Class I: Square to gently rounded.

Class II: Tapering or 'V' shaped.

Class III: Flat.

Classification of mandibular ridge contour:

Class I: Inverted 'U' shaped (parallel walls, medium to tall ridge with broad ridge crest) (Fig. 2.26).

Class II: Inverted 'U' shaped (short with flat crest) (Fig. 2.27).

Class III: Unfavourable

- Inverted 'W' (Fig. 2.28).
- Short inverted 'V' (Fig. 2.29).
- Tall, thin inverted 'V' (Fig. 2.30).
- Undercut (results due to labioversion or linguoversion of the teeth (Fig. 2.31).

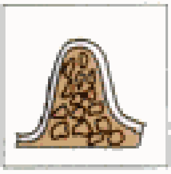


Fig. 2.26: Rounded square ridge contour

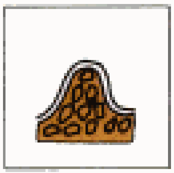


Fig. 2.27: Inverted 'U' shaped ridge contour

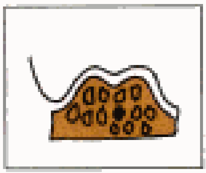


Fig. 2.28: Inverted 'W' shaped ridge contour

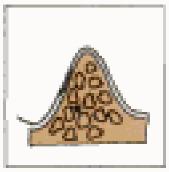


Fig. 2.29: Short inverted 'V' shaped ridge contour

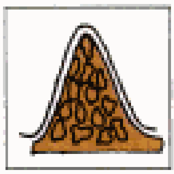


Fig. 2.30: Tall thin inverted 'V' shaped ridge contour

Fig. 2.31: Undercut ridge contour

Ridge relation Ridge relation is defined as, "*The positional relation of the mandibular ridge to the maxillary ridge*" - GPT.

While examining ridge relation, the pattern of resorption of the maxillary and mandibular arches should be remembered *(maxilla resorbs upward and inward while the mandible resorbs downward and outward).*

Ridge relation refers to the anterior posterior relationship between the ridges. Angle classified ridge relationship.

Class I: Normal (Fig. 2.32).

Class II: Retrognathic (Fig. 2.33).

Class III: Prognathic (Fig. 2.34).

Ridge parallelism Ridge parallelism refers to the relative parallelism between the planes of the ridges. The ridges can be parallel or non-parallel. Teeth setting is easy in parallel-ridges.

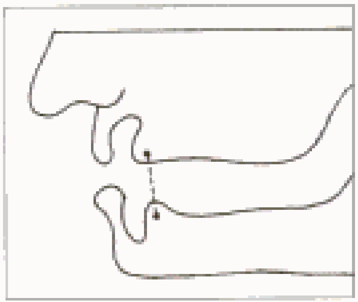


Fig. 2.32: Normal ridge relation

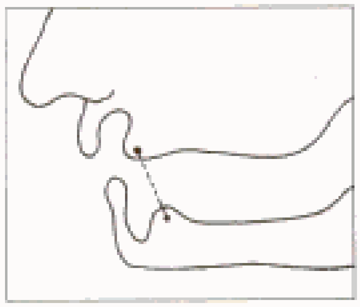


Fig. 2.33: Retrognathic ridge relation

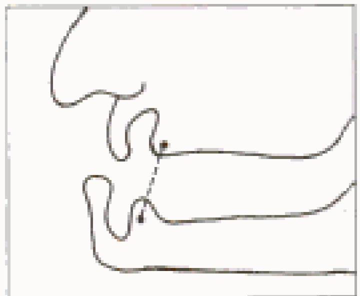


Fig. 2.34: Prognathic ridge relation

Ridge parallelism can be classified as:

Class I: Both ridges are parallel to the occlusal plane (Fig. 2.35).

Class II: The mandibular ridge diverts from the occlusal plane anteriorly (Fig. 2.36).

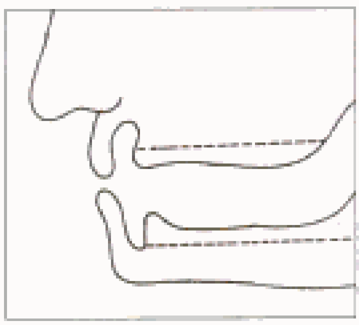


Fig. 2.35: Normal ridge parallelism

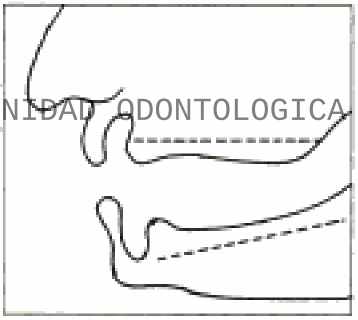


Fig. 2.36: Anterior deviation of mandible

Class III: Either the maxillary ridge diverts from the occlusal plane anteriorly or both ridges divert from the occlusal plane anteriorly (Fig. 2.37).

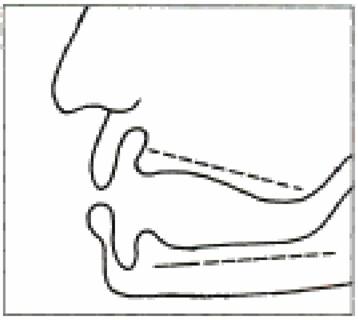


Fig. 2.37: Anterior deviation of maxilla

Inter-arch space The amount of inter-arch space should be measured and recorded. Increase in inter-arch space will be due to excessive residual ridge resorption. These patients will have decreased retention and stability of their dentures.

Decrease in inter-arch space will make teeth-arrangement a difficulty. However, stability of the denture is increased in these patients due to decrease in leverage forces acting on the denture. *Inter-arch space can be classified as follows:*

Class I: Ideal inter-arch space to accommodate the artificial teeth (Fig. 2.38).

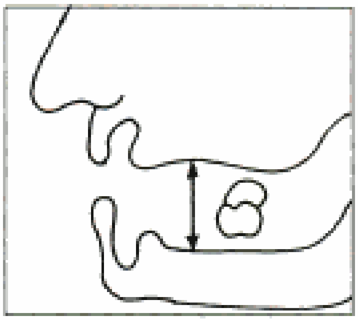


Fig. 2.38: Class I inter-arch space

Class II: Excessive inter-arch space (Fig. 2.39).

Class III: Insufficient inter-arch space to accommodate the artificial teeth (Fig. 2.40).

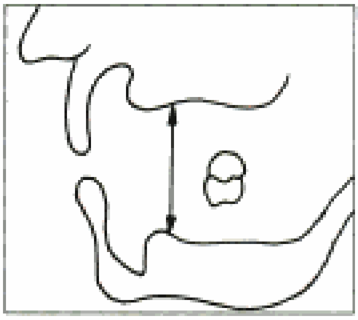


Fig. 2.39: Class II inter-arch space

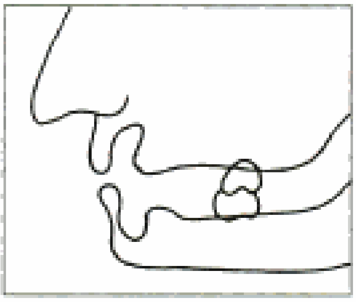


Fig. 2.40: Class III inter-arch space

Ridge Defects

Ridge defects include exostosis and pivots that may pose a problem while fabricating a complete denture.

Redundant Tissue

It is common to find flabby tissue covering the crest of the residual ridges. These movable tissues tend to cause movement of the denture when forces are applied. This leads to loss of retention.

Hyperplastic Tissues

The most common hyperplastic lesions are epulis fissuratum, papillary hyperplasia of the mucosa and hyperplastic folds. Treatment for these lesions includes rest, tissue conditioning and denture adjustments. Surgery is considered if the above mentioned treatments fail.

Hard Palate

The shape of the vault of the palate should be examined. *Hard palates can be classified as:*

- *U-shaped:* Ideal for both retention and stability (Fig. 2.41).
- *V-shaped:* Retention is less, as the peripheral seal is easily broken (Fig. 2.42).
- Flat: Reduced resistance to lateral and rotatory forces (Fig. 2.43).

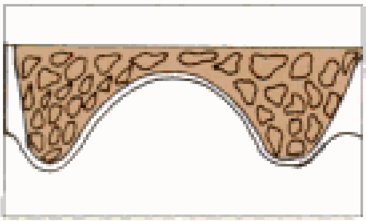


Fig. 2.41: 'U' shaped palate

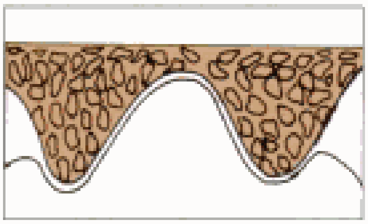


Fig. 2.42: 'V' shaped palate

Fig. 2.43: Flat palate

Soft Palate and Palatal Throat Form

While examining soft palates, it is important to observe the relationship of the soft palate to the hard palate. The relationship between the soft palate and the hard palate is called *palatal throat form*. On this basis, soft palates can be classified as:

Classification of soft palates

Class I: It is horizontal and demonstrates little muscular movement. In this case more tissue coverage is possible for posterior palatal seal (Fig. 2.44).

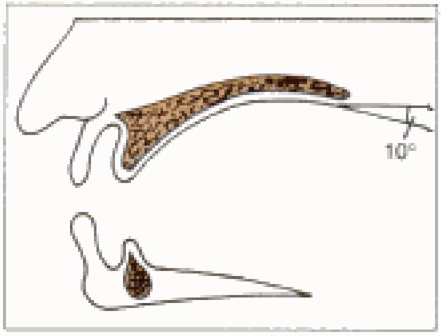


Fig. 2.44: Class I soft palate (10°)

Class II: Soft palate makes a 45° angle to the hard palate. Tissue coverage for posterior palatal seal is less than that of a class I condition (Fig. 2.45).

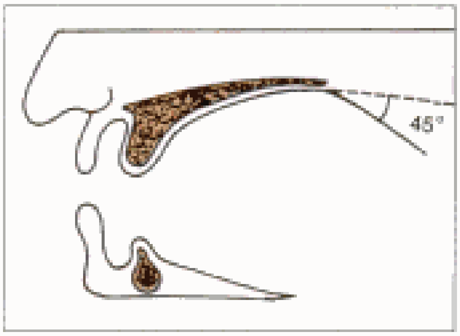


Fig. 2.45: Class II soft palate (45°)

Class III: Soft palate makes a 70° angle to the hard palate. Tissue coverage for posterior palatal seal is minimum (Fig. 2.46).

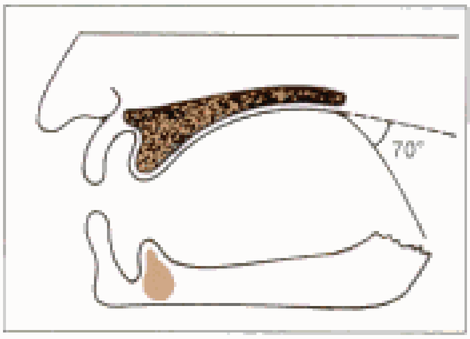


Fig. 2.46: Class III soft palate (70°)

It should be observed here that a class—III soft palate is commonly associated with a V-shaped palatal vault and class—I or class—II soft palates are associated with a flat palatal vault.

Classification of Palatal Throat Forms

House's classification of the relationship between the soft palate and the hard palate is called the *classification of palatal throat forms.* House classified palatal throat forms as:

Class I: Large and normal in form, relatively with an immovable band of tissue 5 to 12 mm distal to a line drawn across the distal edge of the tuberosities (Fig. 2.47).

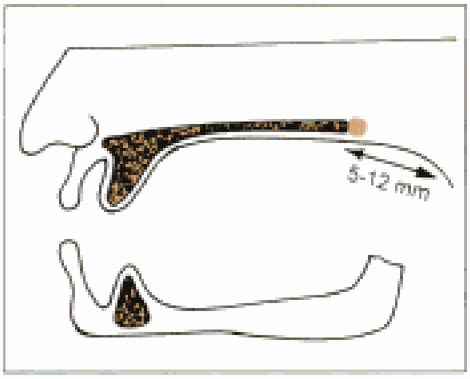


Fig. 2.47: Class I palatal throat form

Class II: Medium sized and normal in form, with a relatively immovable resilient band of tissues 3 to 5 mm distal to a line drawn across the distal edge of the tuberosities (Fig. 2.48).

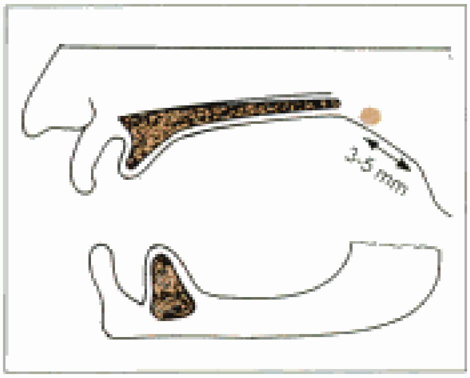


Fig. 2.48: Class II palatal throat form

Class III: Usually accompanies a small maxilla. The curtain of soft tissue turns down abruptly 3 to 5 mm anterior to a line drawn across the palate at the distal edge of the tuberosities (Fig. 2.49).

Lateral Throat Form

Neil classified lateral throat form (retromylohyoid fossa) area as Class—I (Fig. 2.50), Class—II (Fig. 2.51) and Class—III (Fig. 2.52).

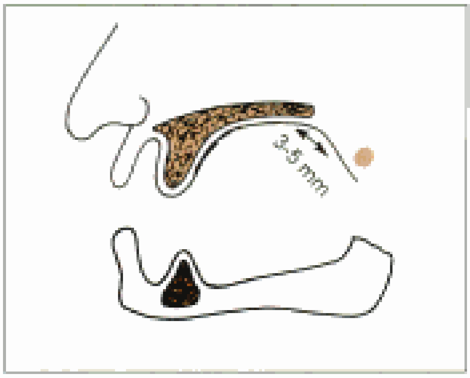


Fig. 2.49: Class III palatal throat form

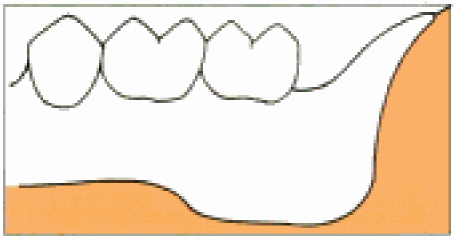


Fig. 2.50: Class I deep lateral throat form

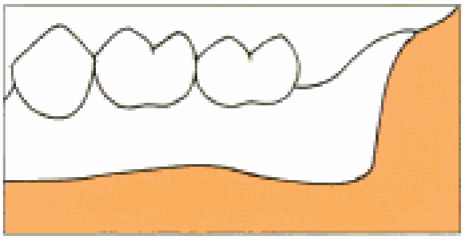


Fig. 2.51: Class II moderate lateral throat form

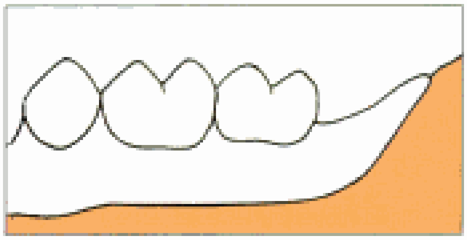


Fig. 2.52: Class III shallow lateral throat form

Gag Reflex and Palatal Sensitivity

Some patients may have an exaggerated gag reflex, the cause of which can be due to a systemic disorder, psychological, extraoral, intraoral or iatrogenic factors. The management of such patients is through clinical, psychological and pharmacological means. If the patient lacks progress he/she should be referred to a specialized consultant.

House classified palatal sensitivity as:

Class I: Normal

Class II: Subnormal (Hyposensitive)

Class III: Supernormal (Hypersensitive)

Bony Undercuts

Bony undercuts do not help in retention, rather they interfere with peripheral seal. Bony undercuts are seen both in the maxilla and the mandible.

In the maxillary arch, they are found in the anterior region and laterally in the region of the tuberosities. In the mandibular arch, the area under the mylohyoid ridge acts as an undercut (Fig. 2.53).

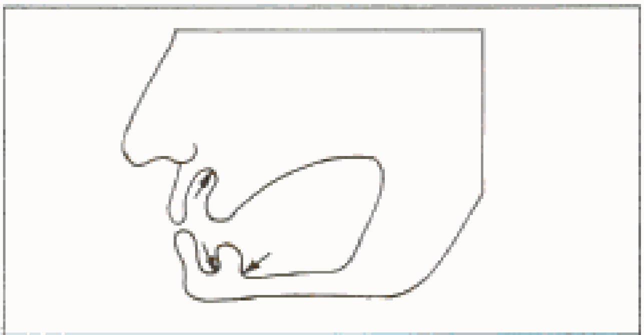


Fig. 2.53: Bony undercuts in the maxilla and mandible

In case of maxillary arch, surgical removal of the undercut is not necessary, providing relief is enough. In case of the mylohyoid ridge, surgical reduction or repositioning of the mylohyoid attachment can be done. Bilateral undercuts should be eleminated.

Tori

Tori are abnormal bony prominences found in the middle of the palatal vault and on the lingual side of the mandible in the premolar region. It is not necessary to remove maxillary tori surgically unless they are very big.

In order to prevent injury to the thin mucosa covering the tori, adequate relief should be provided in that region during complete denture fabrication. Rocking of the denture around the tori will occur in cases with excessive residual ridge resorption.

On the other hand, lingual tori are a constant hindrance to complete denture construction and have to be removed surgically.

Maxillary and mandibular tori can be classified as:

Class I: Tori are absent or minimal in size. Existing tori do not interfere with denture construction (Fig. 2.54).

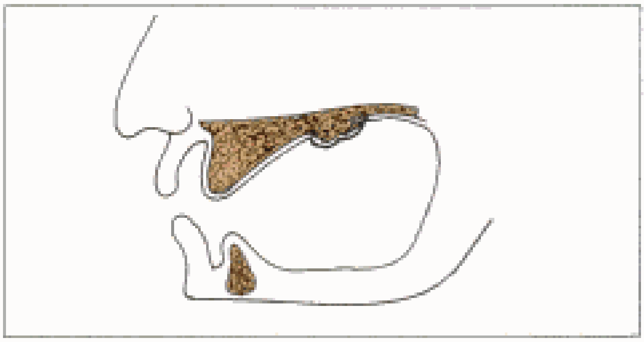


Fig. 2.54: Class I tori

Class II: Clinical examination reveals tori of moderate size. Such tori offer mild difficulty in denture construction and use. Surgery is not required (Fig. 2.55).

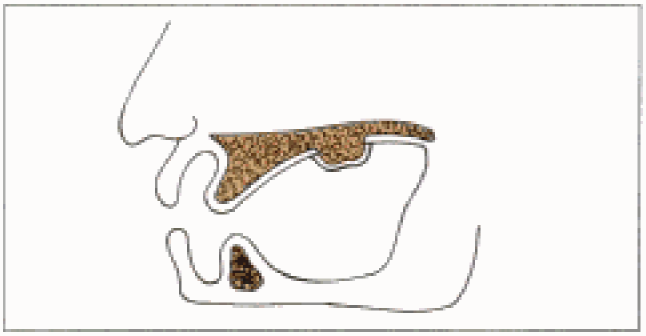


Fig. 2.55: Class II tori

Class III: Large tori are present. These tori compromise the function and fabrication of dentures. Such tori require surgical contouring or removal (Fig. 2.56).

Muscle and Frenal Attachments

Muscular and frenal attachment should be examined for their position in relation to the crest of the ridge. In cases with residual ridge resorption, it is common to see the maxillary labial and

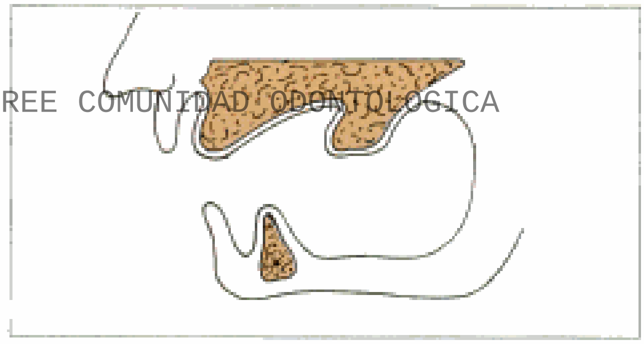


Fig. 2.56: Class III tori

lingual frenal attachments close to the crest of the ridge.

These abnormal attachments can produce displacement of the denture during muscular action. These muscular and frenal attachments should be surgically relocated.

House classified border and frenal attachments.

Classification of border attachments

Class I: Attachments are placed away from the crest of the ridge. There is at least 0.5 inches distance between the attachment and the crest of the ridge (Fig. 2.57).

Class II: Distance between the crest of the ridge and the attachment is around 0.25 to 0.5 inches (Fig. 2.58)

Class III: Distance between the crest of the ridge and the attachment is less than 0.25 inches (Fig. 2.59).

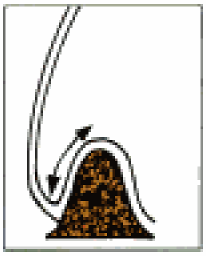


Fig. 2.57: Class I border attachments

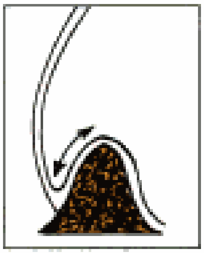


Fig. 2.58: Class II border attachments

Fig. 2.59: Class III border attachments

Classification of frenal attachments

Class I: The frenum is located away from the crest of the ridge (Fig. 2.60)

Class II: The frenum is located nearer to the crest of the ridge (Fig. 2.61)

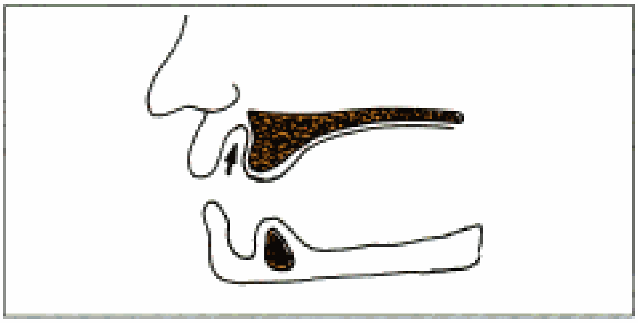


Fig. 2.60: Class I frenal attachment

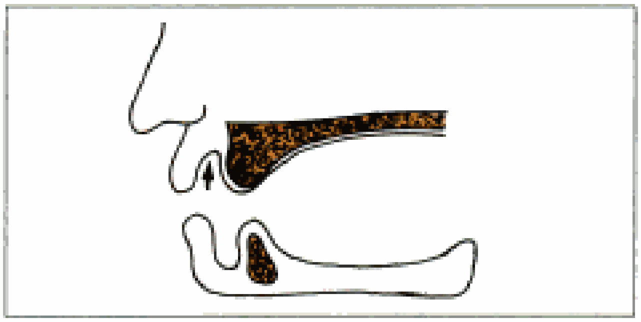


Fig. 2.61: Class II frenal attachment

Class III: Freni encroach the crest of the ridge and may interfere with the denture seal. Surgical correction may be required (Fig. 2.62).

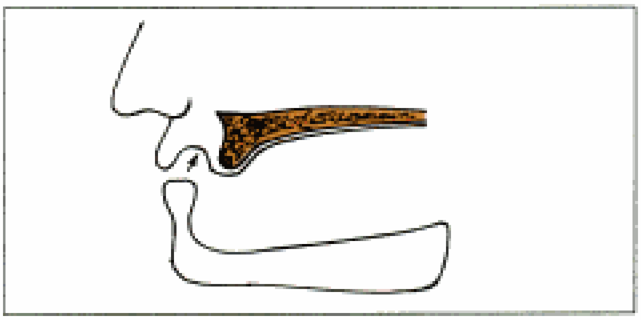


Fig. 2.62: Class III frenal attachment

Tongue

The tongue should be examined for the following:

- *Size:* Presence of a large tongue decreases the stability of the denture and are also a hindrance to impression making. Tongue-biting is common after insertion of the denture. A small tongue does not provide adequate lingual peripheral seal.

- *Movement and coordination:* Tongue movements and coordination are important to register a good peripheral tracing. They are also necessary in maintaining the denture in the mouth during functional activities like speech, deglutition and mastication, etc.

House's classification of tongue sizes

Class I: Normal in size, development and function. Sufficient teeth are present to maintain this normal form and function (Fig. 2.63).

Class II: Teeth have been absent long enough to permit a change in the form and function of the tongue (Fig. 2.64).

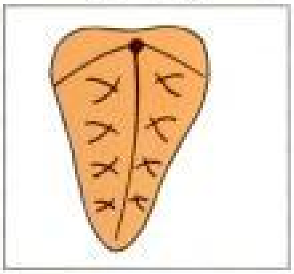


Fig. 2.63: House's class I tongue

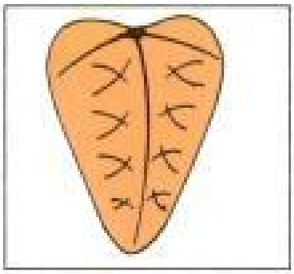


Fig. 2.64: House's class II tongue

Class III: Excessively large tongue. All teeth have been absent for a extended period of time, allowing for abnormal development of the size of the tongue. Insufficient denture can sometimes lead to the development of class— 3 tongue (Fig. 2.65).

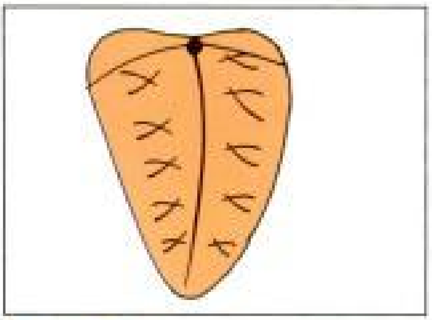


Fig. 2.65: House's class III tongue

Wright's classification of tongue positions

Class I: The tongue lies in the floor of the mouth with the tip forward and slightly below the incisal edges of the mandibular anterior teeth (Fig. 2.66).

Class II: The tongue is flattened and broadened but the tip is in a normal position (Fig. 2.67).

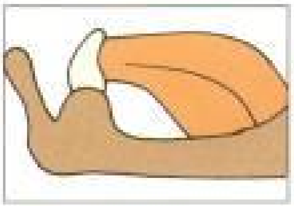


Fig. 2.66: Wright's class I tongue

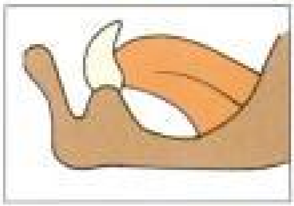


Fig. 2.67: Wright's class II tongue

Class III: The tongue is retracted and depressed into the floor of the mouth, with the tip curled upward, downward or assimilated into the body of the tongue (Fig. 2.68).

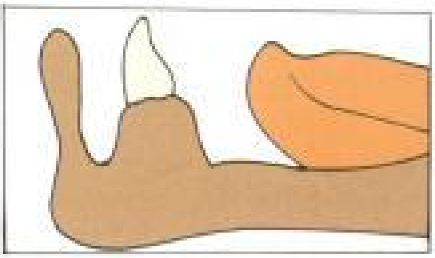


Fig. 2.68: Wright's class III tongue

Class-I position is ideal, because in such a case the floor of the mouth is at an adequate height, hence the lingual flange of the denture contacts it and maintains the peripheral seal of the denture.

This is not the case in class-II and especially class-III. In class-II and class-III cases, the floor of the mouth is too low, hence, the dentist tends to overextend the denture flange. This leads to loss of retention instead of obtaining peripheral seal because the denture flange impinges on the tissue and gets displaced during the activation of the floor of the mouth.

Floor of the Mouth

The relationship of the floor of the mouth to the crest of the ridge is crucial in determining the prognosis of the lower complete denture.

In some cases, the floor of the mouth is found near the crest of the ridge, especially in the sublingual and mylohyoid regions. This decreases the stability and retention of the denture. The floor of the mouth can be measured with a William's probe. The patient should touch his upper lip with the tongue to activate the muscles of the floor of the mouth (Fig. 2.69).

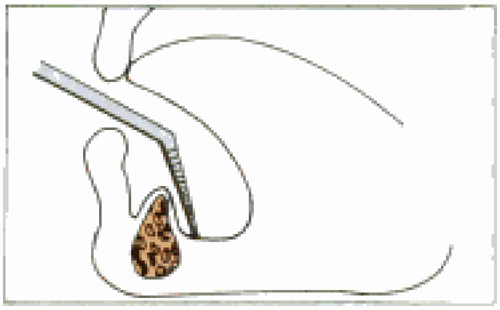


Fig. 2.69

RADIOGRAPHIC EXAMINATION

The radiograph of choice for the examination of a completely edentulous patient is panoramic radiograph because they image the entire mandible and maxilla.

Considerations During Radiographic Examination

- The jaws should be screened for retained root fragments, unerupted teeth, rarefaction, sclerosis, cysts, tumours and TMJ disorders.
- The amount of ridge resorption should be assessed. *Wical and Swoope* devised a method for measuring ridge resorption. According to them, the distance between the lower border of the mandible and the lower border of the mental foramen multiplied by three will give the original alveolar ridge crest height. The lower edge of the mental foramen divides the mandible into upper two-thirds and lower one-third.
- The quantity and quality of the bone should be assessed.

Radiographic Assessment of Bone Resorption

The amount of resorption can be classified as follows:

Class I: (mild resorption) loss of upto one-third of the vertical height.

Class II: (moderate resorption) loss of upto two-thirds of the vertical height.

Class III: (severe resorption) loss of more than two-thirds of the vertical height.

Radiographic Assessment of Bone Quantity and Quality

Branemark et al classified bone quantity radiographically as Classes A,B,C,D and E (Fig. 2.70). He classified bone quality radiographically as Classes 1,2,3 and 4 (Fig. 2.71).

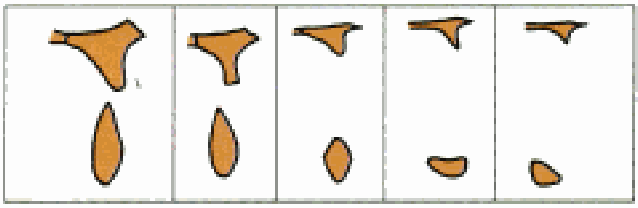


Fig. 2.70: Radiological assessment of bone quantity

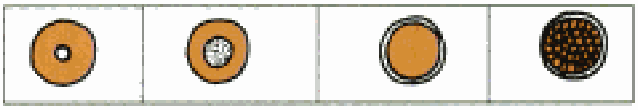


Fig. 2.71: Radiological assessment of bone quality

TREATMENT PLAN

ADJUNCTIVE CARE

Elimination of Infection

Sources of infection like infected necrotic ulcers, periodontally weak teeth, and nonvital teeth should be removed. Infective conditions like candidiasis, herpetic stomatitis, and denture stomatitis should be treated and cured before commencement of treatment.

Elimination of Pathology

Pathologies like cysts and tumours of the jaws should be removed or treated before complete denture treatment begins. The patient should be educated about the harmful effects of these conditions and the need for the removal of these lesions. Some pathologies may involve the entire bone. In such cases, after surgery, an obturator may have to be placed along with the complete denture.

Preprosthetic Surgery

Preprosthetic surgical procedures enhance the success of the denture. Some of the common preprosthetic procedures are:

- Labial frenectomy.
- Lingual frenectomy.
- Excision of denture granulomas.
- Excision of flabby tissue.
- Reduction of enlarged tuberosity.
- Excision of hyperplastic retromolar pad.
- Alveoloplasty.
- Alveolectomy.
- Reduction of genial tubercle.
- Reduction of mylohyoid ridge.
- Excision of tori.
- Vestibuloplasty.
- Lowering the mental foramen.
- Ridge augmentation procedures.
- Implants

Tissue Conditioning

The patient should be requested to stop wearing the previous denture for at least 72 hours before commencing treatment. He/she should be taught to massage the oral mucosa regularly.

Special procedures should be done in patients who have adverse tissue reactions to the denture. Denture relining material should be applied on the tissue side of the denture to avoid denture irritation. *Treatment dentures* or *acrylic templates* can be prepared to carry tissue-conditioning material during the treatment of abused tissues.

Nutritional Counseling

Nutritional counseling is a very important step in the treatment plan of a complete denture. Patients showing deficiency of particular minerals and vitamins should be advised a proper balanced diet. Patients with vitamin B_2 deficiency will show angular cheilitis. Prophylactic vitamin A therapy is given for xerostomic patients. Nutritional counseling is also done for patients showing age-related changes such as osteoporosis.

PROSTHODONTIC CARE

The type of prosthesis, denture base material, anatomic palate, tooth material and teeth shade should be decided as a part of treatment planning. Depending upon the diagnosis made, the patient can be treated with an appropriate prosthesis. For example:

- For a patient with few teeth, which are likely to be extracted an immediate or conventional, definitive or interim, implant or soft tissue supported dentures can be given.
- For a patient who is already edentulous a soft tissue supported or implant supported denture can be given.
- For patients with acquired or congenital deformities, a denture with an obturator can be given.

Dentulous patients who are to extract all the teeth and edentulous patients require different treatment plans.

For Patients Destined to be Edentulous

- Immediate or conventional denture.
- Definitive or interim denture.
- Implant or soft tissue supported denture.

For Patients Already Edentulous

- Soft tissue supported.
- Implant supported (fixed or removable).
- Material of choice.
- Selection of teeth.
- Anatomic palate.

Chapter 3
Diagnostic Impressions in Complete Dentures

- Diagnostic Impression
- Making the Diagnostic Cast

3

Diagnostic Impressions in Complete Dentures

Some patients may have abnormal landmarks, which are unfavourable for placing a denture. These unfavourable tissues should be corrected before making the primary impression. Procedures that involve the correction of these soft tissue abnormalities are collectively known as preprosthetic surgical procedures.

As a first step in preprosthetic surgery, a diagnostic cast is prepared and surveyed to determine the amount of surgery required. In this chapter we shall discuss in detail about making the diagnostic impression, pouring the diagnostic cast, and surveying the diagnostic cast.

DIAGNOSTIC IMPRESSION

Diagnostic impressions are made as a part of treatment planning. It should be understood that this impression cannot be used to fabricate the denture. A diagnostic impression is defined as *"the negative replica of the oral tissues used to prepare a diagnostic cast."*

As mentioned above, the diagnostic cast is used for study purposes like measuring the undercuts, locating the path of insertion, etc. and not for any fabrication purposes.

Making the Impression

Diagnostic impressions are prepared using an elastic impression material like agar or alginate. Rigid impression materials are contraindicated for making diagnostic impressions. This is because the rigid materials get locked in the undercuts and tend to break easily. Alginate is chosen because it is elastic (records the undercuts) and economical.

Armamentarium

- Diagnostic instruments (mouth mirror, probe).
- Perforated stock trays.
- Rubber bowl and spatula.
- Alginate impression material.
- Measuring scoops.

Procedure

- It is done only after complete healing is ensured.
- The patient's oral cavity is examined for ulcers and undercuts. Care should be taken not to pressurize the freshly healed areas while making the impression.
- Stock tray selection:
  - — Perforated edentulous stock trays are used for alginate impressions.
  - — The stock tray should have atleast 2-3 mm clearance. It should not be too large or small.
  - — The borders of the tray should be about 2 mm short of the vestibule.
- Modifying the tray to suit the patient (Fig. 3.1).
  - — The tray can be bent or contoured to suit the patient using an orthodontic plier.

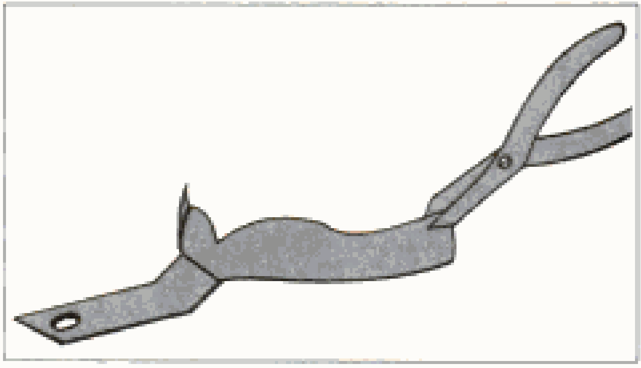


Fig. 3.1: Modifying a metal stock tray

— There should be an even space of 2 mm between the tray and the tissue surfaces.

— If the sulcus is too deep, the borders of the tray should be built using utility wax.

- Required quantity of water is taken in a clean rubber bowl. Alginate powder is dispensed (sifted) into it.
- The alginate can be mixed manually using *'figure of 8'* motion or mechanically using an alginate spatulator (Fig. 3.2).

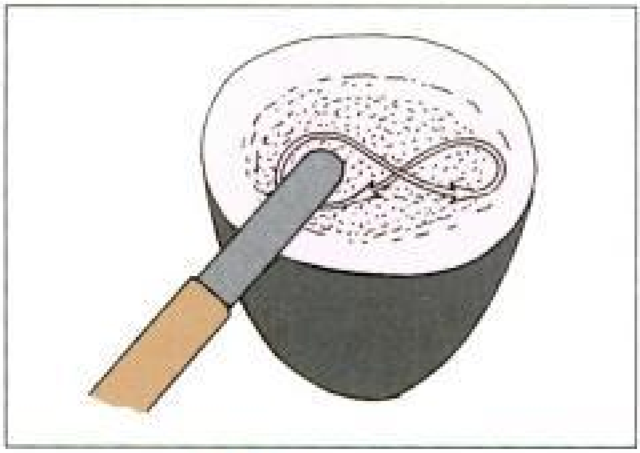


Fig. 3.2: Mixing alginate

- After mixing, the material is loaded quickly on the tray and inserted into the patient's mouth.
- The operator should lift and manipulate the patient's lips and cheeks while making the impression. The lips should be moved upward, outward and downward. This helps to record the freni and sulci (Fig. 3.3).
- The tray should be supported till the impression material is set.
- After the material is set the impression should be removed in a snap. The impression should be removed very quickly and gently in a snap.

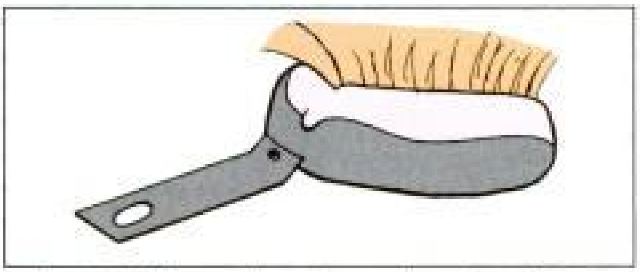


Fig. 3.3: Making a primary impression using alginate

- Excessive impression material should not be loaded, because it can produce gagging.
- For patients with hypersalivation, antisialogagues like methanthaline bromide, etc. can be used to reduce salivation.
- If there is a single large undercut, the impression should be removed along the direction of the undercut. This helps to prevent distortion of the impression.

Technical Considerations

- If the patient has teeth to be extracted , care should be taken not to traumatize the remaining teeth while removing the impression. In such cases, the impression should be withdrawn along the long axis of the remaining teeth.
- The impression is inspected for extent and voids. If there are gross deficiencies, the impression should be repeated.

MAKING THE DIAGNOSTIC CAST

Cleaning and Disinfecting the Diagnostic Impression

- Dental stone should be sprinkled on the impression to identify the saliva present on the impression. The remnants of patients saliva should be removed using a Camel-hair brush dipped in water. Impression should not be washed under direct water because it may get distorted.
- The impression should be disinfected before pouring the cast. Immersing the impression in a disinfectant like iodophor for 10 minutes is sufficient for complete disinfection.
- After disinfecting the impression, it should be placed in slurry water to avoid shrinkage. Slurry water improves the wettability of plaster over the impression surface.
- Excess impression material should be trimmed gently with a B.P. blade. Failure to trim the alginate will lead to distortion when the tray is placed on the table and the impression rests on the excess material (Fig. 3.4).

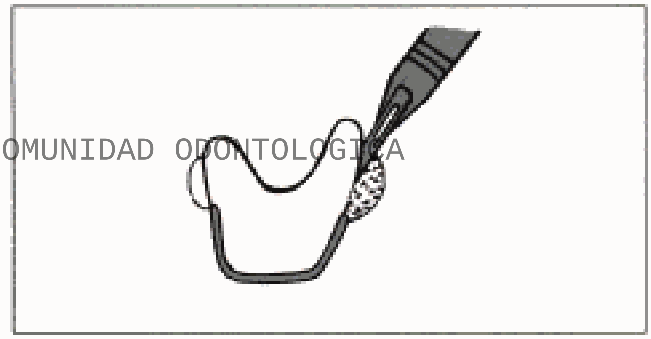


Fig. 3.4: Trimming the excess impression material

Pouring the Diagnostic Cast

- The cast should be poured within 15 minutes after impression making.
- A base former can be used to make a proper base.
- Usually a diagnostic cast is poured using dental plaster. Dental plaster is preferred because it is economical and reproduction of finer details is not an important requisite.
- The impression is placed and stabilized over a piece of cotton so that the ridge appears parallel to the table.
- Required quantity of water and powder are dispensed in a rubber bowl and mixed in a circular motion.
- Once the plaster reaches a sufficient consistency, it should be placed on a vibrator to remove air bubbles.
- Impressions are usually poured in three pours. In the first pour it should be of a more liquid consistency. The plaster mix should be placed on the distal end of the impression and allowed to flow all over. This prevents the entrapment of air bubbles (Fig. 3.5). The impression should be placed in a vibrator to avoid the occurrence of air bubbles. The first pour should extend upto half the height of the ridge. (Fig. 3.6).
- The second pour should be a little thicker in consistency. Surface irregularities should not be removed because they act as retentive agents while pouring the last pour. After pouring the second pour it should be placed in slurry water to keep the plaster moist. The second pour should fill the entire ridge (Fig. 3.7).

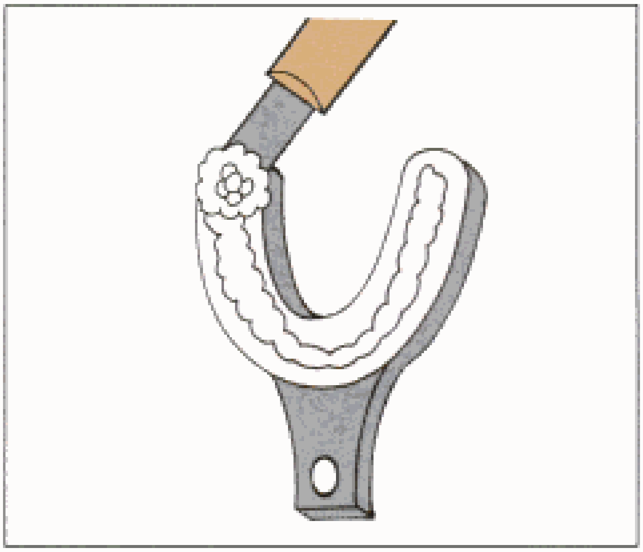


Fig. 3.5: Pouring the first pour from the distal end of the impression

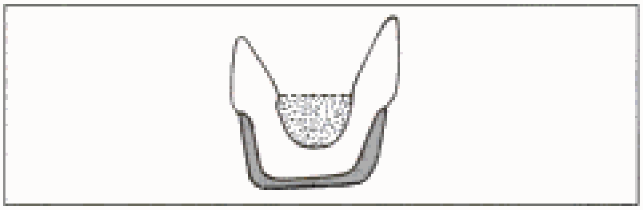


Fig. 3.6: First pour of the impression

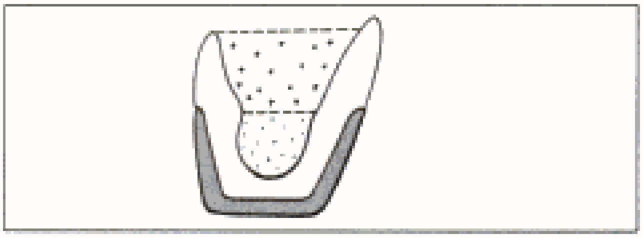


Fig. 3.7: Second pour of the impression

- The last pour or the base pour is done using a base former. Plaster is mixed and poured onto the base former. A small quantity is applied over the second pour. The impression with the second pour is inverted over the base former. The third pour is contoured on the peripheral areas to remove any demarcation between the second and third pours (Fig. 3.8).

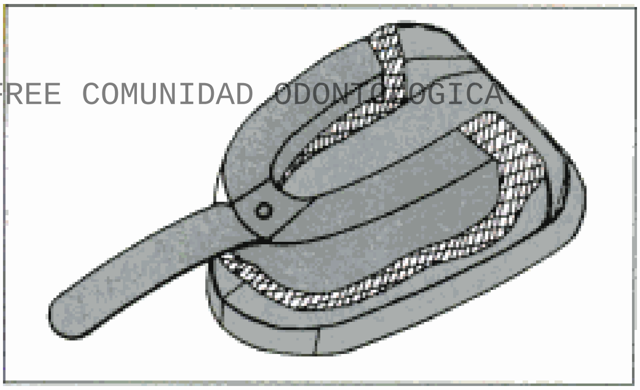


Fig. 3.8: The third or base pour

- The base should have a minimum thickness of 10 mm at its thinnest portion:
  — 10 mm at the centre of hard palate in the Maxilla.
  — 10 mm at the depth of lingual sulcus in the mandible.
- Excess plaster should be trimmed away.
- In case of mandibular impressions, the excess plaster in the tongue space area should be removed and contoured using a plaster knife. Care should be taken to avoid overtrimming the plaster.
- In the absence of a baseformer a mix of plaster is spread over a glass plate or tile and the impression is inverted over it. Later, this base should be trimmed as per standards.

Finishing the Diagnostic Cast

- The diagnostic cast should be separated from the impression only an hour after its initial set.
- Since alginate is elastic, it is easy to remove the impression away from the cast. Care should be taken while removing the impression material from the undercut areas.
- Small nodules and projections on the impression surface should be removed.
- The cast should not be washed under direct water because the superficial surface of the plaster will dissolve and get washed away.
- If a base former is not used during the third pour, then the base of the cast should be trimmed using a model trimmer.
- Before using the model trimmer, the cast should be soaked in slurry water for 5 minutes.
- A base should have the following characteristics (Figs 3.9 and 3.10):
  — The sides of the cast are trimmed so that they are parallel to the buccal surfaces of the teeth. Posterior surface of the cast must be perpendicular to the floor. Edentulous casts will not have distinct surfaces.

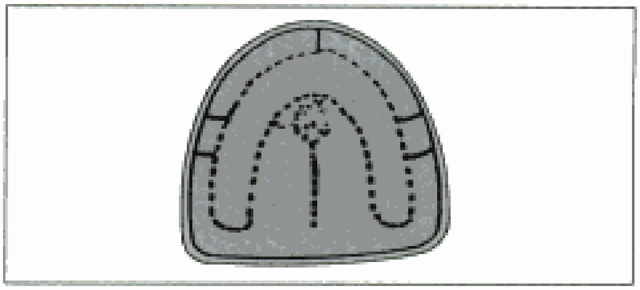


Fig. 3.9: Diagnostic cast showing the land area

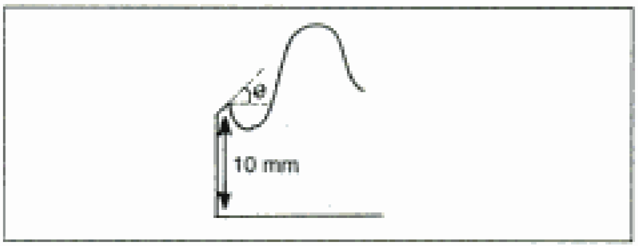


Fig. 3.10: Cross-section of the diagnostic cast showing the augulation of the land plane and the minimum required height of the cast • θ = 45°

  — Land area/periphery should be 3 mm wide all around the cast. This is done to preserve the depth and width of the sulcus.
- When the cast is trimmed in a model trimmer the trimmed plaster forms a paste, which is called *sludge*. Sludge should be removed when it is wet. Removing dry sludge is difficult and often results in damage to the cast.
- Excess plaster present in the lingual aspect of the mandibular casts should be removed using a bevelled chisel.
- The base should be properly smoothened using sandpaper.
- The cast is ready for use.

Ideal Requirements of a Diagnostic Cast

- They should be free of voids or projections.
- The surface should be smooth, dense and free of sludge.

- It should cover all the areas, which provide denture support. E.g. it should extend 3 to 4 mm beyond the retromolar pad.
- The walls of the cast should be vertical or tapering outward but never inward.
- The tongue space in a mandibular cast should be smooth. The lingual peripheral seal (The lingual sulcus, lingual frenum and sublingual fold space) should also be intact.
- The cast should not show any traces of moisture.
- The occlusal table should be parallel to the floor.

Purpose of Making a Diagnostic Cast

A diagnostic cast can be used for the following purposes:

- To measure the depth and extent of the undercuts.
- To determine the path of insertion of the denture.
- To identify and plan the treatment for interferences like tori.
- To perform mock surgeries for maxillofacial prosthesis.
- To determine the amount of preprosthetic surgery required.
- To evaluate the size and contour of the arch.
- To get an idea about retention and stability offered by the tissues.
- To determine the need for additional retentive features like over denture abutments, implant abutments, etc.

Surveying the Diagnostic Cast

Most of the above-mentioned procedures like determining the depth of the undercuts, path of insertion and evaluating the surgical correction required are all done by a procedure called surveying. *Surveying* is done using an instrument called *Surveyor*. Surveyors are discussed in detail in the removable partial denture section (Ref Chapter 18).

Measuring the Depth of the Undercut Using a Surveyor

Surveying procedure includes mounting the cast, tilting the cast to avoid undercut, marking the height of contour and finally measuring the depth of the undercuts.

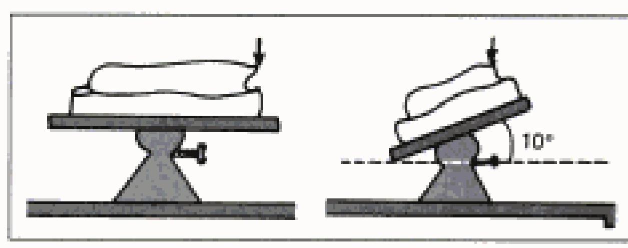
Mounting the Cast (Fig. 3.11)

- The cast is mounted by placing and locking it on the surveying table.
- It should be placed in the centre with its tissue surface in a horizontal plane.
- Once the symmetry (placement at the centre) is checked, the cast position is marked so that it can be remounted anytime.

Tilting the Cast (Fig. 3.12)

It is done to change the path of insertion of a complete denture.

- When an undercut is present on one side of the ridge, tilting the denture to that side during insertion solves the problem.
- The cast should not be tilted more than 10^0 or else it will require excessive mouth opening at the time of insertion.



Figs 3.11 and 3.12: Tilting the cast to compensate for the unilateral undercut

Marking the Height of Contour (Fig. 3.13)

This is done to demarcate the undercuts on a cast.

- A carbon marker is placed on the surveying arm of the surveyor.
- The marker is made to run around the ridge.
- Wherever the marker touches the side of the ridge, is the highest point or the height of contour of the ridge. The area below the height of contour is called *undercut*.

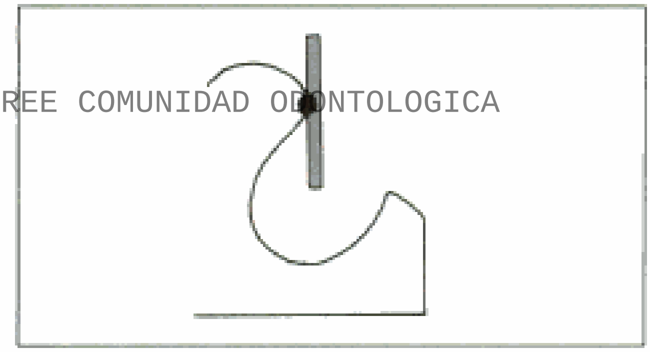


Fig. 3.13: Marking the height of contour using a carbon marker

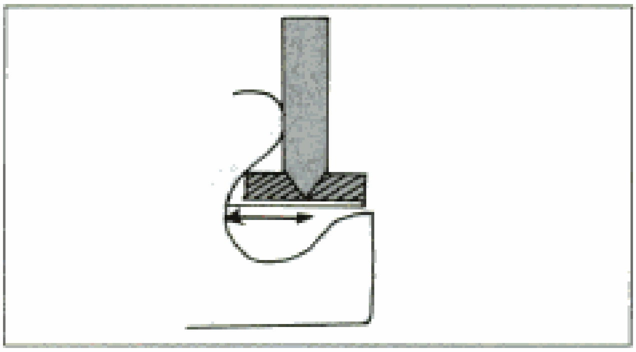


Fig. 3.14: Measuring the depth of the undercut using an undercut gauge

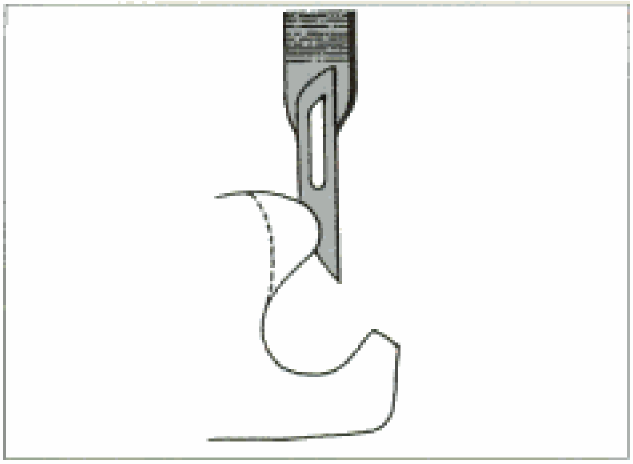


Fig. 3.15: Surveying knife used to prepare mock preparations

Measuring the Depth of the Undercut (Fig. 3.14)

- The depth of an undercut is measured using an undercut gauge.
- The gauge is positioned on the surveying arm and the distance between the deepest point of the undercut and the height of contour is measured.

Sometimes a surveying knife is mounted on the surveying arm and the height of contour of the ridge should be reduced upto the depth of the undercut. This is something like a mock surgery preparation. The scrapped cast gives an idea about the amount of surgical reduction required (Fig. 3.15).

4

Mouth Preparation for CD

Mouth preparation includes all the measures taken to correct tissue discrepancies that pose a difficulty in the placement of a denture. Mouth rehabilitation is defined as a "*Restoration of the form and function of the masticatory apparatus to as nearly normal as possible*".—GPT

Adjunctive Care

Ulcer, lesion and abscess, etc. require immediate attention. The lesion should be cured and the tissue should be given adequate rest for sufficient healing. During the healing period adjunctive therapies like the tissue massage, use of mouth-washes, etc. should be carried out.

For patients with normal tissues, 48-hour rest with frequent tissue massage is sufficient. The patient should be advised to stop wearing the existing dentures.

Tissue-conditioning materials can be used to reline the existing dentures to reduce tissue inflammation and thus facilitate in subsequent surgical procedures.

Removal of Retained Dentition

The decision to remove or preserve the tooth is planned during treatment planning. An OPG gives a clear idea about the status of remaining dentition.

Removal of Unerupted Teeth

- The unerupted teeth lying close the the ridge should be removed.
- Deeply submerged, non-symptomatic teeth with normal bony trabeculae can be left untouched.

Removal of Retained Roots

- All retained roots should be removed especially if there is any sign of pathology.
- Asymptomatic roots, which are present deep in the bone, whose removal can result in a large bony defect, can be cautiously left untouched.

Correction of Hypermobile Ridge Tissue (Fig. 4.1)

Hypermobile tissues result due to excessive residual ridge resorption.

- Small areas of hypermobile tissue, which may not affect the functioning of the denture, can be left untouched. These mobile tissues should be recorded carefully using a mucostatic impression.
- Large pendulous hypermobile tissues should be removed.

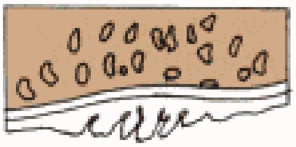


Fig. 4.1: Hypermobile tissues

Removal of Soft Tissue Interferences

- Firm soft tissue interferences, which do not affect the stability of the denture, can be left intact.
- In case of a maxillary tuberosity with excessive fibrous tissue, the need for surgical removal is evaluated by articulating the diagnostic casts (Fig. 4.2).

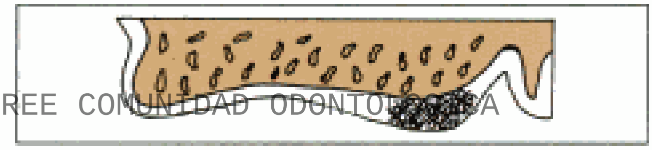


Fig. 4.2: Excessive fibrous proliferation in the maxillary tuberosity

Removal of Hypertrophic Maxillary Labial Frenum

- If the frenal attachment is high, but not close to the crest of the ridge, it is not mandatory to do any surgical procedure. Additional relief in the labial notch of the denture may be sufficient.
- In case of a highly attached frenum where relief of the labial notch can break the peripheral seal of the denture, surgical treatment is recommended (Fig. 4.3).

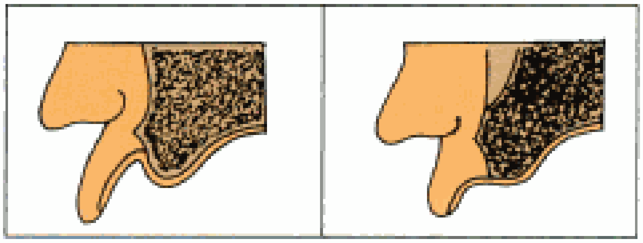


Fig. 4.3: (a) Normal labial frenum (b) Hypertrophic labial frenum

Removal of A Hypertrophic Lingual Frenum

Frenectomy is indicated for cases with a hypertrophic lingual frenum.

In case of a hypertrophic tongue-tie, surgical management should be done. Tongue-tie test should be done to determine the need for surgical correction. The patient is asked to touch his upper lip with his tongue. If the lingual frenum produces displacement of the denture, then frenectomy should be done (Fig. 4.4).

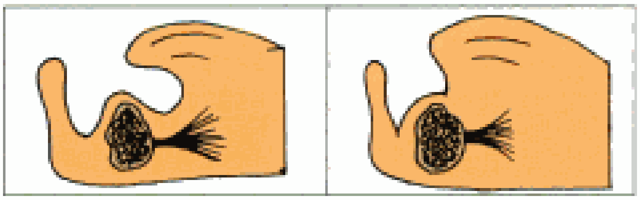


Fig. 4.4: (a) Normal lingual frenum (b) hypertrophic lingual frenum

Correction of Prominent Buccal Frenum

- Usually they never present themselves large enough to warrant surgical correction.
- The buccal frenum is soft and hence it can be easily displaced by the denture without producing any injury (Fig. 4.5).

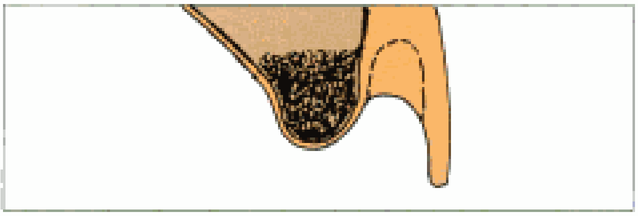


Fig. 4.5: Prominent buccal frenum

Removal of Papillary Hyperplasia

- These are hyperplastic lesions, which occur in localized areas due to some form of irritation.
- The lesions may be either small or large and if the lesion is small it is treated by curettage. Large lesions are treated by split thickness supraperiosteal excision (Fig. 4.6).

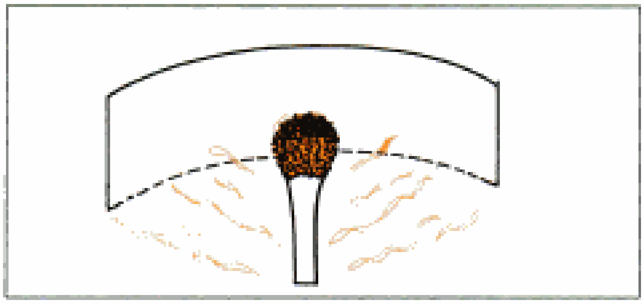


Fig. 4.6: Papillary hyperplasia

Treatment of Epulis Fissuratum

- It is a soft tissue reaction that appears in the sulcular region due to overextension of the denture flanges. It is commonly seen in immediate denture cases where rapid ridge resorption occurs (Fig. 4.7).
- It does not require any special treatment. Shortening and smoothening the denture border is sufficient.
- Once the tissues heal, the borders of the denture should be refined.

Fig. 4.7: Epulis fissuratum

Removal of Ridge Undercuts

- Small undercuts, which do not pose much difficulty in the insertion of the prosthesis, can be left untouched.
- Moderate single-sided undercuts also do not require any surgical treatment because the path of insertion of denture can be altered parallel to the direction of the undercut (Fig. 4.8).

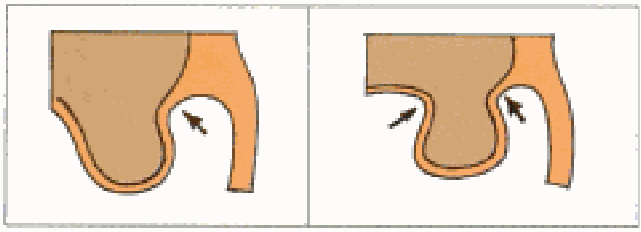


Fig. 4.8: (a) Unilateral ridge undercut (b) Bilateral ridge undercut

- Severe undercuts or bilateral (double-sided) moderate undercuts require surgical correction (alveoloplasty, ridge augmentation).

Management of Prominent Mylohyoid and Internal Oblique Ridges

- Internal oblique and mylohyoid ridges are seen in the lingual surfaces of the mandible. Sometimes they become very prominent due to ridge resorption (Fig. 4.9).
- They should be surgically reduced when there is repeated ulceration, loss of peripheral seal, etc.

Reduction of Maxillary Tuberosity

- A wide tuberosity is easier to reduce compared to vertically large tuberosity.

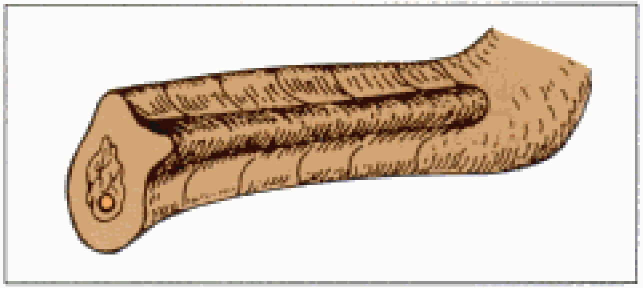


Fig. 4.9: Prominent mylohyoid ridge

- The maxillary sinus tends to expand into the tuberosity. Hence, radiological evaluation is mandatory before surgical reduction (Fig. 4.10).
- The interarch distance should be evaluated and the thickness of denture flange should also be reduced accordingly.

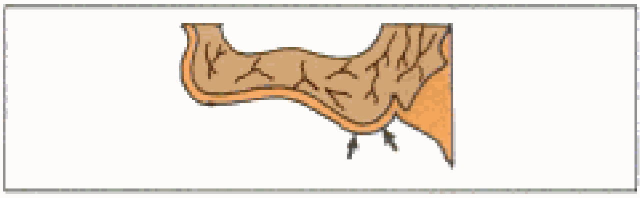


Fig. 4.10: Over sized maxillary tuberosity

Treatment of Sharp Spiny Ridges (Figs 4.11 and 4.12)

- These ridges usually occur in the lower anterior region due to resorption of the labial and lingual cortical plates.
- Ridge augmentation can be done. Usually dentures with large flanges are constructed to avoid load on the crest of the ridge.
- Meyer classified knife edge ridges into three types:
    - Saw-tooth
    - Razor-like
    - Ridge with discrete spiny projections.

All three ridges have a sensitive mucosal lining. Care should be taken to protect the mucosa.

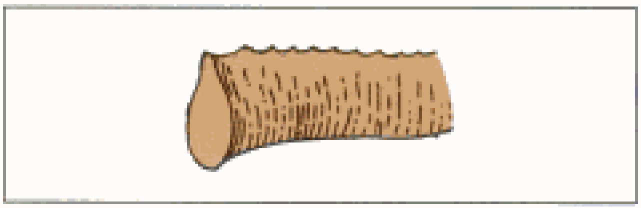


Fig. 4.11: Saw-tooth ridge

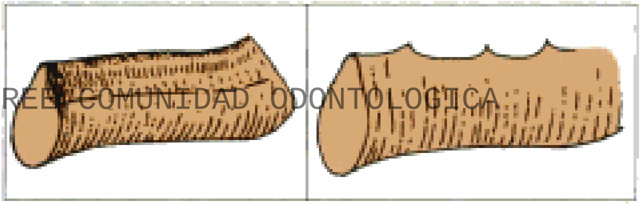


Fig. 4.12: (a) Razor- like ridge (b) Ridge with discrete sharp bony projections

Excision of Tori (Fig. 4.13)

- These are small bony projections of unknown etiology, which grow to their maximum size by the end of third decade of life.
- Indications for removal of maxillary tori:
  - a. Interference of speech
  - b. Loss of posterior palatal seal
  - c. Poor denture stability.
- All mandibular tori should be excised because the mucosa over the tori is more prone to irritation due to constant movement of the denture during mastication.

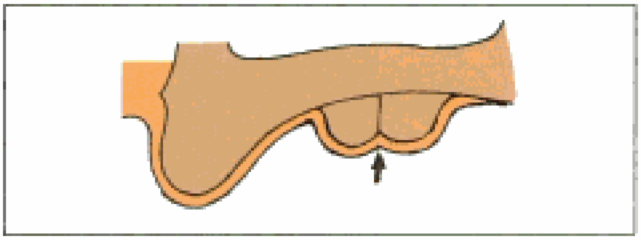


Fig. 4.13: Tori

Vestibuloplasty

It is a surgical procedure to increase the vestibular depth. It can be done using one of the following techniques:

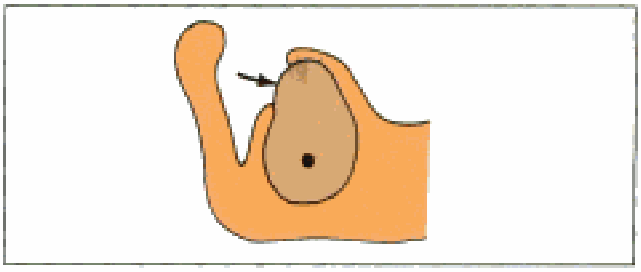


Fig. 4.14: Secondary epithelisation

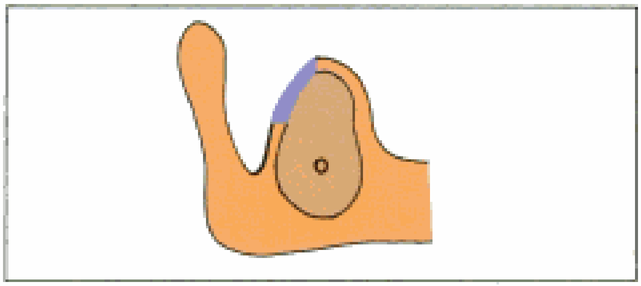


Fig. 4.15: Epithelial graft vestibuloplasty

Mucosal Advancement

It involves the dissection and apical repositioning of the sulcular mucosa using a surgical stent.

Secondary Epithelialisation (Fig. 4.14)

A full thickness flap is reflected, apically repositioned and sutured with the periosteum at a lower level. The exposed area is allowed to heal by secondary intention.

Epithelial Graft Vestibuloplasty (Fig. 4.15)

It is similar to secondary epithelialisation except that a full thickness graft is placed over the exposed region allowing it to heal by primary intention.

Chapter 5
Primary Impressions in Complete Denture

- Introduction and Classification of Impressions
- Anatomical Landmarks
- Principles of Impression Making
- Objectives of Impression Making
- Recording the Primary Impression
- Refining the Primary Impression

5

Primary Impressions in Complete Denture

INTRODUCTION AND CLASSIFICATION OF IMPRESSIONS

Introduction

An impression is defined as, *"an imprint or negative likeness of the teeth and/or edentulous areas where the teeth have been removed, made in a plastic material which becomes relatively hard or set while in contact with these tissues. Impressions may be made of full complements of teeth, of areas where some teeth have been removed, or in mouth from which all teeth have been removed"*- GPT.

"A complete denture impression is a negative registration of the entire denture bearing, stabilizing and border seal areas present in the edentulous mouth."- GPT.

Impression making is the primary step in the process of complete denture fabrication. Impressions are made to produce a negative replica of the patient's mouth into which plaster or stone can be poured to form the positive replica—*the cast*. The cast acts as a template over which the CD is fabricated. Errors in impression making can lead to treatment failure.

A primary impression is made after the preprosthetic surgery is complete. It is used to prepare a special tray. If the patient did not require preprosthetic surgery, then the diagnostic cast made from the diagnostic impression can be used directly to fabricate the special tray.

Classification

Impressions can be classified as:

1. Depending on the theories of impression making:
   - Mucostatic or passive impression.
   - Mucocompressive or functional impression.
   - Selective pressure impression.
2. Depending on the technique:
   - Open-mouth technique.
   - Closed-mouth technique.
3. Hand manipulation for functional movements (Dynamic impression): Border moulding.
4. Depending on the type of tray:
   - Stock tray impression.
   - Custom tray impression.
5. Depending on the purpose of the impression:
   - Diagnostic impression.
   - Primary impression.
   - Secondary impression.
6. Depending on the material used:
   - Reversible hydrocolloid impression.
   - Irreversible hydrocolloid impression.
   - Modelling plastic impression (Impression compound).
   - Plaster impression.
   - Wax impression.
   - Silicone impression.
   - Thiokol rubber impression.

Mucostatic or Passive Impression

It was first proposed by Richardson and later popularised by Henry Page. In this mucostatic technique, the impression is made with the oral mucous membrane and the jaws in a normal, relaxed condition. Border moulding is not done here.

The impression is made with an oversized tray. Impression material of choice is impression plaster. Retention is mainly due to interfacial surface tension. The mucostatic technique results in a denture, which is closely adapted to the mucosa of the denture-bearing area but has poor peripheral seal. Thus, these dentures will have good stability but poor retention.

Mucocompressive Impression (Carole Jones)

The mucocompressive technique records the oral tissues in a functional and displaced form. The materials used for this technique include impression compound, waxes and soft liners.

The oral soft tissues are resilient and thus tend to return to their anatomical position once the forces are relieved. Dentures made by this technique tend to get displaced due to the tissue rebound at rest. During function, the constant pressure exerted onto the soft tissues limit the blood circulation leading to residual ridge resorption.

Selective Pressure Impression (Boucher)

In this technique, the impression is made to extend over as much denture-bearing area as possible without interfering with the limiting structures at function and rest.

The selective pressure technique makes it possible to confine the forces acting on the denture to the stress-bearing areas. This is achieved through the design of the special tray in which the nonstress-bearing areas are relieved and the stress-bearing areas are allowed to come in contact with the tray (Fig. 5.1).

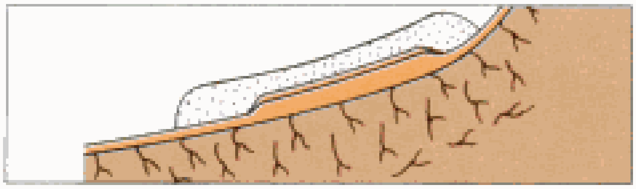


Fig. 5.1: Selective pressure technique: The area of tissue contacted by the tray are recorded under pressure and the tissues not contacted by the tray are recorded at a state of rest

Relief is given using wax in the special tray, which should be removed before impression making. It is discussed in detail in the Chapter 7.

Open-mouth Impression

The open mouth method includes the impression techniques, which record the tissues in an undisplaced position. Pressure or pressureless impressions can be made using this technique.

Closed-mouth Impression

This method records the tissues in the functional position. In this technique, record blocks (trays with occlusal rims) are used instead of impression trays.

Both upper and lower record blocks are lined with impression material and placed inside the patient's mouth at the same time. The patient is asked to close his mouth exerting pressure on the occlusal rims and perform functional movements such as swallowing, grinning and pursing of the lips.

The impression materials used are impression compound, waxes and soft liners.

Disadvantages

- As the tissues are recorded in the functional compressed form, they will rebound at rest due to resiliency leading to denture displacement.
- The denture base exerts constant pressure over the tissues. Hence the blood supply is decreased leading to ridge resorption.

Hand Manipulated Functional Movements (Dynamic Impression)

It is a mucofunctional technique, which involves recording functional movements of the mucosa while making the impression. *Border moulding* or *peripheral tracing* or *muscle trimming* is a mucofunctional technique used in CD fabrication.

It is defined as, *"The shaping of the borders of an impression tray to conform accurately to vestibular areas and border seal areas"*.

In this technique, a mouldable material is added along the borders of the tray and seated in position.

Once this is done, the dentist performs passive functional movements of the lips and cheeks to obtain a functional impression of the vestibular areas. The patient is also asked to perform movements of the tongue to record the alveololingual sulcus. Active opening and closing movements of the jaws are performed to record the distobuccal portion of both the impressions.

Diagnostic Impression

It is made to prepare diagnostic cast, which is used for the following purposes:

- To survey undercuts.
- To estimate the amount of preprosthetic surgery required and to perform mock surgeries.
- Articulate the casts in a tentative jaw relation and evaluate the interarch space.
- To determine the ability to establish occlusal balance.

Primary Impressions or Preliminary Impression

Primary impression is defined as, "*An impression made for the purpose of diagnosis or for the construction of a tray*" - GPT.

This is the first step in fabrication of a CD. The preliminary impression is made with a stock tray. The following points should be considered during tray selection:

- There should be at least 5 mm clearance between the stock tray and the ridge.
- With the stock tray in position, the handle of the tray is tilted downwards and the posterior border of the tray is observed. The tray should extend over the tuberosity and the hamular notch. Similarly, the mandibular tray should be raised anteriorly to check for posterior extension upto the retromolar pad.
- If the tray is deficient, utility wax can be added along the posterior border of the tray.

The preliminary impression can be made using impression compound, alginate or impression plaster.

Secondary Impressions or Wash Impression

This is a clinical procedure in complete denture fabrication done to prepare a master cast. This is done after mouth preparation is complete. It is a very important step as it should record the denture-bearing area in great detail and also record the muscular peripheral tissues in function.

This method makes use of a custom tray or special tray prepared from the primary cast. The borders of the tray should end 2 mm short of the peripheral structures. The tray can be made of auto-polymerizing resin or reinforced shellac base plate.

Once the tray is ready, the peripheral structures are recorded by a procedure called *Border moulding* or *Peripheral tracing*. Tracing compound or elastomers can be used. The movements of the lips, cheeks and other muscles are simulated passively by the dentist to record the length and width of the vestibule.

The impression material chosen for the secondary impression should be of low viscosity to record the structures accurately. The amount of material loaded onto the tray should be able to form a uniform, thin layer. Loading excess material onto the tray may lead to an overextended impression.

The materials of choice for a secondary impression are Zinc oxide Eugenol impression paste and medium-bodied elastomeric impression materials.

Reversible Hydrocolloid Impression

This impression makes use of *agar* (a reversible hydrocolloid) as the impression material. The agar is taken from the tempering section, which is at 46°C and loaded onto a water-cooled rim-lock tray. The impression is made using this tray.

It has excellent surface detail reproduction (upto 25 microns). But it has poor dimensional stability due to syneresis and imbibition. It is an elastic material and can be used to record undercuts. *Generally elastic impression materials are indicated for recording undercuts.*

Irreversible Hydrocolloid Impression

Alginate is the hydrocolloid used for this type of impression. It is available as a powder, which can be mixed with water in a rubber bowl. Spatulation is carried out until a homogeneous mix is obtained. The mix is loaded onto an impression tray and the impression is made.

These alginate impressions have a better peripheral seal than other impressions. They are economical. They do not cause cross-infections as they are used only once.

Their main disadvantage is poor dimensional stability due to syneresis and imbibition. *All hydrocolloid impressions should be poured immediately after they are made.*

Modelling Plastic Impression

Impression compound is a reversible thermoplastic material, which is used for making preliminary impressions. It is softened in a water bath at 64°C and kneaded until a uniform mass is obtained. The impression is made using a stock tray.

The main advantage of this material is its low cost and ease of use. It has good dimensional stability but excessive water incorporation during wet kneading can cause dimensional change.

Its disadvantage is its viscosity. As it is highly viscous, it can displace the tissue surface. It also does not record surface details very accurately.

Plaster Impression

Type I dental plaster (Soluble plaster) is used here. The impression plaster is mixed with water in a prescribed ratio and loaded onto the tray.

This material has potato starch which helps in easy separation of the cast from the impression. To separate the cast from the impression, the impression along with the cast should be immersed in a bowl of hot water. The starch in the impression plaster will swell up and break the impression thus making it easy to remove the cast.

Impression plaster is generally avoided as it causes patient discomfort and has poor handling characteristics.

Silicone Impression

Silicone impression materials can be classified as:

Condensation polymerizing silicone It is available as a reactor paste and an activator paste. Both of them are mixed in the recommended ratio to produce a uniform mix. This mix is used to make the impression.

The disadvantage is their dimensional instability due to the formation and evaporation of ethyl alcohol from the impression.

Addition polymerizing silicone This is available as two varieties namely tubes and cartridges. While using the tube forms, the method of manipulation is similar to condensation silicones. When cartridges are used, they have to be dispensed in dispenser guns and used accordingly.

This variety of silicone does not undergo dimensional change. The casts can be poured even after a week. Apart from tubes and cartridges, the material is available in jars (Putty).

Thiokol Rubber Impression

Thiokol rubbers are polysulfide impression materials. They are available as base and accelerator pastes. Manipulation is similar to other elastomeric materials.

Polysulfide materials are hydrophobic. Precaution should be taken to avoid any moisture contamination on the tissue surface.

Silicone and thiokol impression materials are used to make a secondary impression. All other mentioned materials are used to make primary impressions.

For more information refer books on dental materials.

ANATOMICAL LANDMARKS

The anatomy of the edentulous ridge in the maxilla and mandible is very important for the design of a CD. The consistency of the mucosa and the architecture of the underlying bone is different in various parts of the edentulous ridge. Hence, some parts of the ridge are capable of withstanding more force than other areas. A thorough knowledge of these landmarks is essential even prior to impression making.

Mucous Membrane (Figs 5.2 to 5.5)

- The entire oral cavity is lined by the oral mucosa.
- The oral mucosa has two layers namely the mucosa and a submucosa.
- The mucosa has a keratinised, stratified squamous epithelium.
- The mucosa covering the hard palate and the crest of the residual ridge including the residual attached gingiva is called the *Masticatory mucosa*.
- The submucosa varies in thickness and consistency and it is responsible for supporting the denture. When it is thin, it easily gets traumatized. When it is loosely attached, inflamed or edematous, it gets easily displaced.

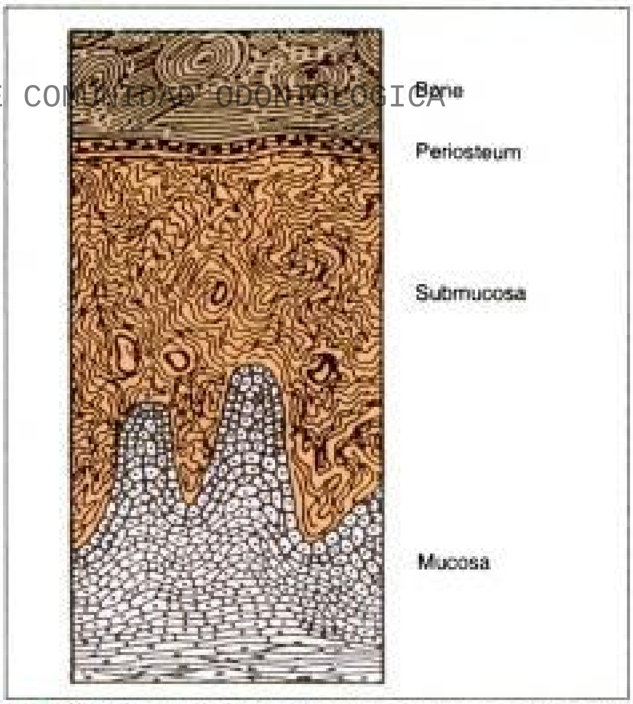


Fig. 5.2: Histology of the mucous membrane covering the crest of the residual ridge. Notice that the submucosal layer is sufficiently thick to provide resiliency for support to complete dentures and that bone covering the crest of the upper ridge is often compact

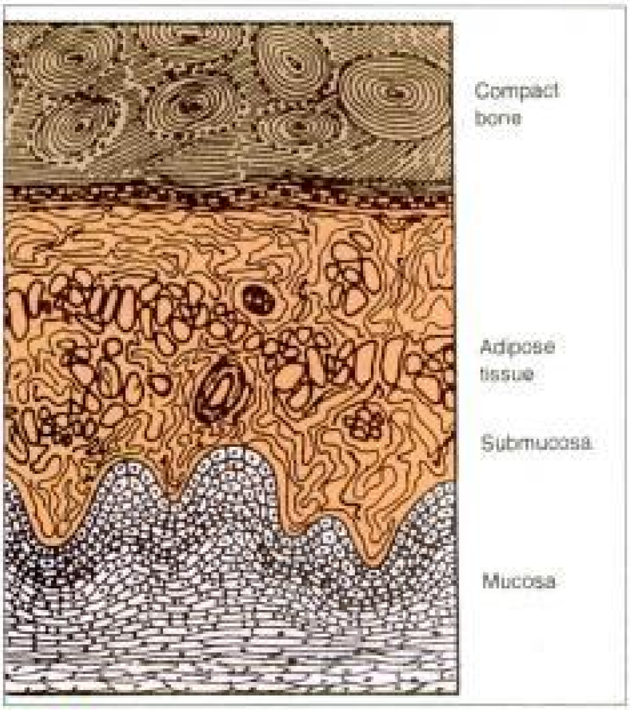


Fig. 5.3: Histology of the mucous membrane in the anterolateral part of the hard palate. Notice that the submucosa contains abundant adipose tissues

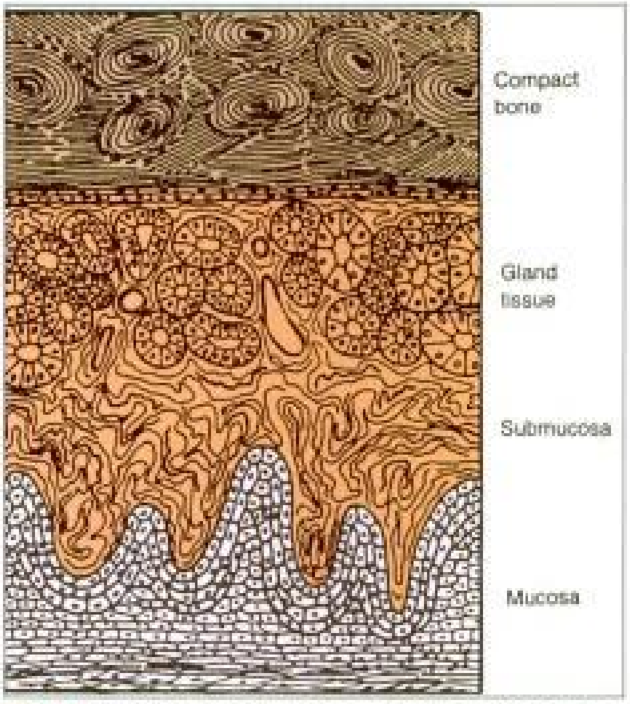


Fig. 5.4: Histology of the mucous membrane in the posterolateral hard palate. Notice the abundance of gland tissue

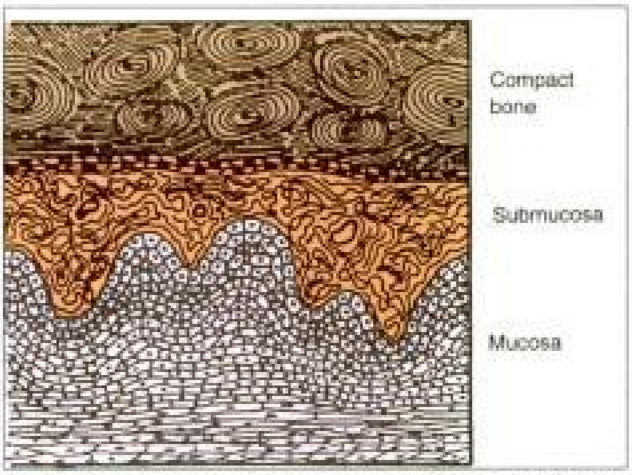


Fig. 5.5: Histology of the mucous membrane covering the median palatal suture. The submucosal layer is thin or may be practically nonexistent, making this part of the mouth unsuitable for support of an upper denture

In denture wearers, the keratinisation is reduced and the stratum corneum of epithelium is thinner. This reduces the resistance of epithelium to trauma.

Removing the dentures for 6-8 hours everyday can provide rest to the soft tissues. Toothbrush physiotherapy over the soft tissues can stimulate keratinisation of the epithelium.

ANATOMICAL LANDMARKS INTHE MAXILLA

The anatomical landmarks in the maxilla are:

Limiting Structures

- Labial frenum
- Labial vestibule
- Buccal frenum
- Buccal vestibule
- Hamular notch
- Posterior palatal seal area.

Supporting Structures

Primary stress-bearing areas:

- Hard palate (Jacobson and Krol)
- The postero-lateral slopes of the residual alveolar ridge

Secondary stress-bearing areas:

- Rugae
- Maxillary tuberosity, alveolar tubercle.

Relief Areas

- Incisive papilla
- Cuspid eminence
- Mid-palatine raphe
- Fovea palatina.

Limiting Structures

They determine and confine the extent of the denture.

Labial Frenum

It is a fibrous band covered by mucous membrane that extends from the labial aspect of the residual ridge to the lip. It has no muscle fibers. Hence it is a passive frenum. A V-shaped notch should be recorded during impression making to accommodate the labial frenum. The labial notch of the denture should be narrow but deep enough to avoid interference (Fig. 5.6).

Labial Vestibule

It is defined as, "*That portion of the oral cavity which is bounded on one side by the teeth, gingiva, and alveolar ridge (in the edentulous mouth the residual ridge) and on the other side by the lips and cheeks*"- GPT.

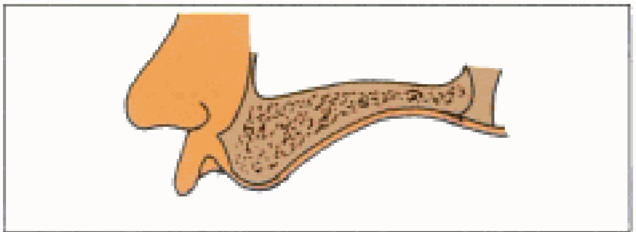


Fig. 5.6: Labial frenum

It runs from the buccal frenum on one side to the other, on the labial side of the ridge. It is divided into two compartments by a labial frenum namely the right and left. The vestibule is covered by the lining mucosa.

Orbicularis oris is the main muscle of the lip. Its tone depends on the support received from the labial flange of the denture and the position of artificial teeth. Its fibers run horizontally and it has an indirect displacing effect on the denture.

The muscles in this region are thin and their influence is minimal. The labial and buccal borders of the denture are not important for a border seal because the lips and cheeks create a *facial seal*.

Buccal Frenum

The buccal frenum separates the labial and buccal vestibule. It has attachments of the following muscles,

Levator anguli oris	- Attaches beneath the frenum
Orbicularis oris	- Pulls the frenum in a forward direction.
Buccinator	- Pulls the frenum in the backward direction.

These muscles influence the position of the buccal frenum hence it needs greater (wider and relatively shallower) clearance on the buccal flange of the denture (Fig. 5.7).

Buccal Vestibule

It extends from the buccal frenum anteriorly to the hamular notch posteriorly.

The size of the buccal vestibule varies with the

- Contraction of buccinator
- Position of the mandible
- Amount of bone loss in the maxilla.

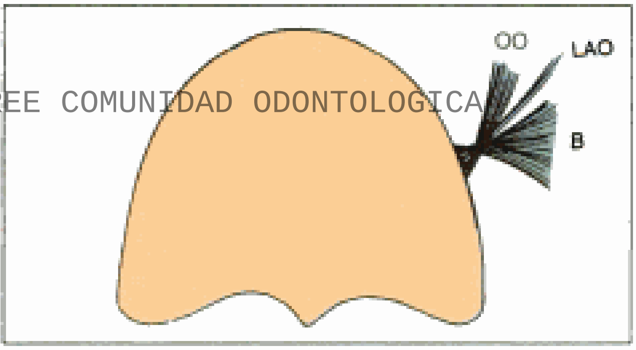


Fig. 5.7: Buccal frenum. Showing the orbicularis oris (O,O), levator anguli oris (LAO) and buccinator (B) muscles

The ramus and coronoid process of the mandible and masseter modify the size of this vestibule during mouth opening. When the mouth is opened and the mandible is moved from side to side, the coronoid process of the mandible will come near the distobuccal portion of the maxillary sulcus. The distal end of buccal flange of the denture should be adjusted in such a way that there is no interference to the coronoid process during mouth opening.

Hamular Notch

The hamular notch is a depression situated between the maxillary tuberosity and the hamulus of medial pterygoid plate. It is soft area of loose areolar tissue. The tissues in this region can be safely displaced to achieve the posterior palatal seal. The distolateral border of the denture base rests in the hamular notch.

The denture border should extend till the hamular notch. If the border is located anteriorly near the maxillary tuberosity, the denture will not have any retentive properties because the border seal is absent when placed over nonresilient tissues (Fig. 5.8).

Posterior Palatal Seal Area (Postdam)

It is defined as *" The soft tissues at or along the junction of the hard and soft palates on which pressure within the physiological limits of the tissues can be applied by a denture to aid in the retention of the denture."* - GPT.

This is the area of the soft palate that contacts the posterior surfaces of the denture base. It

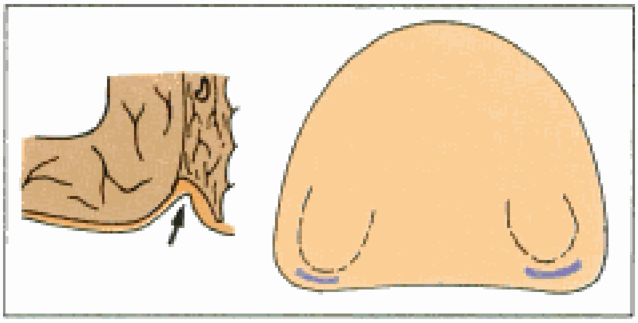


Fig. 5.8: Hamular notch

prevents air entry between the denture base and soft palate. It is the area between the anterior and posterior vibrating lines (explained later) (Fig. 5.9).

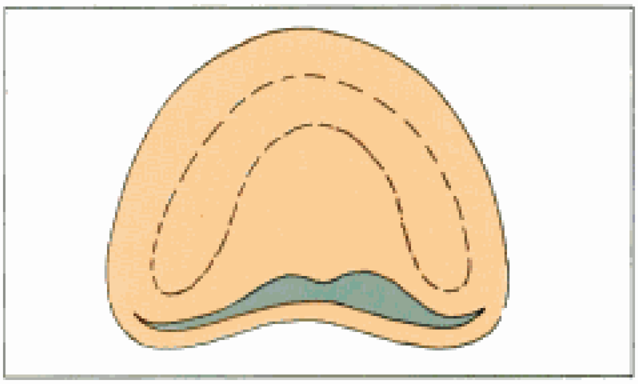


Fig. 5.9: Posterior palatal seal area

Functions of the posterior palatal seal The posterior palatal seal, that is recorded and reproduced in the denture, has the following functions:

- Aids in retention by maintaining constant contact with the soft palate during functional movements like speech, mastication and deglutition.
- Reduces the tendency for gag reflex as it prevents the formation of the gap between the denture base and the soft palate during functional movements.
- Prevents food accumulation between the posterior border of the denture and the soft palate.
- Compensates for polymerization shrinkage.

The posterior palatal seal area can be divided into two regions based upon anatomical landmarks, namely:

Pterygomaxillary seal
Postpalatal seal.

Pterygomaxillary seal This is the part of the posterior palatal seal that extends across the hamular notch and it extends 3 to 4 mm anterolaterally to end in the mucogingival junction on the posterior part of the maxillary ridge.

The hamular notch is located between the maxillary tuberosity and the hamular process of the sphenoid bone. It contains loose connective tissue and few fibres of *Tensor Veli Palatini* muscle covered by a thin layer of mucous membrane. The position of this membrane changes with mouth opening hence it should be recorded accurately during impression making .The posterior extent of the denture in this region should end in the hamular notch and not extend over the hamular process as this can lead to severe pain during denture wear (Fig. 5.10).

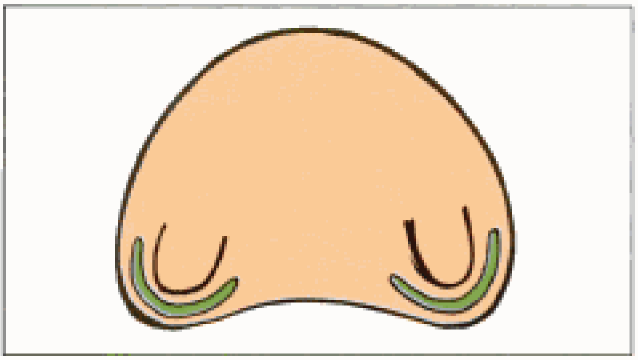


Fig. 5.10: Pterygomaxillary seal

Postpalatal seal This is a part of the posterior palatal seal that extends between the two maxillary tuberosities (Fig. 5.11).

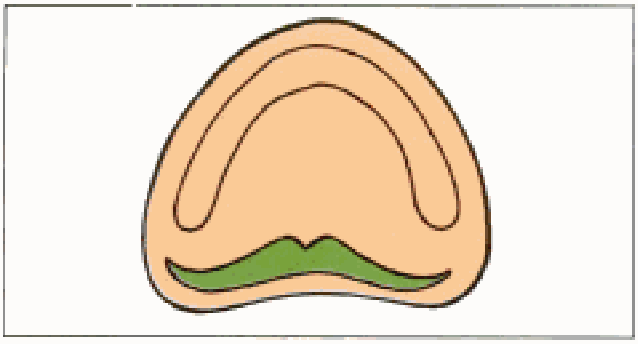


Fig. 5.11: Postpalatal seal

The following points should be remembered while recording the posterior palatal seal:

- The posterior border of the denture should not be placed over the mid-palatine raphe or the posterior nasal spine.
- If there is a palatine torus, which extends posteriorly so that it interferes with the posterior palatal seal, then the tori should be removed.
- The position of the fovea palatina also influences the position of the posterior border of the denture. The denture can extend 1-2 mm across the fovea palatina.
- If a mid-palatine fissure is present, then the posterior palatal seal should extend in to it to obtain a good peripheral seal.
- In patients with thick ropy saliva, the fovea palatina should be left uncovered or else the thick saliva flowing between the tissue and the denture can increase the hydrostatic pressure and displace the denture.

Vibrating Line

It is defined as *"The imaginary line across the posterior part of the palate marking the division between the movable and immovable tissues of the soft palate which can be identified when the movable tissues are moving."* - GPT.

- It is an imaginary line drawn across the palate that marks the beginning of motion in the soft palate, when the individual says "ah".
- It extends from one hamular notch to the other.
- It passes about 2 mm in front of the fovea palatina. The fovea is formed by coalescence of the ducts of several mucous glands. This acts as a guide to locate the posterior border of the denture.
- This line should lie on the soft palate.
- The distal end of the denture must cover the tuberosities and extend into the hamular notches. It should end 1-2 mm posterior to the vibrating line.

Another school of thought considers the presence of two vibrating lines namely:

- Anterior vibrating line.
- Posterior vibrating line.

Anterior vibrating line *It is an imaginary line lying at the junction between the immovable tissues over the hard palate and the slightly movable tissues of the* *soft palate* (Fig. 5.12). It can be located by asking the patient to perform the "Valsalva" maneuver. It can also be measured by asking the patient to say "ah" in short vigorous bursts. (*Valsalva maneuver: the patient is asked to close his nostrils firmly and gently blow through his nose*). The anterior vibrating line is cupid's bow-shaped.

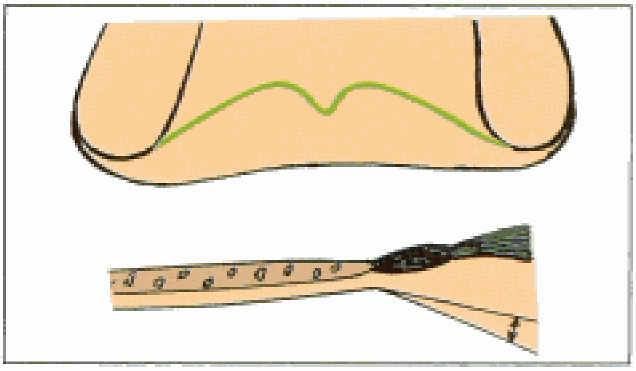


Fig. 5.12: Anterior vibrating line

Posterior vibrating line It is an imaginary line located at the junction of the soft palate that shows limited movement and the soft palate that shows marked movement. It also represents the junction between the aponeurosis of the tensor veli palatini muscle and the muscular portion of the soft palate (Fig. 5.13). It is recorded by asking the patient to say "ah' in short but normal non-vigorous fashion. This line is usually straight.

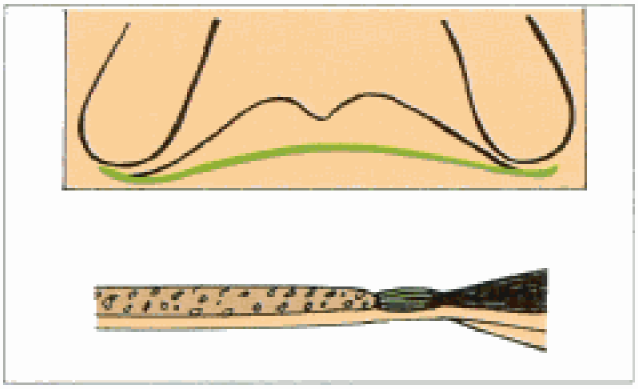


Fig. 5.13: Posterior vibrating line

Supporting Structures

These areas are the load-bearing areas. They show minimal ridge resorption even under constant load. The denture should be designed such that most of the load is concentrated on these areas. The posterolateral slope of the hard plate is the *primary stress-bearing area*. The rugae area is the *secondary stress-bearing area*.

It was previously considered that the crest of the ridge was the primary stress-bearing area, the rugae was the secondary stress-bearing area and the posterior part of the hard palate was the *tertiary stress-bearing area*. This concept is not accepted now.

Hard Palate (Fig. 5.14)

The anterior region of the palate is formed by the palatine shelves of the maxillary bone, which meet at the center to form the median suture. The horizontal plate of the palatine bone forms the posterior part of the palate.

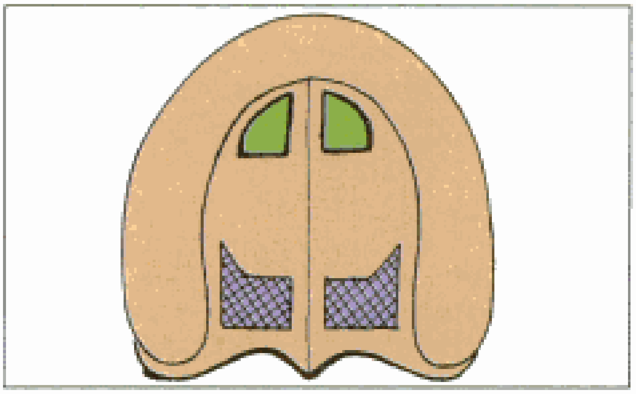


Fig. 5.14: Hard palate
Blue—Primary support area
Green—Secondary support area

The submucosa in the mid-palatine suture is extremely thin. Hence, relief should be provided in the part of the denture covering the suture.

The horizontal portion of the hard palate lateral to the midline acts as the *primary support area*. The trabecular pattern in the bone is perpendicular to the direction of force, making it capable of withstanding any amount of force (without marked resorption). The rugae area acts as a *secondary support area*. The incisive papillae, nasopalatine canal and the midpalatine raphe must be relieved.

Residual Ridge (Fig. 5.15)

It is defined as *"The portion of the alveolar ridge and its soft tissue covering which remains following the removal of teeth."* - GPT.

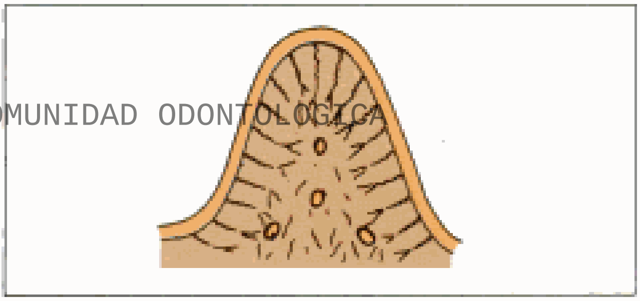


Fig. 5.15: Cross-section of the residual alveolar ridge: Note the trabecular pattern of bone is perpendicular to the surface

It resorbs rapidly following extraction and continues throughout life in a reduced rate. The submucosa over the ridge has adequate resiliency to support the denture.

The crest of the ridge may act as a secondary stress-bearing area. Loosely attached tissues along the slopes of the ridge cannot withstand the forces of mastication. The posterolateral portion of the residual ridge is a *primary stress-bearing area*.

Rugae

These are mucosal folds located in the anterior region of the palatal mucosa. They act as a *secondary support area*. The folds of the mucosa play an important role in speech. Metal denture bases reproduce this contour making it very comfortable for the patient (Fig. 5.16).

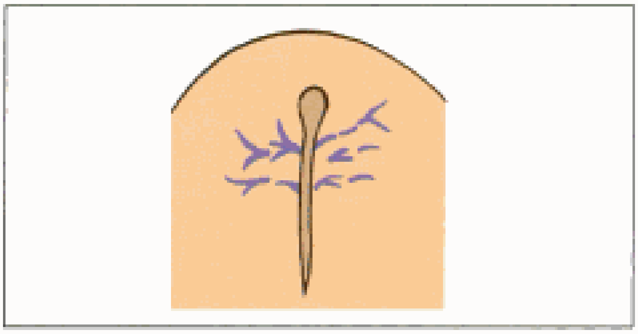


Fig. 5.16: Rugae

Maxillary Tuberosity

It is a bulbus extension of the residual ridge in the second and third molar region. The posterior part of the ridge and the tuberosity areas are considered as one of the most important areas of support because they are least likely to resorb (Fig. 5.17).

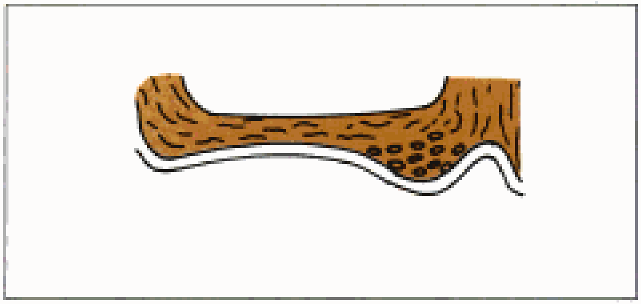


Fig. 5.17: Maxillary tuberosity

A rough prominence formed behind the position of the last tooth is called the *Alveolar tubercle*.

Relief Areas

These areas resorb under constant load or contain fragile structures within. The denture should be designed such that the masticatory load is not concentrated over these areas.

Incisive Papilla

It is a midline structure situated behind the central incisors. It is the exit point of the nasopalatine nerves and vessels. It should be relieved if not, the denture will compress the vessels or nerves and lead to necrosis of the distributing areas (Fig. 5.18) and paraesthesia of anterior palate.

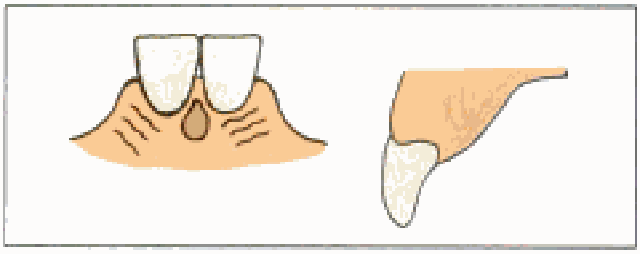


Fig. 5.18: (a) Incisive papilla (b) Cross-sectional view

Mid-Palatine Raphe

This is the median suture area covered by a thin submucosa. It should be relieved during denture fabrication. This area is the most sensitive part of the palate to pressure (Fig. 5.19).

Fovea Palatina

The fovea is formed by coalescence of the ducts of several mucous glands (Fig. 5.20). This acts as

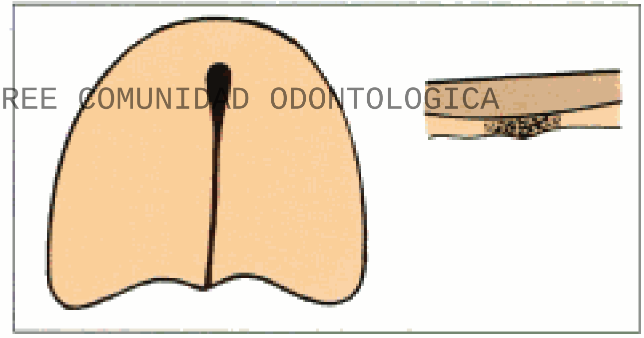


Fig. 5.19: (a) Mid-palatine raphe (b) Cross-sectional view

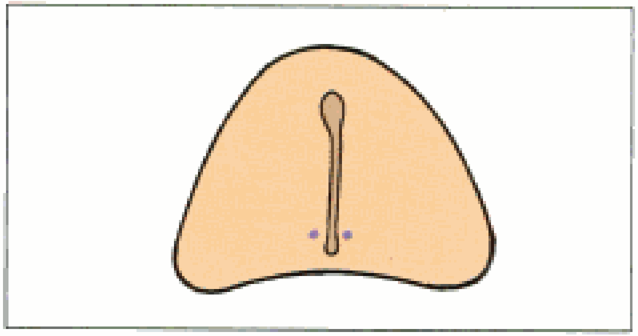


Fig. 5.20: Fovea palatina

an arbitrary guide to locate the posterior border of the denture. The position of the fovea palatina also influences the position of the posterior border of the denture. The denture can extend 1-2 mm beyond the fovea palatina. The secretion of the fovea spreads as a thin film on the denture thereby aiding in retention.

In patients with thick ropy saliva, the fovea palatina should be left uncovered or else the thick saliva flowing between the tissue and the denture can increase the hydrostatic pressure and displace the denture.

Cuspid Eminence

It is a bony elevation on the residual alveolar ridge formed after extraction of the canine. It is located between the canine and first premolar region (Fig. 5.21).

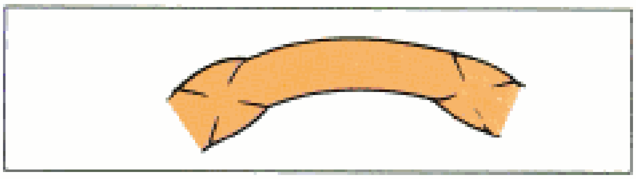


Fig. 5.21: Cuspid eminence

ANATOMICAL LANDMARKS IN THE MANDIBLE

They can be broadly grouped into:

Limiting Structures

- Labial frenum.
- Labial vestibule.
- Buccal frenum.
- Buccal vestibule.
- Lingual frenum.
- Alveololingual sulcus.
- Retromolar pads.
- Pterygomandibular raphe.

Supporting Structures

- Buccal shelf area
- Residual alveolar ridge

Relief Areas

- Crest of the residual alveolar ridge.
- Mental foramen.
- Genial tubercles
- Torus mandibularis.

Limiting Structures

Labial Frenum (Fig. 5.22)

It is a fibrous band similar to that found in the maxilla. The muscles, incisivus and orbicularis oris influence this frenum. Unlike the maxillary labial frenum, it is active. The mandibular labial frenum receives attachment from the orbicularis oris muscle. Hence, it is quite sensitive and active. On opening wide, the sulcus gets narrowed. Hence, the impression will be the narrowest in the anterior labial region.

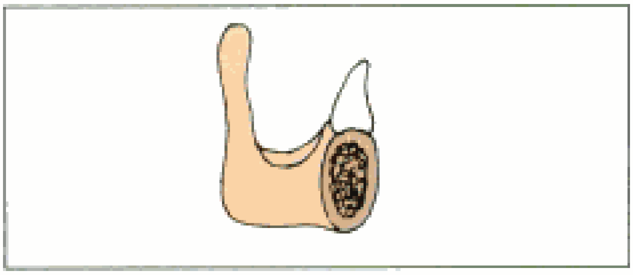


Fig. 5.22: Labial frenum

Labial Vestibule

This is the space between the residual alveolar ridge and the lips. The length and thickness of the labial flange of the denture occupying this space is crucial in influencing lip support and retention.

Buccal Frenum (Fig. 5.23)

It overlies the depressor anguli oris. The fibers of the buccinator are attached to the frenum. It should be relieved to prevent displacement of the denture during function.

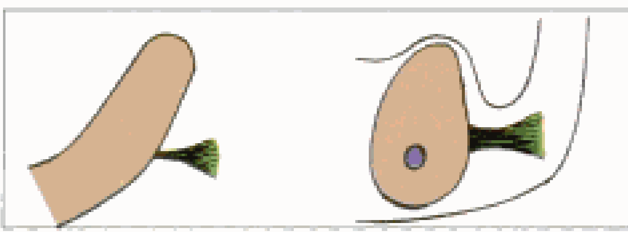


Fig. 5.23: Buccal frenum

Buccal Vestibule

It extends posteriorly from the buccal frenum till the retromolar region. It is bound by the residual alveolar ridge on one side and buccinator on the other side.

This space is influenced by the action of masseter. When the masseter contracts, it pushes inward against the buccinator, producing a bulge into the mouth. This bulge can be recorded only when the masseter contracts. It is reproduced as a notch in the denture flange called the *masseteric notch*.

Lingual Frenum (Fig. 5.24)

The height and width of the frenum varies considerably. Relief should be provided in the anterior portion of the lingual flange. This anterior portion of the lingual flange is called *sub-lingual crescent area*. A *high-lingual frenum* is called a *Tongue Tie*. It should be corrected if it affects the stability of the denture.

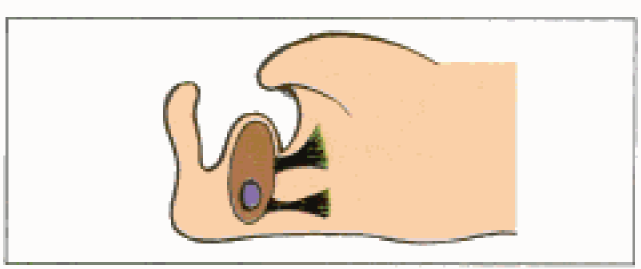


Fig. 5.24: Lingual frenum

Alveololingual Sulcus

It extends from the lingual frenum to the retromylohyoid curtain. It is considered in three regions namely:

Anterior region It extends from the lingual frenum to the premylohyoid fossa, where the mylohyoid curves below the sulcus. The flange will be shorter anteriorly and it should touch the mucosa of the floor of the mouth when tip of the tongue touches the upper incisors (Fig. 5.25).

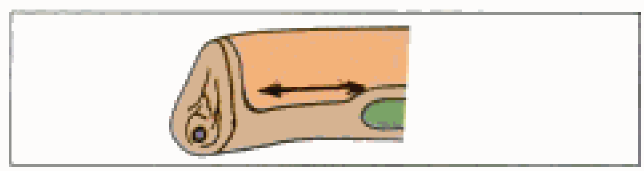


Fig. 5.25: Anterior portion of the alveololingual sulcus

Middle region It extends from the pre-mylohyoid fossa to the distal end of the mylohyoid ridge. This region is shallower than other parts of the sulcus. This is due to the prominence of the mylohyoid ridge and action of the mylohyoid muscle (Fig. 5.26).

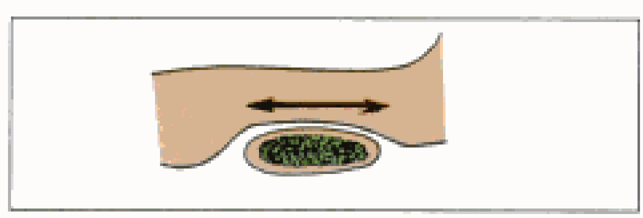


Fig. 5.26: Middle portion of the alveololingual sulcus: Note that it is shallower than the anterior portion

The lingual flange should slope medially towards the tongue. This sloping helps in three ways:

- The tongue rests over the flange stabilizing the denture.
- Provides space for raising the floor of the mouth without displacing the denture.

- The peripheral seal is maintained during function.

Posterior region The retro-mylohyoid fossa is present here. The denture flange in this region should turn laterally towards the ramus of the mandible to fill up the fossa and complete the typical S-form of the lingual flange of the lower denture (Fig. 5.27). This is also called *lateral throat form*.

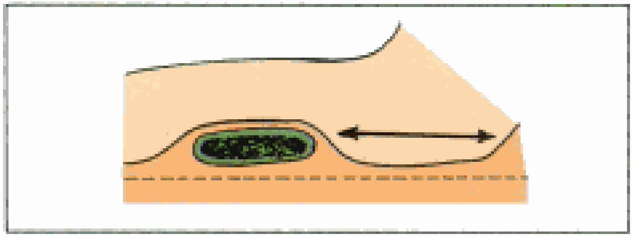


Fig. 5.27: Posterior portion of the alveolo-lingual sulcus. It is commonly known as lateral throat form

Retro-mylohyoid Fossa

It belongs to the posterior part of the alveolo-lingual sulcus. It lies posterior to the mylohyoid muscle (Fig. 5.28).

This fossa is bounded:

- Anteriorly by the retro-mylohyoid curtain
- Posterolaterally by the superior constrictor of the pharynx
- Posteromedially by the palatoglossus and lateral surface of the tongue
- Inferiorly by the sub-mandibular gland.

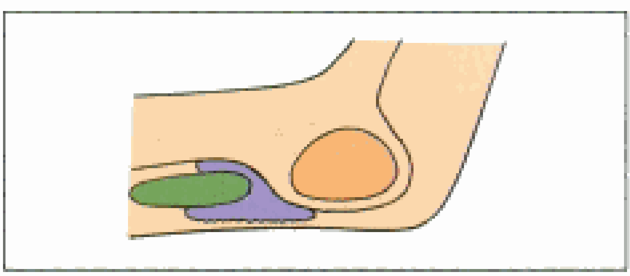


Fig. 5.28: Retromylohyoid fossa,
Green: Mylohyoid muscle;
Blue: Submandibular salivary gland

Retromolar Pad

The retromolar pad is an important structure, which forms the posterior seal of the mandibular denture. It is a non-keratinized pad of tissue seen as a posterior continuation of the pear-shaped pad. The pear-shaped pad is a triangular keratinized soft pad of tissue at the distal end of the ridge.

Sicher described retromolar pad as a triangular soft elevation of mucosa that lies distal to the third molar. It is nothing but a collection of loose connective tissues with an aggregate of mucosal glands. It is bounded posteriorly by the tendons of the temporalis, laterally by the buccinator and medially by the pterygomandibular raphe and superior constrictor.

These muscles limit the denture extent and prevent the placement of extra pressure during impression making. Hence, the denture base should extend only one half to two third over the retromolar pad (Fig. 5.29).

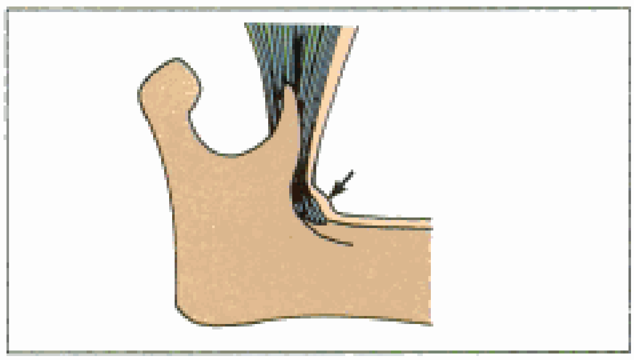


Fig. 5.29: Pear-shaped pad

Retromolar Papilla It is described as a pear-shaped papilla. Craddock coined this term and described it as a small elevation. It is nothing but a residual scar formed after the extraction of the third molar. It lies along the line of the ridge. The denture should terminate at the distal end of the pear-shaped papilla. Beading this area improves retention (Fig. 5.30).

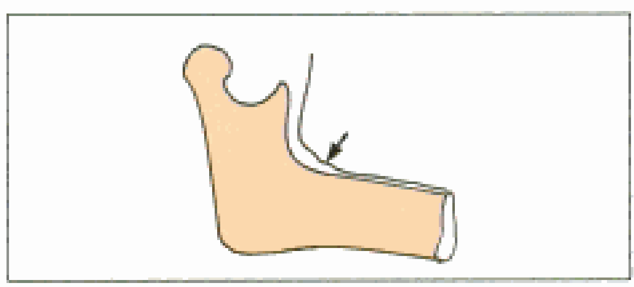


Fig. 5.30: Retromolar papilla

The retromolar pad has a stippled and keratinized mucosa.

Pterygomandibular Raphe

Pterygomandibular raphe arises from the hamular process of the medial pterygoid plate and gets attached to the mylohyoid ridge. A raphe is a tendinous insertion of two muscles. In this case, the superior constrictor is inserted posteromedially and the buccinator is inserted anterolaterally (Fig. 5.31).

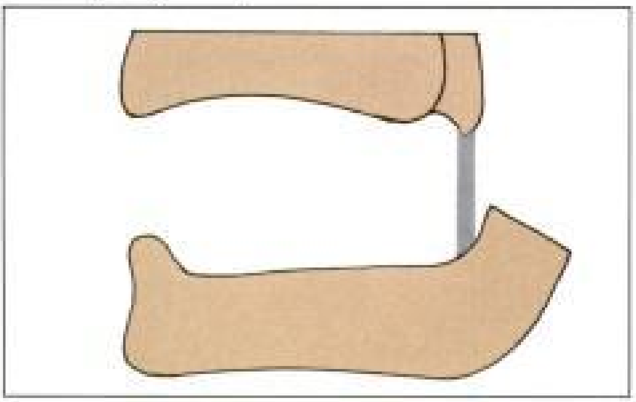


Fig. 5.31a: Pterygomandibular raphe

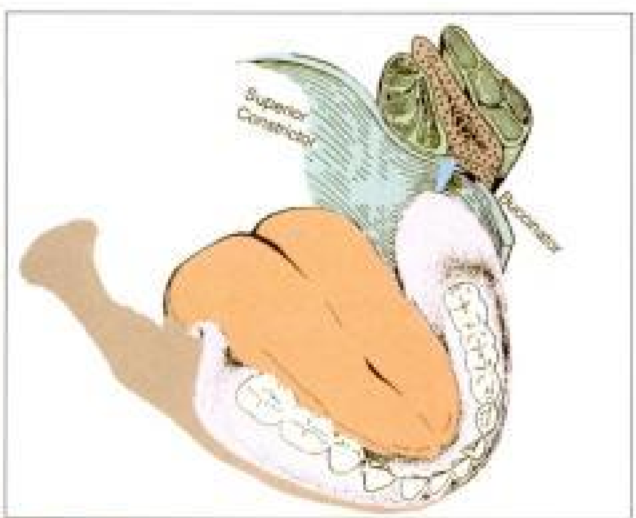


Fig. 5.31b: The pterygomandibular raphe formed by the tendinous insertion of the buccopharyngeus part of superior constrictor and the buccinator muscle. Note: The buccinator is lateral to the ramus and the superior constrictor is medial to the ramus

It is very prominent in some patients where a notch-like relief may be required on the denture. Most patients do not require any clearance. A simple wide-open visual and digital inspection is sufficient to determine the need for clearance.

Supporting Structures

The mandibular denture poses a great technical challenge. The support for a mandibular denture comes from the body of the mandible. The available denture-bearing area for an edentulous mandible is 14 cm^2 but for maxilla it is 24 cm^2. Hence, the mandible is less capable of resisting occlusal forces.

Buccal Shelf Area (Fig. 5.32)

It is the area between the buccal frenum and anterior border of the masseter. Its boundaries are:
- Medially the crest of the ridge
- Distally the retro-molar pad
- Laterally the external oblique ridge

The width of the buccal shelf area increases as alveolar resorption continues. It has a thick submucosa overlying a cortical plate. As it lies at right angles to the occlusal forces, it serves as a primary stress-bearing area.

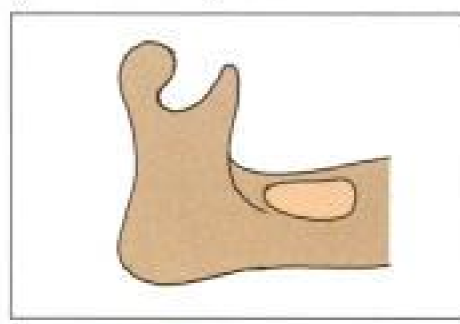


Fig. 5.32: Buccal shelf area

Residual Alveolar Ridge (Fig. 5.33)

The edentulous mandible may become flat with a concave denture-bearing surface. In such cases the attaching structures on the lingual side of ridge attach over the ridge. Due to resorption, the mandible inclines outward and becomes progressively wider. The maxillae resorb upward and inward making it smaller. This gives the prognathic appearance in long-term edentulous patients.

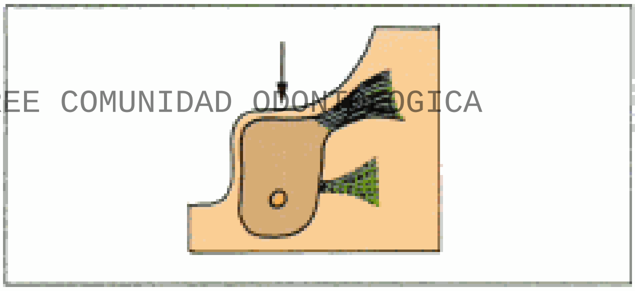


Fig. 5.33: Residual alveolar ridge showing a concave surface with a superior attachment of the adjoining structures.

Relief Areas

Mylohyoid Ridge (Fig. 5.34)

It runs along the lingual surface of the mandible. Anteriorly the ridge lies close to the inferior border of mandible while posteriorly, it lies flush with the residual ridge. The thin mucosa over the mylohyoid ridge may get traumatized and should be relieved. The area under this ridge is an undercut.

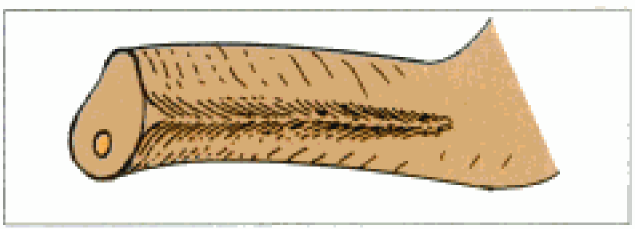


Fig. 5.34: Mylohyoid ridge

Mental Foramen (Fig. 5.35)

It lies between the first and second premolar region. Due to ridge resorption, it may lie close to the ridge. It should be relieved in these cases as pressure over the nerve produces para-esthesia.

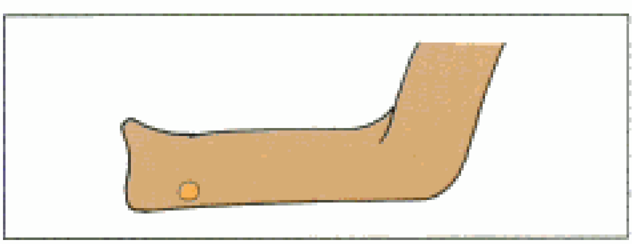


Fig. 5.35: Mental foramen

Genial Tubercles (Fig. 5.36)

These are a pair of bony tubercles found anteriorly on the lingual side of the body of the mandible. Due to resorption, it may become increasingly prominent making denture usage difficult.

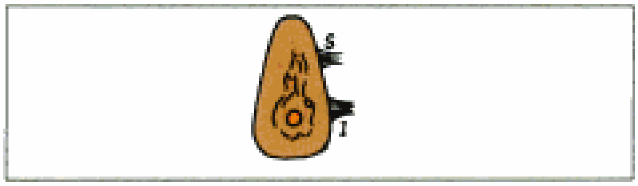


Fig. 5.36: Genial tubercles. The superior one gives attachment to the genioglossus muscle and the inferior tubercle gives attachment to the geniohyoid muscle

Torus Mandibularis (Fig. 5.37)

It is an abnormal bony prominence found bilaterally on the lingual side, near the premolar region. It is covered by a thin mucosa. It has to be relieved or surgically removed as decided by its size and extent.

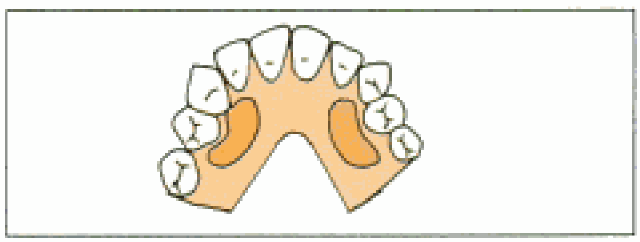


Fig. 5.37: Tori on the mandibular premolar area

PRINCIPLES OF IMPRESSION MAKING

Principles of Impression Making

The concepts to be followed to get a successful impression are:

- The oral tissues must be healthy.
- Impression should include all of the basal seat within the limits of health and function of the supporting and limiting tissues.
- The borders must be in harmony with the anatomical and physiological limitations of the oral structures.
- Physiological type of border moulding should be performed

- Sufficient space should be provided within the impression tray for the selected impression material.
- Impression must be removed from the mouth without damaging the mucosa.
- Selective pressure should be applied on the basal seat during impression making.
- A guiding mechanism should be provided for correct positioning of the tray within the mouth.
- The tray and impression material should be made of dimensionally stable materials.
- The external shape of the impression should be similar to the external form of complete denture.

OBJECTIVES OF IMPRESSION MAKING

An impression should be made with the purpose of obtaining the following characteristics in the dentures to be fabricated.

- Retention.
- Stability.
- Support.
- Aesthetics.
- Preservation of remaining structures.

Retention

It is defined as *"That quality inherent in the prosthesis which resists the force of gravity, adhesiveness of foods, and the forces associated with the opening of the jaws"*- GPT.

Retention is the ability of the denture to withstand displacement against its path of insertion.

The factors that affect retention can be classified as:

- Anatomical factors.
- Physiological factors.
- Physical factors.
- Mechanical factors.
- Muscular factors.

Anatomical Factors

The various anatomical factors that affect retention, are:

- Size of the denture-bearing area.
- Quality of the denture-bearing area.

Size of the denture-bearing area Retention increases with increase in size of the denture-bearing area. The size of the maxillary denture-bearing area is about 24 cm^2 and that of mandible is about 14 cm^2. Hence, maxillary dentures have more retention than mandibular dentures (Fig. 5.38).

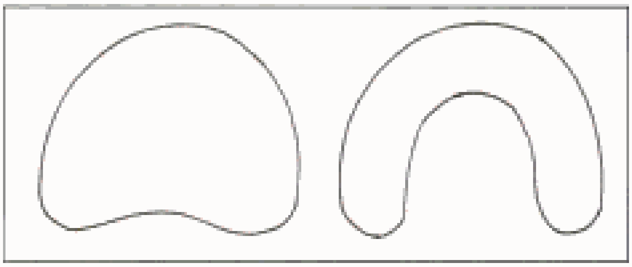


Fig. 5.38: (a) Maxillary denture-bearing area: 24 cm^2 (b) Mandibular denture-bearing area: 14 cm^2

Quality of the denture-bearing area The displaceability of the tissues influences the retention of the denture. Tissues displaced during impression making will lead to tissue rebound during denture use, leading to loss of retention.

Physiological Factors

Saliva The viscosity of saliva determines retention. Thick and ropy saliva gets accumulated between the tissue surface of the denture and the palate leading to loss of retention. Thin and watery saliva can also lead to compromised retention.

Cases with ptyalism can lead to gagging and in patients with xerostomia, dentures can produce soreness and irritation.

Physical Factors

The various physical factors which affect retention, are:

- Adhesion.
- Cohesion.
- Interfacial surface tension.
- Capillarity or capillary attraction.
- Atmospheric pressure and peripheral seal.

Adhesion (Fig. 5.39) It is defined as *"The physical attraction of unlike molecules to one another."*- GPT.

The role of saliva is very important for adhesion. Saliva wets the tissue surface of the denture

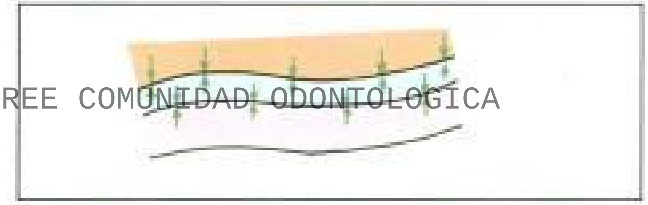


Fig. 5.39: Schematic representation showing adhesion between the saliva and tissues (black arrows) and the adhesion between the saliva and the denture base (green arrows)

and the mucosa. A thin film of saliva is formed between the denture and the tissue surface. This thin film helps to hold the denture to the mucosa. The amount of adhesion present is proportional to the denture base area.

In patients with xerostomia, adhesion does not play a major role.

Cohesion (Fig. 5.40) It is defined as "*The physical attraction of like molecules for each other*".

The cohesive forces act within the thin film of saliva. The effectiveness of these forces increase with increase in denture-bearing area. Watery serous saliva can form a thinner film and is more cohesive than thick mucous saliva.

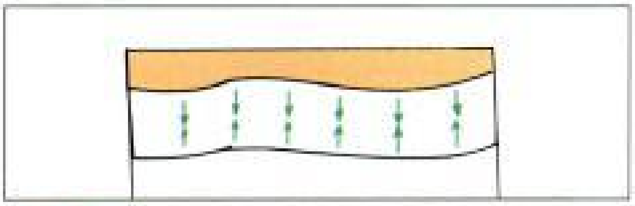


Fig. 5.40: Schematic representation showing cohesive forces within the saliva (green arrows)

Interfacial surface tension It is defined as "*The tension or resistance to separation possessed by the film of liquid between two well-adapted surfaces*"-GPT.

These forces are found within the thin film of saliva separating the denture base from the tissues. This film of saliva tends to resist the displacing forces, which tend to separate the denture from the tissues. It plays a major role in the retention of a maxillary denture. It is totally dependant on the presence of air at the margins of liquid and solid contact (liquid air interface). Take two glass slabs and wash them in water and place one glass slab over the other. You may realize that the glass slabs are stuck together and it is difficult to move them apart or separate them.

Now place the slabs underwater. You will realize that the glass slabs can be easily separated. This is because there is no liquid-air interface under water. Hence, there is no surface tension. This phenomenon is noticeable in mandibular dentures where there is excess saliva. As there is excess saliva along the borders of a mandibular denture there is minimal interfacial surface tension (Fig. 5.41).

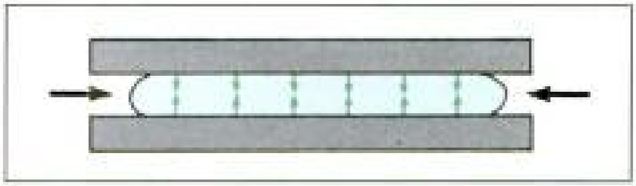


Fig. 5.41a: A liquid drop placed between two glass slabs prevents the separation of the slabs due to the action of forces of surface tension: (green arrows) at the air-water interface (black arrows)

Fig. 5.41b: The same assembly when palced under water, will lose its surface tension due to the loss of its air-water interface

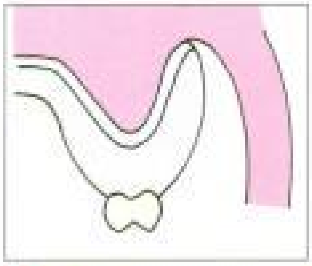


Fig. 5.41c: Surface tension present in the maxillary denture

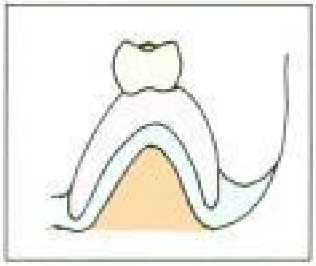


Fig. 5.41d: Surface tension lost in the mandibular denture due to the loss of the air-saliva interface at the denture border

Stefan proposed a formula to calculate the interfacial surface tension.

According to Stefan's law

$$F = \left[\frac{\frac{3}{2} \times 3.14 \times Kr^4}{H^3}\right] \times V$$

where

F - interfacial surface tension.

k - viscosity of the interposed liquid (saliva).

r - denture surface area.

h - the width of the space between the denture base and the mucosa.

V - the velocity of the displacing force.

F decreases with the increase in h.

Increase in r increases the F.

A slow and steady increase in V will have least resistance from interfacial surface tension than a rapid V.

To obtain maximum interfacial surface tension:

- Saliva should be thin and even.
- Perfect adaptation should be present between the tissues and the denture base.
- The denture base should cover a large area.
- There should be good adhesive and cohesive forces, which aid to enhance interfacial surface tension.

Capillarity or capillary attraction It is defined as, *"That quality or state, because of surface tension causes elevation or depression of the surface of a liquid that is in contact with a solid"*-GPT.

A liquid tends to rise in a capillary tube by maximizing its contact along the walls of the tube at the interface between the liquid and glass. When there is close adaptation between the denture and the mucosa, the thin film of saliva tends to flow and increase its surface contact thereby increasing the retention.

Factors that aid to improve capillary attraction:

- Closeness of adaptation of denture base to soft tissue.
- Greater surface of the denture-bearing area.
- Thin film of saliva should be present.

Atmospheric pressure and peripheral seal (Fig. 5.42) Peripheral seal is the area of contact between the peripheral borders of the denture and the resilient-limiting structures. This peripheral seal prevents air entry between the denture surface and the soft tissue. Hence, a low pressure is maintained within the space between the denture and the soft tissues.

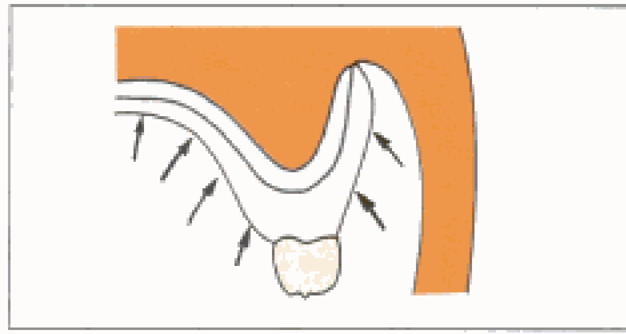


Fig. 5.42: Diagram showing the action of the forces of atmospheric pressure against the downward displacement of a maxillary denture

To achieve good peripheral seal, the denture borders should rest on soft and resilient tissues. Such tissues allow the movement of the mucosa alongwith the denture base during function thus constantly maintaining peripheral seal.

When displacing forces act on the denture, a partial vacuum is produced between the denture and the soft tissues, which aids in retention.

This property is called the natural suction of a denture. Hence, atmospheric pressure is referred to as *emergency -retentive force or temporary restraining force*. Retention produced by an atmospheric pressure is directly proportional to the denture base area.

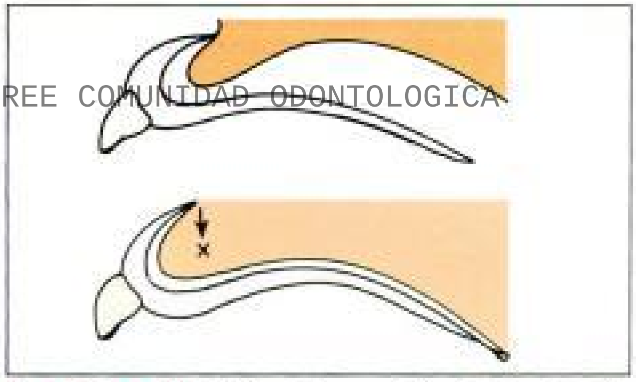
Mechanical Factors

The various mechanical factors, which aid in retention, are:

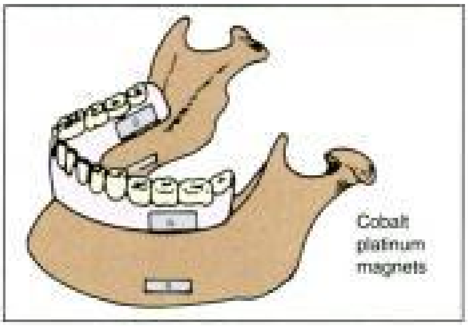
- Undercuts.
- Retentive springs.
- Magnetic forces.
- Denture adhesives.
- Suction chambers and suction discs.

Undercuts Unilateral undercuts aid in retention while bilateral undercuts will interfere with denture insertion and require surgical correction (Fig. 5.43).

Magnetic forces (Fig. 5.44) Intramucosal magnets aid in increasing retention of highly-resorbed ridges. This topic is very vast and beyond the scope of this book.



Figs 5.43a and b: (a) Inserting a maxillary denture into the undercut of the labial sulcus (b) After placing the labial flange within the undercut the posterior part fo the denture is adapted towards the tissues. The arrow indicates that the unilateral anterior undercut will behave like a retentive zone (that prevents the downward displacement of the denture)



Figs 5.44a and b: Intraoral magnet retained dentures

Denture adhesives They are available as creams or gels or powders. They should be coated on the tissue surface before wearing the denture. They are discussed in Chapter 13.

Suction chambers and suction discs In the past suction chambers in the maxillary dentures were used to aid in retention. The suction chamber creates an area of negative pressure, which increases retention. They are avoided now due to their potency for creating palatal hyperplasia (Fig. 5.45).

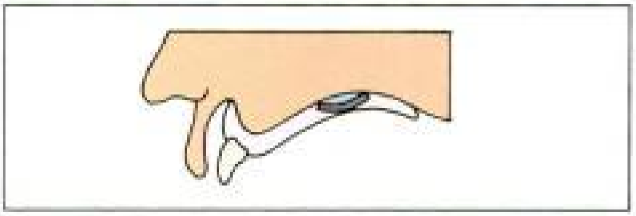


Fig. 5.45a: Cross-sectional view of a suction disc retained denture showing the formation of vacuum (blue)

Fig. 5.45b: Other mechanical attachments

Muscular Factors

The muscles apply supplementary retentive forces on the denture. There is a balance between the forces acting from the buccal musculature and the tongue. This balance is obtained in the *neutral zone*.

Hence, the artificial teeth should be arranged in the neutral zone to achieve the best retention possible. The occlusal plane should be parallel to the residual ridge and divide the interarch space equally (Fig. 5.46).

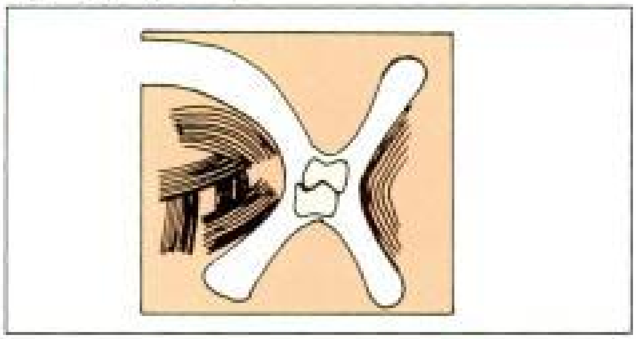


Fig. 5.46: Posterior teeth arrangement in the neutral zone in order to prevent the action of muscular de-stabilizing forces on the denture

Stability

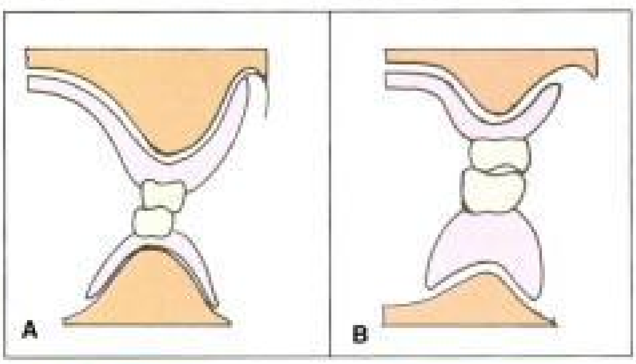
Stability is defined as, *"The quality of a denture to be firm, steady or constant, to resist displacement by functional stresses and not to be subject to change of position when forces are applied"* - GPT.

Stability is the ability of the denture to withstand horizontal forces. The various factors affecting stability are:

- Vertical height of the residual ridge.
- Quality of soft tissue covering the ridge.
- Quality of the impression.
- Occlusal rims.
- Arrangement of teeth.
- Contour of the polished surfaces.

Vertical Height of the Residual Ridge

The residual ridge should have sufficient vertical height to obtain good stability. Highly resorbed ridges offer the least stability (Fig. 5.47).



Figs 5.47a and b: (a) Good ridge height available to provide horizontal stability to the denture (b) Poor ridge height will not be able to provide horizontal stability to the denture

Quality of Soft Tissue Covering the Ridge

The ridge should provide a firm soft tissue base with adequate submucosa to offer good stability. Flabby tissues with excessive submucosa offer poor stability.

Quality of the Impression

- An impression should be as accurate as possible.
- The impression surface should be smooth and duplicate all the details accurately.
- It should be devoid of voids and any rough surfaces.
- The impression should not warp on removal.
- The impression should be dimensionally stable and the cast should be poured as soon as possible.

Occlusal Plane

The occlusal plane should be oriented parallel to the ridge. If the occlusal plane is inclined, then the sliding forces may act on the denture, reduce its stability. The occlusal plane should divide the interarch space equally (Fig. 5.48).

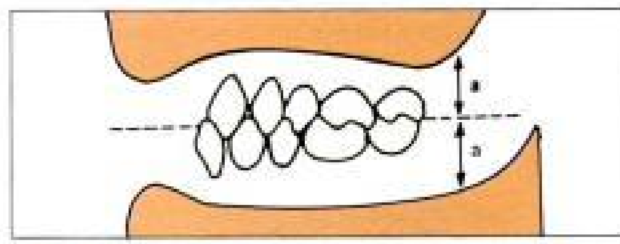


Fig. 5.48: The plane of occlusion should approximately divide the interarch space equally

Teeth Arrangement (balanced occlusion and neutral zone)

The position of the teeth and their occlusion play an **important** role in the stability of the denture. Balanced occlusion facilitates the even distribution of forces across the denture. Absence of balanced occlusion may produce unbalanced, lever type forces on any one side of the denture leading to loss of stability (*ref. balanced occlusion*).

The teeth in the denture should be arranged in the neutral zone. The neutral zone is defined as, *"The potential space between the lips and cheeks on one side and the tongue on the other. Natural or artificial teeth in this zone are subject to equal and opposite forces from the surrounding musculature"* - GPT.

Contour of the Polished Surface

The polished surfaces of the denture should be harmonious with the oral structures. They should not interfere with the action of the oral musculature.

Support

Support is defined as, *"The resistance to vertical forces of mastication, occlusal forces and other forces applied in a direction towards the denture-bearing area."*

In order to provide good support, the denture base should cover as much denture-bearing area as possible. This helps to distribute forces over a wide area. This ability of the denture to distribute forces over wide areas due to an increase in the denture-base area is termed the *"snowshoe"* effect (Fig. 5.49). Thus the force per unit area is reduced.

Confining the occlusal forces to stress-bearing areas and reliving the nonstress-bearing areas will aid to improve support.

Aesthetics

Aesthetics is one of the prime concerns of the patient in the complete denture treatment. The thickness of the denture flanges is one of the important factors that govern aesthetics. Thicker denture flanges are preferred in long-term edentulous patients to give the required mouth fullness. Impression should perfectly reproduce the width and height of the entire sulcus for the proper fabrication of the flanges.

Preservation of Remaining Structures

Muller De Van (1952) stated that, *"the preservation of that which remains is of utmost importance and not the meticulous replacement of that which has been lost."*

Impressions should record the details of the basal seat and the peripheral structures in an appropriate form to prevent injury to the oral tissues. E.g. the stress-bearing and nonstress-bearing areas should be recorded under stress and relief respectively. This prevents the damage of the oral structures due to the action of improperly distributed forces.

The peripheral tissues should be recorded accurately to prevent over-extension of the denture and tissue irritation.

RECORDINGTHE PRIMARY IMPRESSION

A primary impression is defined as, *"an impression made for the purpose of diagnosis or for the construction of a tray"* – GPT.

Now we shall discuss the preliminary impression procedures for the maxilla and mandible. Before going into the details of impression making for each arch, we shall discuss tray and material selection which are common to both arches.

Tray Selection

An impression tray is defined as, *"a receptacle into which a suitable material is placed to make an impression"*. *"A device which is used to carry, confine and control an impression material while making an impression"* - GPT.

Trays used for primary impression making are called *stock trays*. They are factory prepared and are available in standard sizes. They are made of metal or plastic, can be perforated or non-perforated. Disposable stock trays are also available (Fig. 5.50).

As standardized trays will not adapt closely to the patients arch, an approximate tray (size and material) should be selected for each patient.

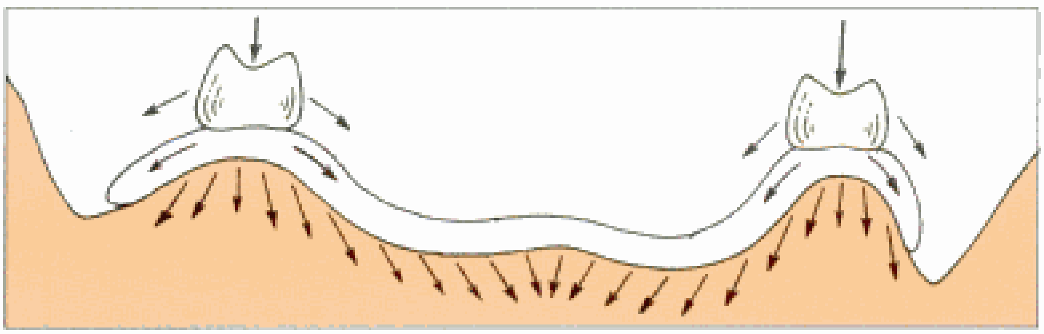


Fig. 5.49: Snowshoe effect of the denture base distributing all the masticatory forces across all the resilient tissues

Figs 5.50a and b: Edentulous stock trays

The following points should be considered during tray selection:

- There should be at least 2-3 mm clearance between the stock tray and the ridge (Fig. 5.51). It should have 5-6 mm clearance for impression compound.

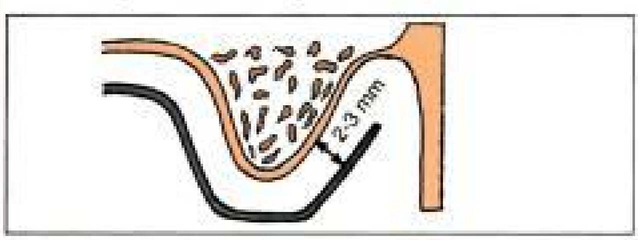


Fig. 5.51: 2-3 mm clearance required between the tray and the tissues

- With the stock tray in position in the patient's mouth, the handle of the tray is tilted downwards and the posterior border of the tray is observed. The tray should extend over the tuberosity and the hamular notch (Fig. 5.52).

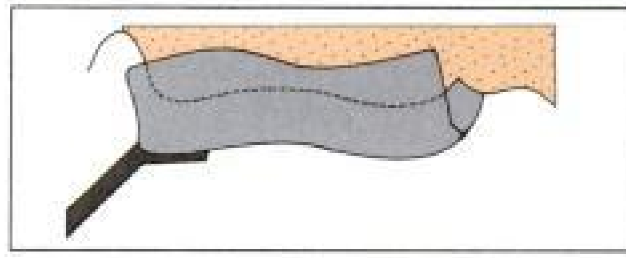


Fig. 5.52: Posterior extension of the tray

- If the tray is too large, it will distort the tissues in the borders of the impression and will push the tissues (cheeks) away from the bone. If the tray is small then modelling wax should be added along the posterior border of the tray. Soft, boxing wax can be used to create a rim that helps to adapt the borders of the tray. It also protects the fragile border tissues (Fig. 5.53).

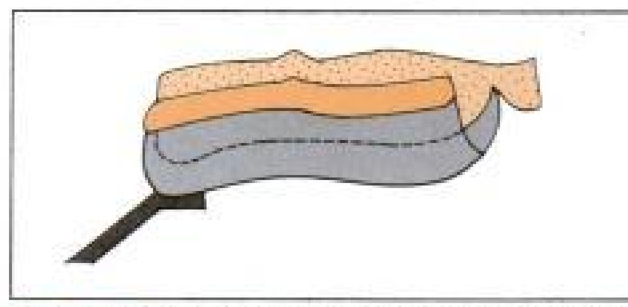


Fig. 5.53: Utility wax added to increase the height of the tray borders if required

- If it is too small, the border tissues will collapse inward to the residual ridge.
- The tray material should not react with the impression material and it should not distort.
- For making alginate impressions, perforated trays are used.
- All primary impressions generally have overextended borders.

Clinical Procedure

Primary Impression Making of the Maxillary Arch

- The objective is to obtain a preliminary impression that is slightly overextended along the borders.

- An impression material with relatively high viscosity is preferred as it will displace the tissues and compensate for the deficiencies in the extent of the tray.

- A sufficient amount of impression compound is softened in a water bath at 140° F. Once the compound softens, it is kneaded to produce a more uniform workable mass with uniform temperature.
- The kneaded material is rolled into a ball and placed on the tray. Using the thumb, the operator should spread and adapt the material all over the tray so that it approximates to the ridge contour (Fig. 5.54).

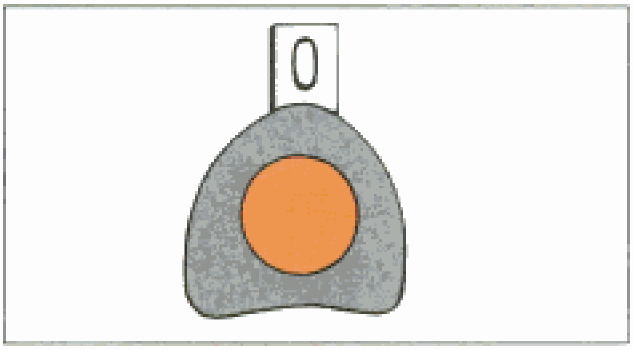


Fig. 5.54a: Placing the kneaded impression material on a maxillary stock tray

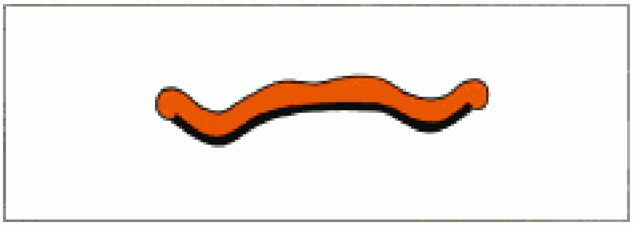


Fig. 5.54b: Spreading and contouring the impression material over the tray, prior to impression making

- If alginate is used, a small amount of material is placed in the anterior part of the palate and the tuberosities (patient's mouth) before making the impression to avoid air entrapment.
- The patient is asked to sit upright and open the mouth halfway. The operator should position himself towards the side and rear of the patient.
- The tray is centred over the upper residual ridge by using the labial frenum as a centering guide.
- After proper positioning, the tray is seated over the ridge by applying pressure in the first molar region, until it touches the posterior palatal seal.
- The tray is stabilized with a finger placed at its centre.
- Borders are refined by asking the patient to suck down into the tray, move the mandible side to side and then open wide.
  This movement moulds the labial and buccal vestibules and records the influence of coronoid processes on the shape of the buccal vestibules.
- Once the material has set, the cheeks and upper lip are lifted away from the borders of the impression to allow air entry. The tray is removed from the mouth in one motion and inspected for any deficiency.
- The borders of the custom tray (to be fabricated) can be marked by,
  — Marking the peripheral outline on the impression (preferred).
  — Outlining the cast.
- The outline and the impression are observed near the patient's mouth.
- The cast is poured with dental plaster and the outline of the custom tray will be evident on the cast.

Primary Impression Making for the Mandible

A suitable impression tray is selected based on the concept described previously. The mandibular impression surface is smaller than the maxillary impression surface, the material of choice for primary impression making in the mandible is impression compound or high viscosity alginate.

- An astringent mouthwash is given to the patient to reduce the viscosity of his/her saliva.
- The selected impression material is manipulated and loaded on to the tray. If alginate is used a small quantity of material is placed on the retromolar pads in the patient's mouth.
- The tray should be rotated within the patient's mouth in a horizontal plane until it is in the center of the residual ridge. The patient should

be asked to raise the tongue to fit into the tongue space of the impression tray.

- The tray is seated gently using alternate pressure on the molar regions of either side. The tongue should be in a relaxed position.
- After seating the impression tray passive movements of the peripheral musculature is done. This is to produce the depth and width of the sulcus in the impression. Various tongue movements (as described in chapter 7) should be performed to record the lingual extension.
- Once the impression material sets, the lips and cheeks are retracted and the impression is removed in a single snap from the patient's mouth.
- The impression is checked for air inclusions, voids and deficiencies. The impression should be inspected if it covers and reproduces all the anatomical landmarks in the patient's mouth. If the border is underextended, additional impression compound is softened, added and the impression is repeated.
- The preliminary impression should be poured within the next 30 minutes. Usually dental plaster is preferred.

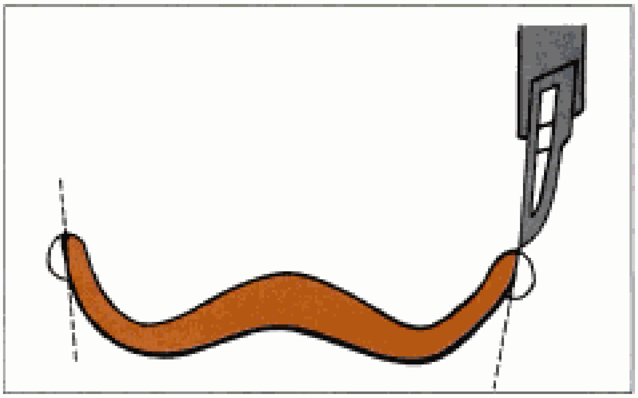


Fig. 5.55: Refining the primary impression

REFINING THE PRIMARY IMPRESSION

It is a very simple procedure done after recording all the landmarks. The borders of the impression are trimmed so that there is no excess bulk of impression material. Usually a B.P. blade is used for this purpose.

After trimming away the excess, the impression is resoftened, retraced and rerecorded before pouring the cast. The primary impression should have sufficient retention (Fig. 5.55).

Chapter 6
Lab Procedures Prior to Master Impression Making

- **Finishing the Primary Cast**
- **Fabrication of a Special Tray**

6

Lab Procedures Prior to Master Impression Making

As mentioned in the first chapter, master impressions are made using custom-made special trays. This chapter covers the details about the making of a primary cast and the fabrication of a special tray.

FINISHING THE PRIMARY CAST

- The primary cast should be poured immediately after making the primary impression because the impression compound tends to distort according to the environmental changes.
- The impression is poured using dental plaster using the same three-pour technique mentioned in detail for the diagnostic cast.
- The cast should be separated from the impression about an hour after the initial set.
- The poured impression is placed in a warm, slurry water bath till the impression compound softens.
- Once softened, the impression can be easily removed. If the material is not softened thoroughly the cast may break during removal.
- If the impression material is oversoftened, the material leaches into the cast, making it difficult to remove.
- If a base former was used while pouring the cast it can be finished quickly. If a base former was not used, then the cast should be trimmed using a model trimmer as described for a diagnostic cast.
- Now the primary cast is ready to fabricate a special tray.

FABRICATION OF A SPECIAL TRAY

Definition

A special tray is defined as, "*A custom made device prepared for a particular patient which is used to carry, confine and control an impression material while making an impression*".

When we make a primary impression using a rigid-high fusing material like impression compound the soft tissues in the palate and in the sulcus usually get displaced. Hence, we get an overextended impression. If we fabricate a denture using this impression, we may end up preparing one with overextended borders (Fig. 6.1).

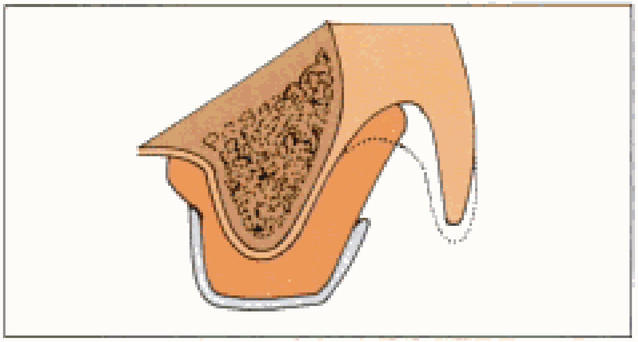


Fig. 6.1: Schematic diagram showing a over-extended primary impression that displaces the tissues beyond their anatomical rest position

Such a denture will lose its retention and easily get displaced during soft tissue, movement. To improve retention, it is necessary to make a functional impression of the sulcus during tissue movement. Green stick compound (type 1 impression compound) is used to record the sulcus in function. A special tray with 2 mm relief at the border is used to load the green stick compound. The major function of a special tray is to provide support for the green stick compound and to provide even thickness of the impression material.

Ideal Requirement

A special tray should fulfil the following requirements:

- It should be well adapted to the primary cast.
- It should be dimensionally stable on the cast and in the mouth.
- The tissue surface should be free of voids or projections.
- It should be at least 2 mm thick in the palatal area and lingual flange for adequate rigidity.
- It should be rigid even in thin sections
- It should not bind to the cast.
- It should be easy to remove.
- It should not react with the impression material.
- It should be easy to manipulate so that it can be easily adapted to a required shape.
- It should not flow or warp.
- It should have a contrasting colour to make its margins appear prominent when placed in the patient's mouth.
- It should have 2 mm relief near the sulcus so that green stick compound can be used to do border moulding.

Conditioning the Primary Cast before Special Tray Fabrication

- The cast should be soaked in slurry water.
- The primary impression usually has overextended borders. Hence the special tray should be 2 - 4 mm short of the sulcus.
- Severe undercuts should be blocked out using wax. Failure to block out the undercuts may result in the breakage of the cast at the time of removal.
- The borders of the special tray should be marked using a pencil.
- The relief areas should also be marked in the cast (Fig. 6.2).

  Some areas are routinely relieved (e.g. incisive papilla, mid-palatine raphe in the maxilla and lingual to the crest of the ridge in the mandible). Additionally, relief may be required for abnormal clinical situations that should be recorded without pressure (e.g. flabby ridge, sharp mylohyoid ridges, sharp glenoid tubercles, areas with the mucosal covering, bony spicules, etc).
- The border of the tray marked on the cast is grooved deeper using a carver. This will act as a guide to trim the tray later.

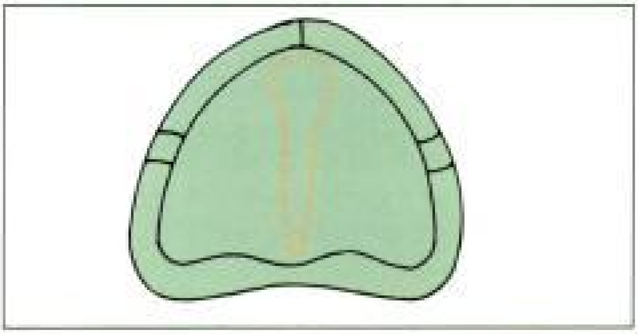
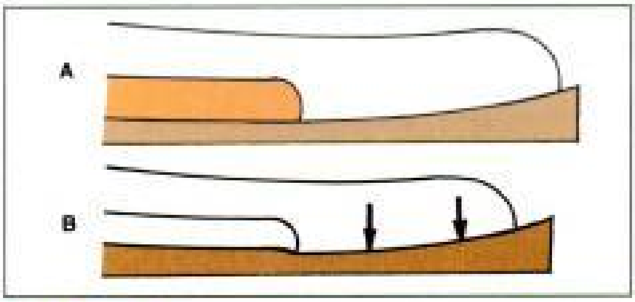


Fig. 6.2: The red dotted lines show the relief areas marked on the master cast

Adapting the Relief Wax

- Relief wax should be adapted over the relief area markings of the cast irrespective of the impression material.
- Relief is given to prevent the tray from exerting excessive pressure on these areas during impression making. This also helps to record the relief tissues in a state of anatomical rest (Fig. 6.3).
- Modelling wax and non-asbestos casting liner are the most commonly used materials for giving relief.



Figs 6.3a and b: The area where the relief wax was adapted, will be recorded in a state of anatomical rest and the area where the relief wax was not adapted and the tray directly contacts the tissues will be recorded under pressure

- The thickness of the relief will vary according to the quality of the tissue.
- The relief material should be adapted only over the non-stress bearing areas.

- In the maxillary cast, the relief wax should be adapted over the incissive papilla and the mid-palatine raphe. In the mandibular cast, the relief wax should be adapted over the crest of the alveolar ridge (Fig. 6.4).

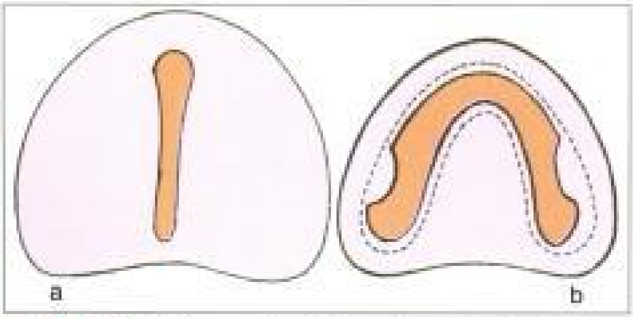


Fig. 6.4: Relief for maxillary (a) and mandibular (b) trays

Adapting the Spacer

In addition to relief wax, a spacer is adapted throughout the extent of the special tray. A spacer is usually not required while making wash impression using ZnOE. Medium bodied elastomers which require a minimum bulk of 2 mm to elicit their properties require a spacer.

- The spacer should be about 2 mm thick. Spacers should be cut out in 2-4 places so that the special tray touches the ridge in these areas. This is done to stabilize the tray during impression making. The part of the special tray that extends into the cut out of the spacer is called *stopper* (Fig. 6.5).
- The location of the stopper is not very critical. Usually 4 stoppers are placed, two on the canine eminences on either side and two on the posterior parts of the ridge.
- The stopper can be a 2 mm square, a 2 by 4 mm rectangle, or 2 mm mesiodistally, palatally, over the crest of the ridge and buccaly half way into the sulcus.

Application of Separating Medium

- The separating medium is applied to avoid the special tray from binding to the cast.

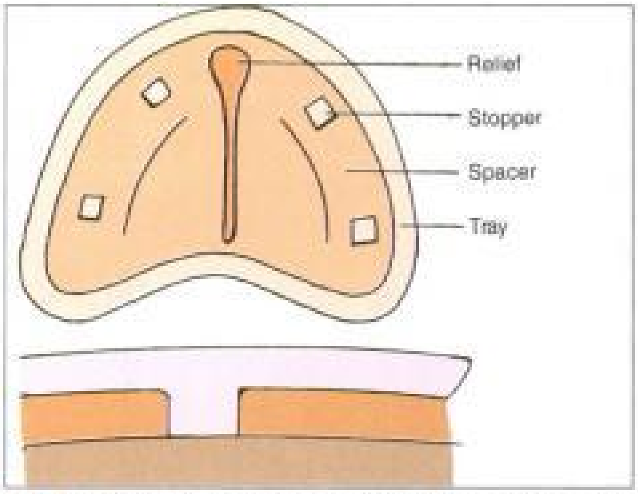


Fig. 6.5: (a) Maxillary spacer with stopper. (b) Diagram showing the stopper of the tray extending between the spacer

- The spacer is removed carefully without any distortion.
- After applying the separating medium on the cast the spacer should be placed back on the cast carefully.
- The spacer should also be coated with a separating medium.
- A surface tension reducing agent can be applied over the spacer to increase the wettability of the separating medium. Commonly used separating media are Cold mould seal, Tin foil, Starch, Vaseline (Petrolatum), Cellulose acetate, etc.

Cold Mould Seal

Cold mould seal is the most commonly used separating medium. It is basically an aqueous solution of sodium alginate.

Composition:

- Sodium alginate (2% in water)
- Glycerin
- Alcohol
- Sodium phosphate
- Preservatives

Soluble sodium alginate reacts with calcium present in the cast to form insoluble calcium alginate. Waxes or oils remaining on the cast should be removed before applying the separating medium. The cast should be warm but not hot as it may break the continuity of the separating medium. The separating medium should be applied with a brush using single-sided strokes.

Fabrication of a Special Tray

Fabrication of the special tray depends on the type of material used. Most commonly used materials for making special tray are:

- Shellac
- Cold cure acrylic
- Vacuum formed Vinyl or Polystyrene
- Vacuum formed thermoplastic resin.
- Type II impression compound (Tray compound).

Shellac

It was the most commonly used material for preparing special trays and base plate. This material is basically a type of wax. It is commercially available in separate shapes for the maxilla and the mandible.

Composition

- Resin — 90.9%
- Wax — 4%
- Glutin — 2.8%
- Moisture — 1.8%
- Colouring agent — 0.5%

Advantages

- Inexpensive.
- Can be easily manipulated.
- Can be readapted even if it distorts.

Disadvantages

- Very brittle and hence it breaks easily.
- It tends to distort easily.
- Sometimes wires may be required to strengthen it.
- Very heat sensitive, it loses its flow properties if over heated.

Technique

- The cast should be treated before adapting shellac so that it does not stick to the cast. This can be done by coating the cast with talcum powder or soaking it in water. Soaking in water may damage the cast. Tin foil can be adapted as an alternative.
- Next, all the undercuts should blocked out (filled) with wax.
- A spacer should be adapted as described before. A non-asbestos casting liner is used as a spacer for these trays . Modelling wax should not be used as a spacer because it may melt during manipulation.
- The shellac plate should be positioned on the cast and the brush flame of the Bunsen burner should be moved across the plate till it becomes shiny and begins to sag (Fig. 6.6).

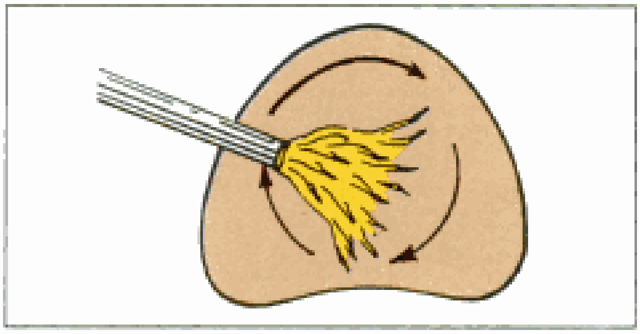


Fig. 6.6

- The palatal surface should be adapted first for the maxillary cast using wet cotton or fingers.
- For the mandibular cast the lingual flange should be adapted first.
- After adapting the palatal or the lingual surface the plate should be reheated and adapted over the crest of the residual alveolar ridge. This prevents the appearance of wrinkles.
- After completing adaptation, the material should be cut using a scissor leaving about 5 mm excess material in the borders (Fig. 6.7).
- The shellac should be re-adapted over the entire cast, especially the sulcus area (Fig. 6.8).

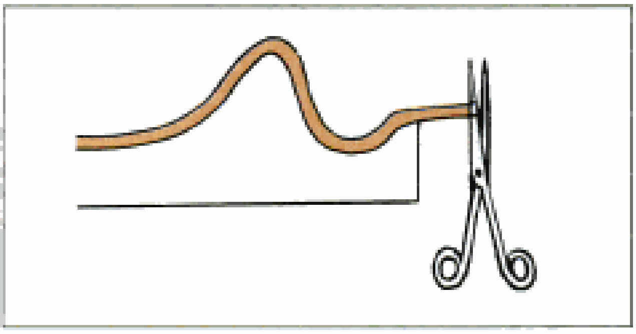


Fig. 6.7

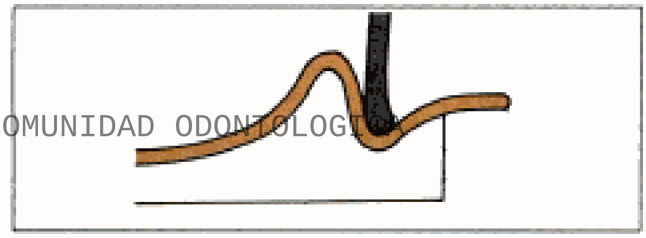


Fig. 6.8

- Excess material should be carefully cut at the deepest point of the sulcus using a scissor (Fig. 6.9).

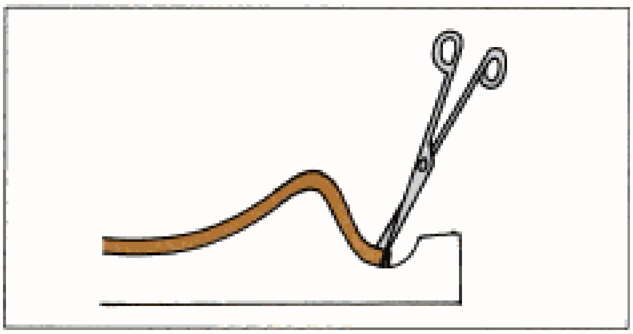


Fig. 6.9

- The margin of the special tray should be finished and smoothened using a triangular file (Fig. 6.10).

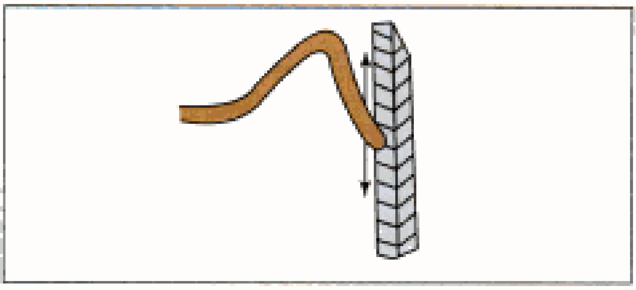


Fig. 6.10

- Filing should be done carefully till the margins of the special tray become 1-2 mm deficient of the sulcus. The file should be held parallel to the slope of the ridge while refining the borders.
- Striations should be made on the anterior portion of the special tray over the incisive papilla using a hot wax knife. This is done to increase the mechanical retention of the handle (Fig. 6.11).

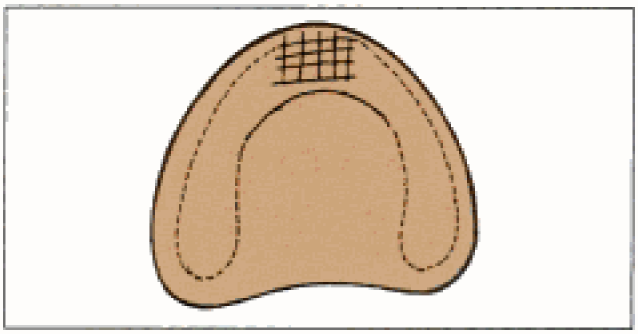


Fig. 6.11

- A small rectangular strip of shellac should be heated over the flame and rolled to form a cylinder (Fig. 6.12).

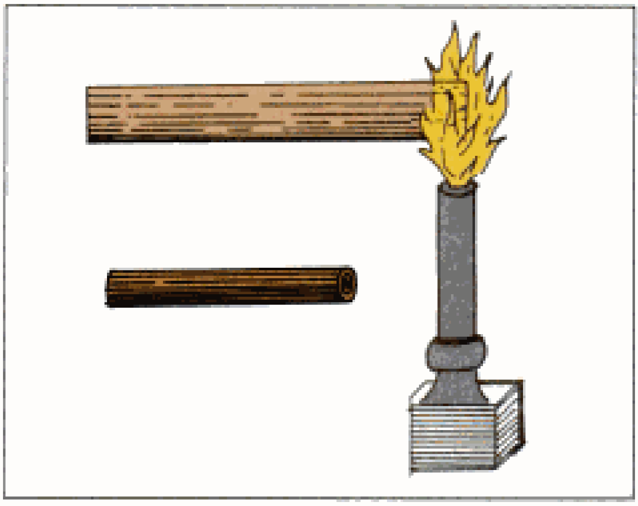


Fig. 6.12

- One end of the cylinder should be heated so that the material begins to sag (Fig. 6.13).

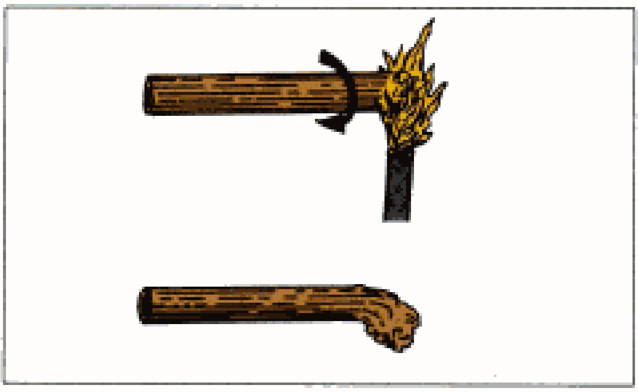


Fig. 6.13

- The sagging end of the cylinder should be compressed firmly over the striation made on the tray near the incisive papilla. The handle should be completely fused to the tray (Fig. 6.14).

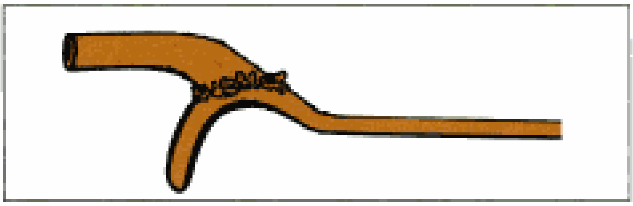


Fig. 6.14

- A hot wax knife can be used to fuse and smoothen the junction of the handle and the tray (Fig. 6.15).

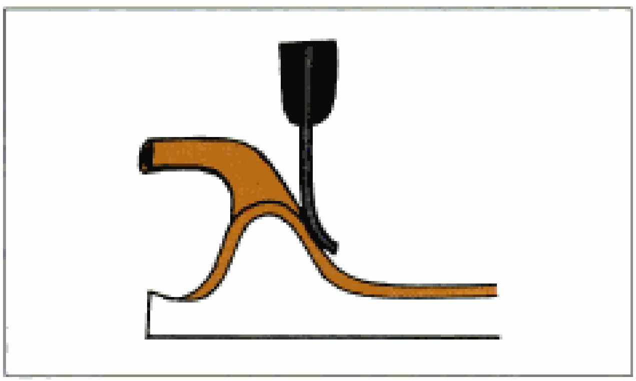


Fig. 6.15

- The special tray and its handle should be sand-papered for a perfect smooth finish. The handle should be 3-4 mm wide 8 mm long and 8 mm high.
- Overheating the special tray will produce smoke, bubbles, blackening and leaching of shellac and wax.
- Over heating may also lead to melting and flowing of the shellac into the pores of the cast.
- These trays should be fabricated 6 hours prior to impression procedure.

Cold Cure Acrylic-Tray Material

It is also known as the auto-polymerising resin. This material is similar to the denture base resin used for the final fabrication of the denture. The material sets by chemical reaction and hence it is irreversible.

Composition

The material is available as powder and liquid.

Powder

• Polymethyl methacrylate	Polymer.
• Benzoyl peroxide	Initiator
• Compounds of mercuric sulphide, Cadmium sulphide	Dyes
• Zinc or titanium oxide	Opacifiers
• Dibutyl phthalate	Plasticizer
• Dyed organic filler and inorganic particles like fibres etc, are added for aesthetics	

Liquid:

• Monomethyl methacrylate	Polymeriser
• NN Dimethyl Paratoluidine	Activator
• Dibutyl phthalate	Plasticizer
• Glycol dimethacrylate 1- 2%	Cross linking agent
• Hydroquinone 0.006%	Inhibitor (increases the shelf life of monomer)

Advantages

- Very strong
- Adapts well to the cast
- Can be trimmed to adequate thickness.
- Good thermal properties.
- Easy to fabricate.
- Good stability.
- Workable at mouth temperature.
- Biocompatible.

Disadvantages

- Cannot be readapted after warpage.
- Trimming and finishing is very time consuming.
- In the presence of undercuts, the material may get locked into them and may tend to break the cast.

Technique

First, the relief areas and the borders of the special trays are marked. A wax spacer is adapted on the relief areas. Separating medium is coated on the entire cast and over the spacer. Two major techniques are commonly used in the fabrication of an acrylic special tray.

Sprinkle on Technique

The powder and liquid are loaded in separate dis-pensers. A small quantity of powder is sprinkled on a particular area over the cast and liquid is sprinkled over the powder. Sprinkling drops of the liquid polymerizes the powder. This is continued till the entire ridge and the associated landmarks are covered. The advantage of this technique include its ease of use and minimal wastage of material (Fig. 6.16).

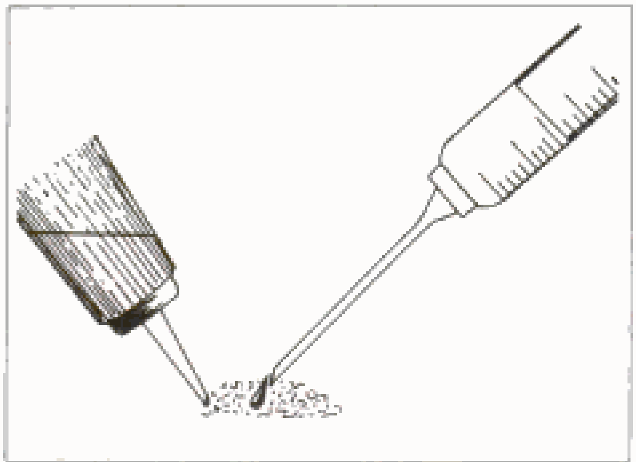


Fig. 6.16: In sprinkle on technique, the powder is dispersed and consequetively wet with drops of liquid

Disadvantages

- An even thickness cannot be obtained.
- Too many porosities may form within the material.
- Time consuming.

Dough Technique

The powder and liquid should be mixed in a mixing jar in the ratio of 3:1 by volume. If this ratio is not maintained and insufficient monomer is used, excessive shrinkage, porosities and granularity may occur.

After mixing the monomer and polymer the mix undergoes six different stages:

- The first stage is called the *wet sandy stage*, where the polymer is soaked in monomer.
- Next is the *early stringy stage* where if the material is touched, fine filaments are seen sticking to the finger.
- Next is the *late stringy stage* where long strings are present. During the end of the late stringy stage the manipulation should be started.
- Next is the *dough stage*. In this stage, the material is very workable.
- Next is the *rubbery stage* where the material cannot be manipulated any more. Trying to manipulate the material in this stage will result in excessive warpage of the tray.
- Next is the *stiff stage*. The material loses its elasticity and becomes more plastic. After the stiff stage, the polymerization is almost complete.

Procedure

- Manipulation is done in the late stringy and the dough stages. The material is kneaded in the hand, to achieve a homogenous mix.
- Then the material is shaped into a 2 mm thick sheet. Flattening the dough can be done using a roller or a plaster mould or by pressing the material between two glass slabs (Figs 6.17 and 6.18).

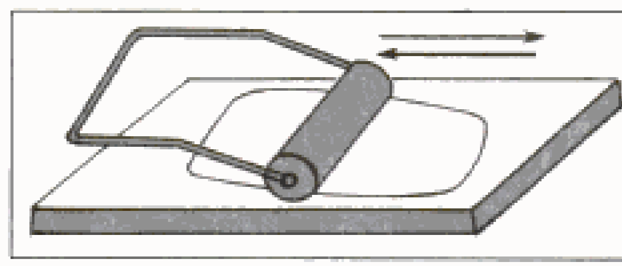


Fig. 6.17: The dough should be rolled over a glass slab using a plastic roll

Fig. 6.18: The dough can also be flattened by pressing it between two glass slabs

- Separating medium should be applied over the roller or the glass slabs to avoid stickiness.
- The rolled sheet of acrylic is adapted over the cast from the centre to the periphery. This prevents the formation of wrinkles.
- Care should be taken not to apply excessive pressure on the ridge areas as it might lead to the thinning of the tray.
- The excess material should be cut out with a B.P. blade before the material sets (Fig. 6.19).
- After cutting out the excess, the material should be held in position as shrinkage and warpage may occur during polymerization.

Fig. 6.19: The excess acrylic should be trimmed using BP blade

- The set material is then trimmed to obtain a smooth surface with smooth margins.
- The grooving done on the cast while marking the margins of the special tray acts as a guide during trimming.

Fabrication of the Handle

The handle is fabricated using the excess dough material. *Dresen* suggested the placement of a single handle in the anterior region. *Merkerly* suggested the placement of three handles (one anteriorly and two posteriorly). The placement of handles depends upon each case requisite (Figs 6.20 and 6.21).

Fig. 6.20

The handle should be parallel to the long axis of the teeth that are to be placed. The handle should not arise horizontally from the tray because it may interfere with lip movements. It should be 3-4 mm thick, 8 mm long and 8 mm high.

Fig. 6.21

Grooves should be made on the site where the handle is to be placed. Drops of monomer should be sprayed on the grooves and the handle in order to enhance chemical bonding. The handle is compressed against the grooves for bonding. Deficiencies at the junction should be filled by sprinkle on technique.

Thermoplastic Resins

Thermoplastic resins are also very good special tray materials. Their composition varies little from that of conventional acrylics. They are adapted using a vacuum former. The procedure is similar to that of polystyrene.

Vacuum-formed Vinyl or Polystyrene

This is the fastest method for making special tray. Its only disadvantage is that it is very expensive.

Technique

- A vacuum-forming machine is required for this procedure (Fig. 6.22a).
- A vinyl sheet is placed on the electric heater coil and heated till it sags
- In the absence of a vacuum former, the vinyl sheet can be heated under direct flame (Fig. 6.22b).
- The cast is placed below the vinyl sheet at the centre of the vacuum-forming chamber.
- The chamber is closed and vacuum is created and the vinyl sheet is made to fall on the cast.

Fig. 6.22a: Vacuum forming machine

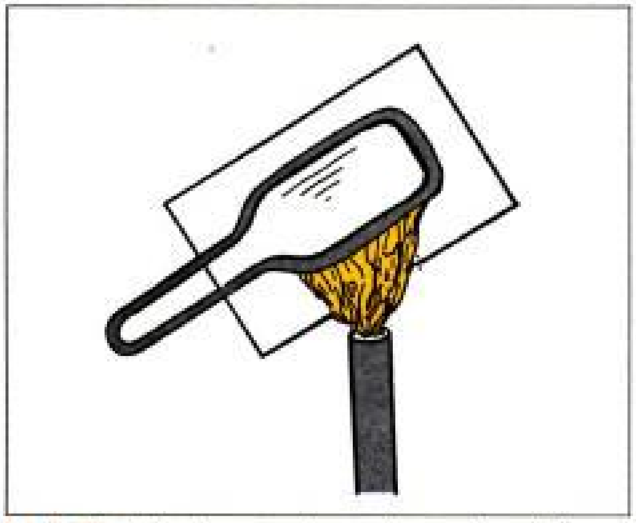


Fig. 6.22b: In the absence of a vacuformer, the polystyrene sheet can be heated using a metal loop under direct flame

Due to vacuum, there will be no air entrapment and the sheet adapts closely to the cast.

- The material is allowed to cool and the excess is trimmed using a bur (Fig. 6.22c).
- Non-asbestos casting liners are used as spacers for this material because a wax spacer will melt in the vacuum chamber.

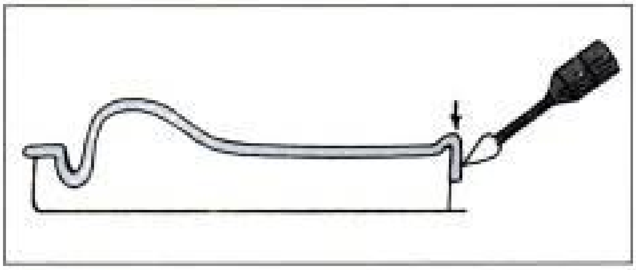


Fig. 6.22c: The excess polystyrene should be trimmed

Type II Impression Compound (Tray Compound)

It is a type of impression compound with more filler content. It is more rigid and dimensionally stable. It does not have the flow properties of impression compound, hence, it cannot record fine details.

A preliminary impression is made using this material. After making the preliminary impression, the borders are trimmed so that it can be used as a special tray.

A wrought wire is attached to act like a handle for carrying the impression. The primary impression itself is used as the special tray (Fig. 6.23).

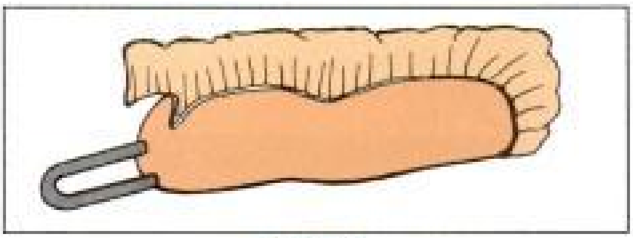


Fig. 6.23

A wash impression is made over the primary impression. The primary and secondary impressions can be made on the same day reducing the laboratory workload and the number of visits for the patient.

Storing the Trays

After fabricating the special tray, it should be stored in the cast till the next appointment. Acrylic special trays should be stored in water to avoid warpage. Shellac tray should be stored in a cool dry place.

Chapter 7
Secondary Impressions in Complete Dentures

- Techniques for Making the Master Impression
- Making a Secondary Impression Using a Special Tray
- Inspecting the Impression
- Disinfecting the Impression
- Remaking the Impression

7 Secondary Impressions in Complete Dentures

Making the secondary impression is an important clinical procedure in the fabrication of a complete denture done to prepare a master cast. Secondary impression procedures involve three steps namely:

1. Border moulding or peripheral tracing
2. Making the master or wash impression, and
3. Postdamming.

Master impression is one of the most important steps in the fabrication of a complete denture. It should record the denture-bearing area at rest to reproduce finer details. It should also record the muscular peripheral tissues in function.

TECHNIQUES FOR MAKING THE MASTER IMPRESSION

There are two major techniques commonly used for recording the master impression of an edentulous arch.

Custom Tray Impression

The most commonly used technique. The custom tray is designed with a spacer adapted over the arch. The tray should be 2 mm short of the sulcus and border moulding should be carried out to record the sulcus in dynamic function.

The spacer is scraped off before making the impression. The area where the relief wax was present, a pressureless impression is recorded. The area where there was no relief wax, the tissues are recorded under pressure. This concept of applying pressure on certain area and relieving the others is called *selective pressure impression making*.

Tray Compound

A primary impression is made using the tray impression compound. This impression is refined and trimmed to avoid over extension. A metal wire is attached to the tray compound to act as a handle. Now the tray compound acts as the custom tray. Border moulding and wash impressions are made over this set primary impression.

MAKING A SECONDARY IMPRESSION USING A SPECIAL TRAY

This is the most commonly used method for making a master impression. The technique varies for the maxilla and the mandible. For both impressions, a custom tray is fabricated with a spacer as described in the previous chapter.

Secondary Impression Procedure for the Maxilla

Secondary impression procedure for maxilla includes:

- Border moulding
- Tray preparation after border moulding.
- Making the wash impression
- Recording the posterior palatal seal
- Checking for errors in the posterior palatal seal

Border Moulding or Peripheral Tracing

Border moulding is defined as "*The shaping of an impression material by the manipulation or action of the tissues adjacent to the borders of the impression*"- GPT.

Border moulding can be performed using two techniques namely:

- Single step or simultaneous border moulding.
- Incremental or sectional border moulding.

Single step or simultaneous border moulding It is a procedure by which the entire periphery of the tray is refined in a single step. Polyether impression material is the material of choice because it fulfils all the requisites.

Ideal requisites for the material used for simultaneous border moulding:

- It should have sufficient viscosity to remain in position along the borders of the tray.
- It should not be sticky, it should be easy to manipulate and load on deficient areas.
- It should have a setting time of 3-5 minutes.
- It should not displace the tissues.
- It should be easily trimmed and shaped.
- It should retain its flow properties when placed inside the mouth.

Self-cure acrylic resin can also be used for simultaneous border moulding, but its use is limited because of its long-setting time and difficulty to trim.

Clinical procedure for maxillary arch

- An adhesive is applied on the outer surfaces and the inner borders of the tray (Fig. 7.1).
- The wax spacer along the periphery of the tray is scrapped off (Fig. 7.2).
- Polyether impression material is mixed using less amount of catalyst to increase the working time.
- The mix is then loaded in the syringe.

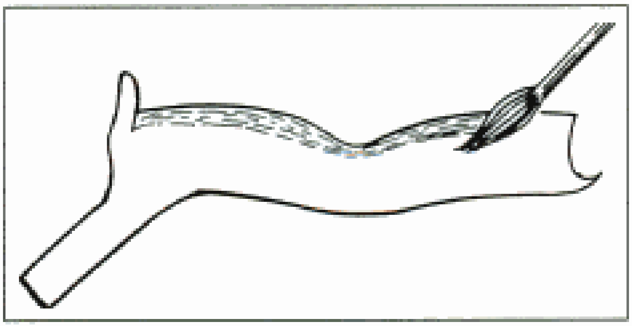
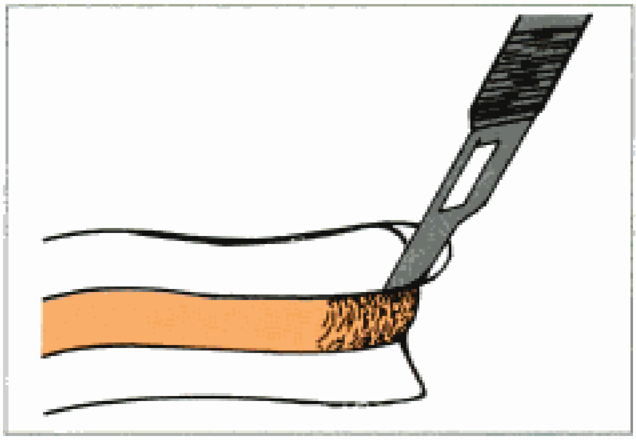


Fig. 7.1



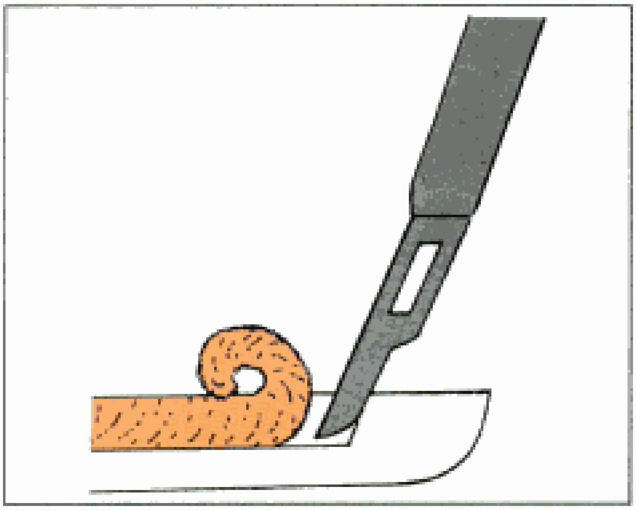


Fig. 7.2: The wax spacer near the periphery of the tray should be scrapped away using a B.P blade

- The material is syringed along the borders of the tray and contoured using wet fingers (Fig. 7.3).
- The patient should be seated in an upright position. The lips and cheeks are retracted and the tray is placed on the mouth.
- Deficiencies in the vestibule can be filled using excess material from the other areas.
- The following passive movements are performed.
  — The lips are first elevated and then extended outwards, downwards and inwards (Fig. 7.4).
  — The cheek is elevated and then pulled outward, downward and inward (Fig. 7.5).

Fig. 7.3: Polyether material is syringed along the borders of the tray

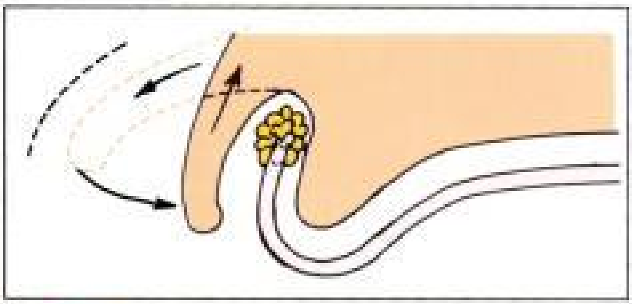


Fig. 7.4: Border moulding of the lip includes upward, outward, downward and inward movement

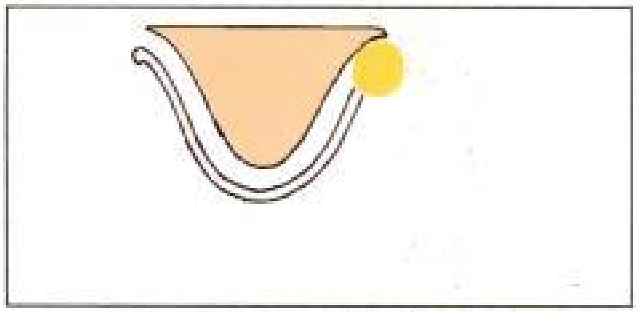


Fig. 7.5: Border moulding the cheek

— The buccal frenum is recorded by pulling the cheek backwards and forwards (Fig. 7.6).

— The distobuccal region is recorded by pulling the cheek outwards, downwards and inwards followed by opening the mouth wide and moving the mandible from side to side.

When the mandible is wide open the coronoid process will come in close approximation to the distal portion of the maxillary buccal sulcus. A thick denture

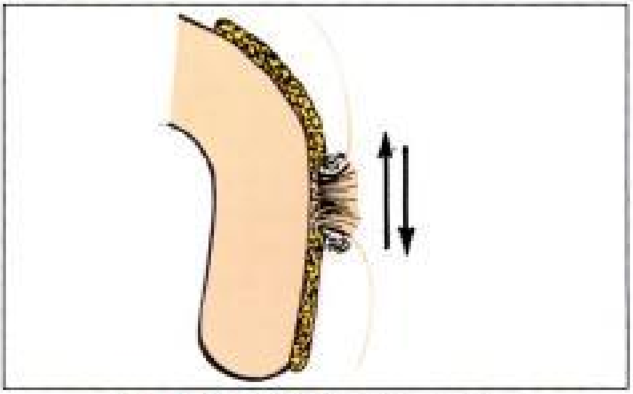


Fig. 7.6: Recording the buccal frenum

flange in this region can produce interference in the movement of the mandible and cause severe pain in that area.

The movement of the coronoid process is recorded in the impression and will become the *coronoid groove* in the finished denture flange (Fig. 7.7a).

- Next the posterior part of the palate is recorded. The patient is asked to say "ah" while refining the posterior border.

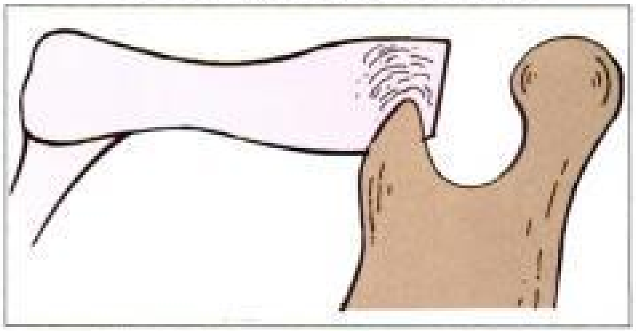


Fig. 7.7a: Recording the coronoid notch

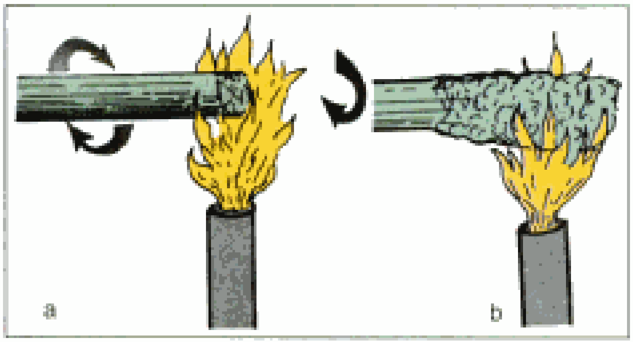
Fig. 7.7b: A finished zinc oxide eugenol impression

- After the border moulding poly ether impression material sets, the tray is removed.
- The borders are examined for deficiencies and over-extensions and a master impression is made (Fig. 7.7b).

Incremental or sectional border moulding It is a procedure in which portions of the periphery of the tray are refined individually. The material of choice for this procedure is green stick compound. In this case the spacer is generally removed just before impression making.

Clinical procedure

- The greenstick compound is softened over flame and added along the portion of the tray where the border is intended to be refined (Fig. 7.8). The material should be tempered with warm water before placing intraorally.
- The labial vestibule is refined first followed by the buccal vestibule and the posterior palatal seal.



Figs 7.8a and b: The greenstick compound should be softened till it sags over a Bunsen flame

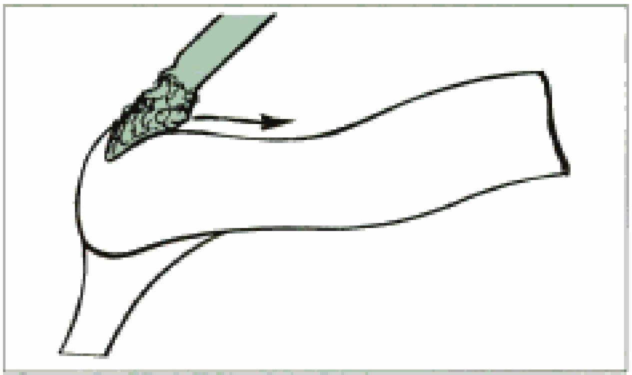


Fig. 7.8c: The softened greenstick compound should be rolled and loaded over a portion of the tray border

- Passive movements are made as described in the simultaneous border moulding technique.
- After border moulding, the moulded section is immersed in cold water.
- After border moulding a particular section, the procedure is carried out for the next adjacent section.

Tray Preparation after Border Moulding

After border moulding, the tray should be prepared before making the secondary impression.

- The wax spacer is removed to provide space for the impression material.
- 0.5 to 1 mm of the tracing material is removed from the outer, inner and top surfaces of the border (Fig. 7.9).
- The material over the posterior palatal seal is not removed because:
  - — It enhances the posterior palatal seal.
  - — It serves as a guide for positioning the tray.
  - — It prevents aspiration of the impression material.

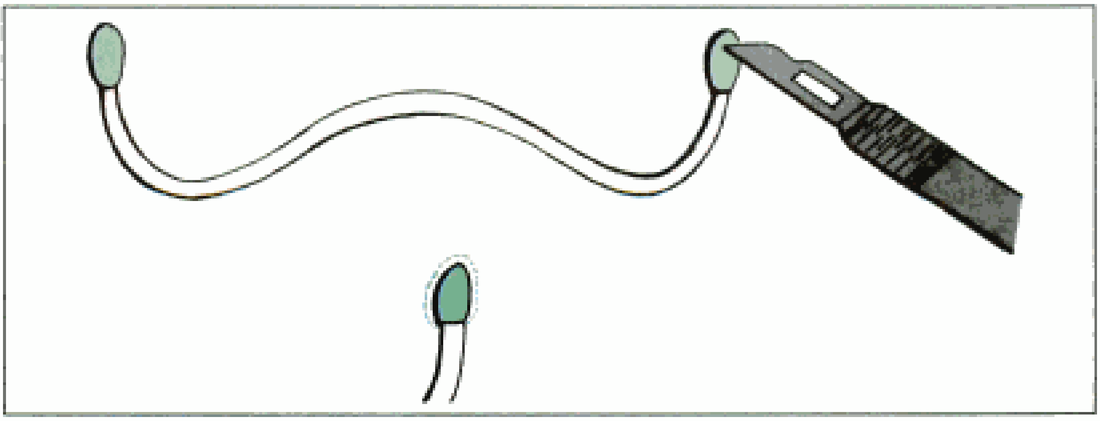


Fig. 7.9: After border moulding, upto 1 mm of the tracing compound should be reduced using a B.P. blade

- Greenstick compound is removed using a scalpel and polyether is removed using either a scalpel or a bur.

- The thickness of the flanges and the border should be 2.5 to 3 mm.
- Holes are drilled on the impression tray to allow escapement of the impression material. These holes are placed in the areas of the mid-palatine raphe, anterolateral and postero-lateral regions of the hard palate and the residual ridge region. These holes prevent tissue displacement during impression making (Fig. 7.10).

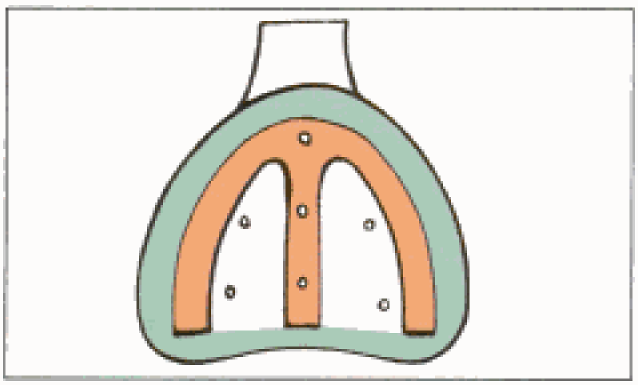


Fig. 7.10: Holes are drilled into the relief area to allow escapment of the impression material.

Making the Master or Wash Impression

The impression material chosen for the secondary impression should be of low viscosity to record the structures accurately. The amount of material loaded onto the tray should be able to form a uniform, thin layer. Loading excess material onto the tray may lead to an overextended impression.

The materials of choice for a secondary impression are zinc oxide eugenol (ZnOE) impression paste or medium-bodied elastomeric impression materials.

- The impression material is manipulated and loaded onto the tray. The patient is made to sit in an upright position. The operator should stand towards the rear or the side of the patient.
- The tray is placed in the patient's mouth using the labial notch as a guide.
- The tray is seated into position by applying alternating pressures on the right and left molar regions using the index fingers.
- Tray placement is complete only when the posterior border of the tray rests in the hamular notch and is in contact with the palate.
- The tray is maintained in this position by placing a finger in the palatal region of the tray, immediately anterior to the posterior palatal seal.
- Passive movements similar to those performed during border moulding are repeated.
- After the material is set, the tray is removed in a single jerk.
- The impression is inspected for deficiencies and voids and is repeated if necessary.

Recording the Posterior Palatal Seal

The posterior palatal seal is defined as, "*The soft tissues along the junction of the hard and soft palates on which pressure within the physiological limits of the tissues can be applied by a denture to aid in the retention of the denture*"- GPT.

Recording the posterior palatal seal is very important for the retention of the denture. We know that one of the important factors controlling retention is peripheral seal. A good posterior palatal seal is essential to provide a peripheral seal. The denture border should rest on soft and resilient tissues, which can move along with the denture during function and prevent loss of peripheral seal. Refer postdam and vibrating lines for further details.

The methods used to mark the postdam are:

- Conventional approach.
- Fluid wax technique.
- Arbitrary scraping of the master cast.
- Extended palatal technique (Silverman proposed that the posterior border of the denture can be extended by 8 mm for patients with class I soft palate. But, this is not accepted now).

Conventional approach

- This procedure is done after the wash impression is made and the master cast is poured.

- A trial base is fabricated using shellac base plate or a well-adapted self-cure resin.

- The patient is asked to sit in an upright position and asked to rinse his mouth with some astringent mouth wash.
- The posterior palatal area is wiped with gauze.
- The "T" burnisher is used to locate the hamular notch by palpating posteriorly to the maxillary tuberosity on both sides. The full extent of the hamular notch is marked with an indelible pencil (Fig. 7.11).

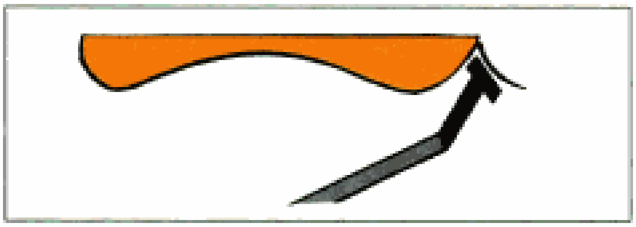
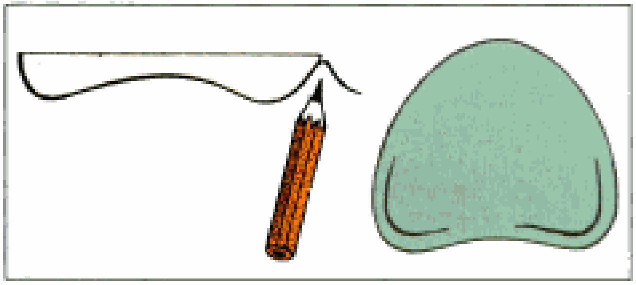


Fig. 7.11a: The hamular notch is palpated using "T" burnisher



Figs 7.11b and c: The hamular notch is marked using indelible pencil

- The posterior vibrating line is marked using a indelible pencil by asking the patient to say "ah' in a non-vigorous manner (Fig. 7.12).

Fig. 7.12: The posterior vibrating line is marked between the movable and immovable soft palate

- The line marked in the hamular notch is connected with the posterior vibrating line using an indelible pencil. This will form the posterior border of the denture (Fig. 7.13).

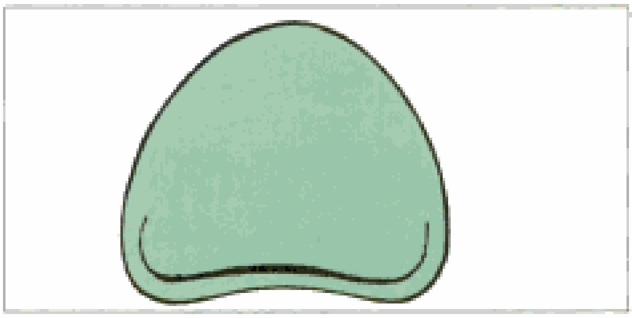


Fig. 7.13: The hamular notch and posterior vibrating line are joined using an indelible pencil

- The trial base is inserted into the patient's mouth so that the indelible markings are transferred to the trial base. The markings on the trial base can be refined if necessary.
- The trial base is seated on the master cast to transfer the markings marked in the patient's mouth to the cast.
- The trial base is trimmed till the posterior border.
- The anterior vibrating line is marked in the patient's mouth using an indelible pencil (Fig. 7.14). While recording the anterior vibrating

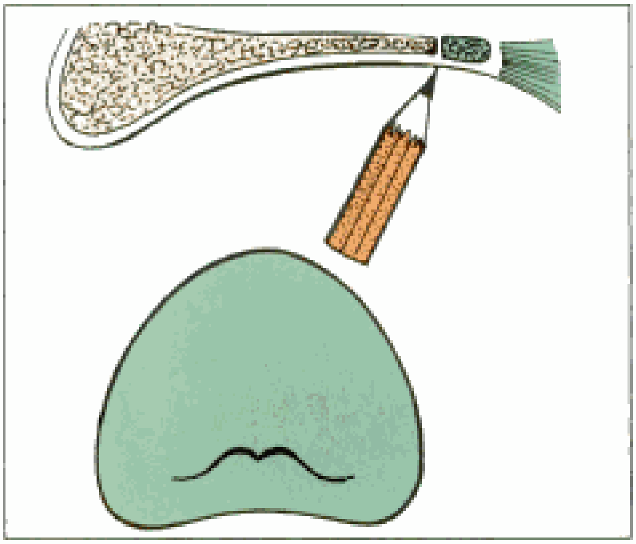


Fig. 7.14: The anterior vibrating line is marked at the junction of the hard and soft palate using an indelible pencil

line, the patient should perform the *Valsalva maneuver (Refer anterior vibrating line in chapter 5)*. The markings are transferred to the master cast as described before for the posterior vibrating line.

- The area between the anterior and posterior vibrating line is scrapped in the master cast to a depth of 1 to 1.5 mm on either side of the mid-palatine raphe. In the region of the mid-palatine raphe, it should be only 0.5 to 1 mm in depth (Fig. 7.15).

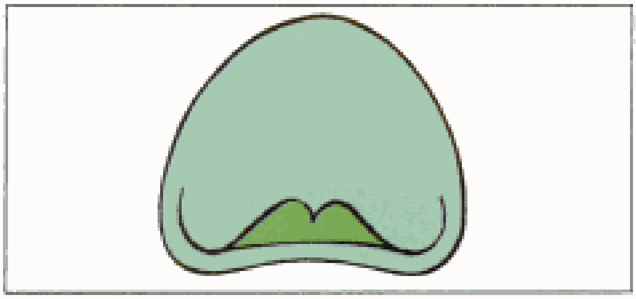


Fig. 7.15: The markings of the anterior and posterior vibrating lines are transferred to the cast. The cast should be scrapped to a depth of 1 to 1.5 mm in the area between the two vibrating lines

- The posterior border of the posterior palatal seal should be tapered so that it blends with the palatal tissues. This entire border of the postdam resembles the shape of a *Cupid's bow.*

Checking the postdam or posterior palatal seal area

- After scrapping the master cast, the postdam should be checked.
- The trial base should be softened and readapted. If a resin trial base is used then the cast is painted with cold mould seal and resin is added to the scrapped areas (Fig. 7.16).
- The modified trial base is now inserted into the patient's mouth.

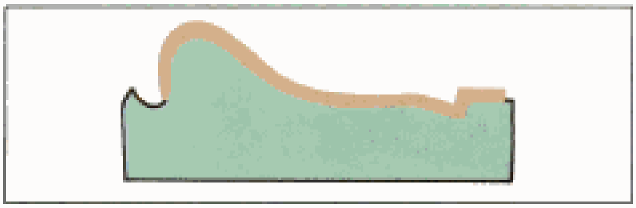


Fig. 7.16: After scrapping the master cast, the base plate is readapted in the postdam area

- A mouth mirror is kept at the distal end of the trial base and checked for any space (Fig. 7.17).
- Presence of a space between the base plate and the soft tissues indicates improper or under postdamming.

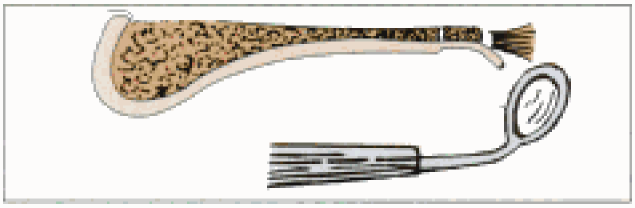


Fig. 7.17: After readapting the base plate, it should be tried on the patient. The adaptation can be checked by viewing distally using a mouth mirror

Advantages of the conventional technique

- The trial base has increased retention due to this technique. Hence, it is easier to retain the trial base during jaw relation.
- The patient can experience the retentive qualities of the denture at an earlier stage.
- The patient has an idea of the posterior extent of the denture base.
- Final adjustments during insertion are minimized.

Disadvantages of the conventional technique

- It is not a physiological technique, hence, it is technique- sensitive.
- Excessive scrapping of the cast can frequently lead to tissue compression.

Fluid Wax Technique

- This technique is done immediately *after* making the wash impression and *before* pouring the mater cast.
- Zinc oxide eugenol and impression plaster are suitable impression materials for this technique as fluid wax adheres well to them.
- The anterior and posterior vibrating lines are marked as described in the conventional technique. These lines are marked in the patients mouth immediately after making the wash impression
- The markings are transferred to the secondary or wash impression by reseating the impression in the mouth.

- The wash impression is painted with fluid wax. Commonly used waxes are *Iowa wax* (white) by Dr.Smith, *Korecta wax* no:4 (orange) by Dr.O.C. Applegate, *Adaptol wax* (green) by Nathan.G.Kaye and *H-L physiologic paste* (yellow-white) by CS Harkins.
- The wax should be painted only within the margins of the palatal seal marked on the impression. Usually it is applied in excess and cooled below mouth temperature so that it gains resistance to flow (Fig. 7.18). These waxes soften at mouth temperature and flow intraorally during impression making.

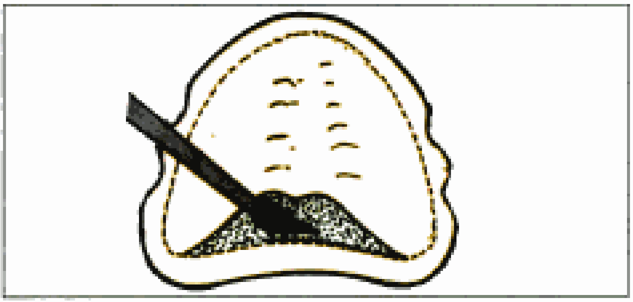


Fig. 7.18: Diagram showing the application of fluid wax in the postdam area

- The patient's head should be positioned such that the Frankfort's horizontal plane is 30° below the horizontal plane. It is only at this position that the soft palate is at its maximal downward and forward functional position. Flexion of the head also helps to prevent aspiration of the impression material and saliva (Fig. 7.19).
- The patient's tongue should be positioned such that it is at the level the mandibular anteriors. This action helps to pull the palatoglossus anteriorly. In completely edentulous patients, the handle of the maxillary custom tray should be designed such that it acts like the lower anteriors to guide the tongue during impression making.
- After positioning the head and the tongue, the impression tray is inserted into the mouth and the patient is asked to make rotational movements of his head without altering the plane to record the functional movements of the palate.
- The impression is removed after 4-6 minutes and examined. In contrast to green stick compound, *glossy areas*, show *tissue contact*. *Dull areas* show areas which were *not in contact* with the tissues. The impression should show uniform tissue contact. Areas which appear dull, are added with more wax and the procedure is repeated.

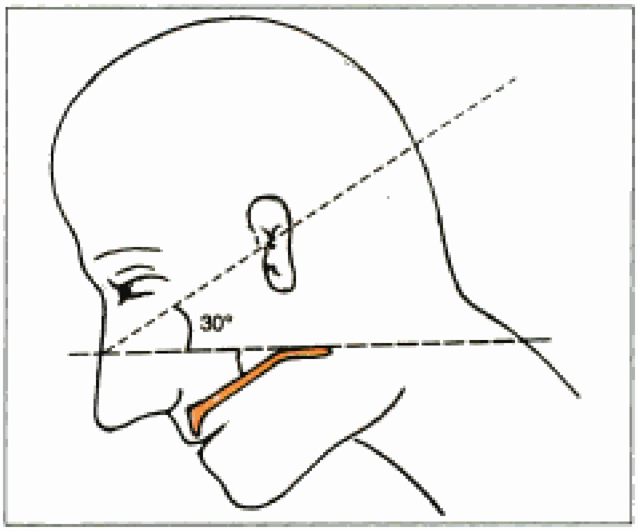


Fig. 7.19: While recording the postdam, the patients head should be tilted downwards by 30°. The blue dotted line shows the Frankfort's plane. Notice that the soft palate hangs down in this position

- Every time the impression is reinserted, the impression should be held for 3-5 minutes under gentle pressure and 2-3 minutes under firm pressure applied in the mid-palatine area.
- The procedure is repeated till even tissue contact is achieved. After achieving even tissue contact, the impression is removed and re-examined.
- The wax in the region of the anterior vibrating line should have a knife-edge margin (Fig. 7.20). Blunt margins indicate improper flow and the impression should be repeated.

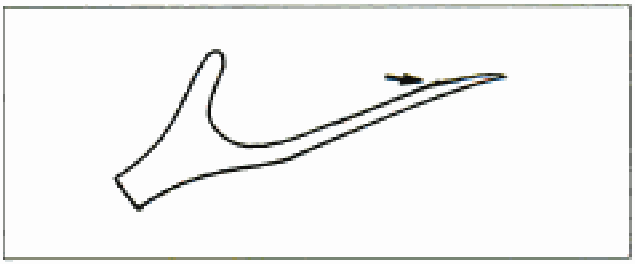


Fig. 7.20: The anterior margin of the postdam recorded using fluid wax should be knife edged as shown in the diagram

- Fluid wax extending beyond the posterior vibrating line should be cut with a hot knife. The impression is refined again till feather-edge margins are produced.

Advantages of fluid wax technique

- It is a physiological technique.
- Chances of overcompression of tissues are less.
- Increased retention of the trial base and convenience in jaw relation.
- There is no need for scrapping the master cast arbitrarily.

Disadvantages of fluid wax technique

- Handling of the material is very difficult.
- Increased chair-side time during patient appointment.

Arbitrary Scrapping of the Master Cast

In this technique, the anterior and posterior vibrating lines are visualized by examining the patient's mouth and approximately marked on the master cast. The lab technician scrapes 0.5 to 1 mm of stone in the posterior palatal seal area of the master cast and fabricates the denture. This technique is inaccurate and not physiological (Fig. 7.21) and should be avoided.

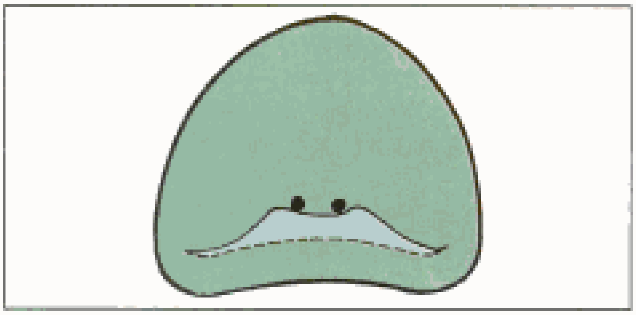


Fig. 7.21: Arbitrary scrapping of the master cast

Errors in Recording the Posterior Palatal Seal

The following errors can occur while recording the posterior palatal seal.

Underextension

This is the most common cause for poor posterior palatal seal. It may be produced due to one of the following reasons:

- When the denture does not cover the fovea palatina, the tissue coverage is reduced and the posterior border of the denture is not in contact with the soft resilient tissue which will move alongwith the denture border during functional movements.
- The dentist may intentionally leave the posterior borders underextended in order to reduce the patient's anxiety to gagging.
- Improper delineation of the anterior and posterior vibrating lines.
- Excessive trimming of the posterior border of the cast by the dental technician.

Overextension

Overextension of the denture base can lead to ulceration of the soft palate and painful deglutition. Covering of the hamular process can lead to sharp pain in that region. In order to relieve these areas, indelible pencil markings are made on them (hamular process, ulcers, etc.) and transferred to the denture. These regions are trimmed and polished.

Underpostdamming

- This can occur due to improper head-positioning and mouth positioning, e.g. when the mouth is wide open while recording the posterior palatal seal the mucosa over the hamular notch becomes taut. This will produce a space between the denture base and the tissues.
- Inserting a wet denture into a patient's mouth and inspecting the posterior border with the help of a mouth mirror can identify underdamming. If air bubbles are seen to escape under the posterior border, it indicates underdamming.
- In order to correct underdamming, the master cast can be scraped in the posterior palatal area or the fluid wax impression can be repeated with proper patient position.

Overpostdamming

- This commonly occurs due to excess scraping of the master cast. It occurs more commonly in the hamular notch region.
- Mild overdamming in the hamular notch region can lead to tissue irritation of the

mucosa and excessive postdamming produces downward displacement of the denture posteriorly.

Secondary Impression Procedure for the Mandible

Impression procedures for the mandible include:
- Border moulding *(Fournet and Tuller's technique)*.
- Tray preparation after border moulding.
- Making the wash or master impression.

Border Moulding

Border moulding can be performed using two techniques namely:
- Single step or simultaneous border moulding.
- Incremental or sectional border moulding.

Irrespective of the technique used, the same procedure is carried out. In both cases the anterior portion is border moulded before the posterior portion. The labial and buccal flange of the tray is border moulded first followed by the lingual flange.

Recording the labial and buccal flanges

- The labial portion is moulded by moving the lip outward, upward and inward.
- The buccal frenum is recorded by moving the cheek outward, upward, backward and forward.
- To record the distobuccal sulcus, the cheek should be well-retracted and moved upward and inward.
- To record the action of the masseter muscle, the patient is asked to willfully close his mouth against resistance. The masseter muscle acting on the buccinator, produces a depression in the impression, called the *masseteric notch*.

Recording the lingual flange

- The anterior lingual border is moulded by asking the patient to protrude his tongue out and later to touch the anterior part of the palate. Protrusion of the tongue helps to record the length of the lingual flange and touching the anterior part of the hard palate helps in establishing the width of the flange.

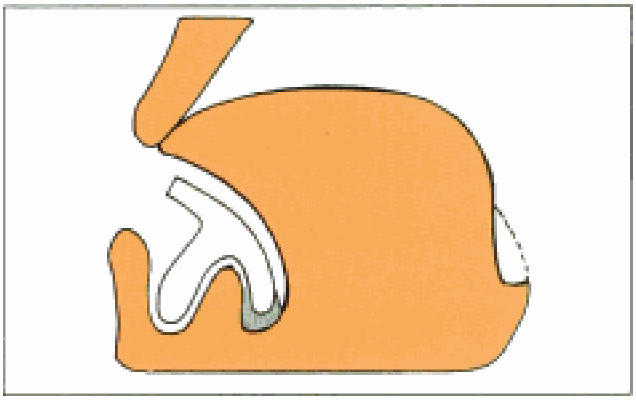


Fig. 7.22: The patient is asked to raise tongue and touch the upper lip while recording the lingual sulcus

- Protrusion of the tongue helps to record the movements of the mylohyoid muscle. This also raises the floor of the mouth (Fig. 7.22).
- The lingual flange thus recorded will be lingually sloping and parallel to the direction of the mylohyoid muscle fibers.
- Increase in the thickness of the posterior part of the lingual flange due to accumulation of the border moulding material can interfere with the action of the mylohyoid muscle.
- While border moulding the distal end of the lingual flange, the action of the retromylohyoid curtain should be recorded. The superior constrictor and the medial pterygoid muscles determine the position of the retromylohyoid curtain.
  - — The action of the superior constrictor is recorded while protruding the tongue.
  - — The action of the medial pterygoid is recorded by asking the patient to close forcefully against resistance.

Recording the retromolar pad

To record the distal end of the tray, the patient is asked to open his mouth wide. After recording the distal end, the impression is verified. If a notch is produced in the posteromedial end of the tray it indicates that the tray is overextended upto the pterygomandibular raphe.

Finally, after border moulding is complete, the patient should be able to touch the entire upper lip with the tongue without displacement of the tray.

Tray Preparation after Border Moulding

It is similar to the procedure done for maxillary impression. But the escape holes should be placed 10 mm apart in the alveolar ridge region and over the retromolar pad.

Making the Final or Master or Wash Impression

- Tray placement should be practiced before making the final impression.
- Dry gauze should be placed in the floor of the mouth to remove the saliva.
- The gauze should be removed before making the impression.
- The impression material is manipulated and loaded onto the tray.
- The tray is rotated in a horizontal plane and inserted into the mouth using the anterior handle.
- The tray is seated completely by applying alternating pressure over the posterior handles. The patient should be asked to touch his upper lip with his tongue while making the impression. Passive movements similar to those performed during border moulding should be repeated.
- After the material is set the impression is removed and examined for any defects.

INSPECTING THE IMPRESSION

The impression made is inspected for air inclusions and voids. The surface is inspected to make sure, that all the landmarks are recorded accurately. Small voids can be rectified by filling them with wax.

DISINFECTING THE IMPRESSION

The impression is disinfected using iodophor or 2 percent gluteraldehyde. It should be left undisturbed for ten minutes.

REMAKING THE IMPRESSION

Errors in impression is a common occurrence in clinical practice. The most common reason to repeat an impression is improper positioning of the impression tray. If the tray placement is improper, the flange of the impression which lies on the side of deviation will be excessively thick and the flange of the impression opposite to the deviation will be thin.

Other reasons for repeating an impression include:

- Large voids
- Improper consistency of impression material
- Movement of the tray during the setting of the impression material.
- Inadequate scrapping of the border moulding material.
- Using too much or too little impression material.

Chapter 8
Lab Procedures Prior to Jaw Relation

- **Preparing the Master Cast**
- **Indexing the Master Cast**
- **Fabricating the Temporary Denture Base**
- **Stabilizing the Base Plates**
- **Fabrication of Occlusal Rims**

8

Lab Procedures Prior to Jaw Relation

After making the master impression, the master cast should be poured and a temporary denture base should be fabricated. Occlusal rims are fabricated over these temporary denture bases to carry out jaw relation. In this chapter we shall discuss in detail about pouring the master cast, preparing a temporary denture base and fabricating occlusal rims.

PREPARING THE MASTER CAST

The master cast is poured using dental stone. High strength, minimal expansion stone is preferred. A stone cast is superior to a plaster cast because the finer particles make it stronger, denser and smoother.

The master cast should accurately reproduce the anatomy of the residual ridge; hence, care should be taken to preserve the depth and width of the sulcus in a cast. The sulcus can be preserved by beading and boxing. Other technical considerations are similar to that described for primary and diagnostic casts.

Beading and Boxing

Beading is done to preserve the width and height of the sulcus in a cast. *Boxing* is done to obtain a uniform, smooth, well-shaped base for the cast.

Special utility waxes are the most commonly used material for beading and boxing. Dental plaster with pumice and caulking compound and paddle boxing are the other alternatives. The technique for beading and boxing is different for each material.

Wax Beading and Boxing

Commercially available beading and boxing waxes are used. Beading waxes are generally blue in colour, boxing waxes are white in colour.

In the absence of beading or boxing waxes, modelling wax can be used as a substitute. A 5 mm strip of modelling wax is rolled with the palm on a flat surface. The rolled wax can be used for beading. Orthodontic tray wax can also be used for beading. A 12 - 15 mm strip of modelling wax is used for boxing. The boxing strip should be at least 13 mm measured vertically from the highest point of the impression.

Procedure

- The impression should be stabilized using soft wax or modelling clay to make the impression surface parallel to the floor (Fig. 8.1).

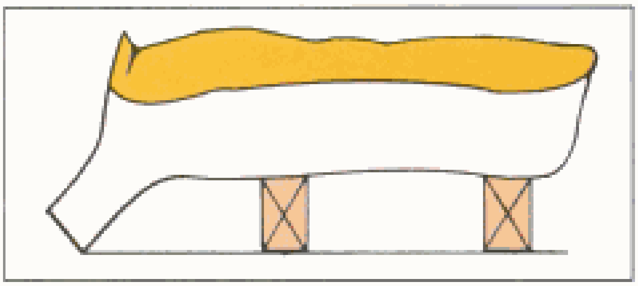


Fig. 8.1

- For a mandibular impression, the tongue space should be covered with a sheet of wax. The wax sheet is cut to a 'U' shape pattern that will approximate to the tongue space. The tongue space wax is fused 3-4 mm below the height of contour of the lingual flange. The wax sheet should be fused accurately to avoid leakage of dental stone while pouring the impression (Fig. 8.2).

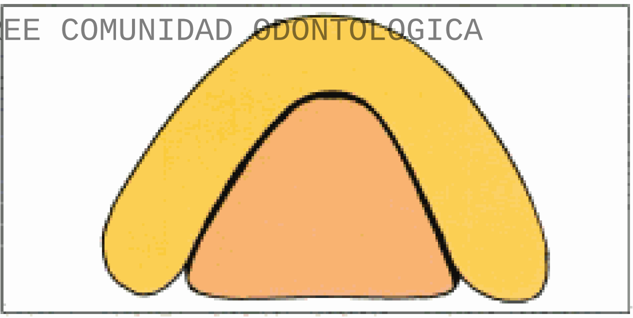


Fig. 8.2a: Boxing the tongue space

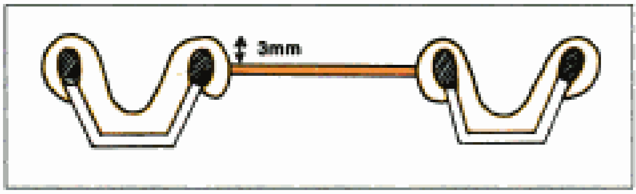
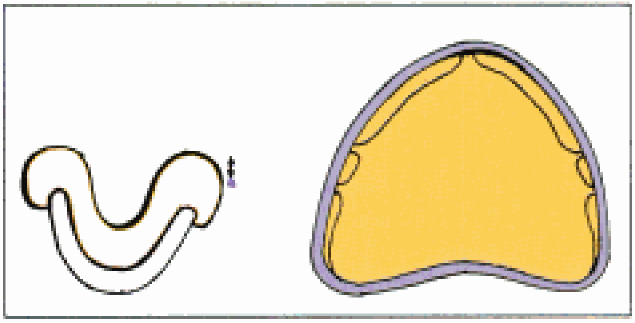


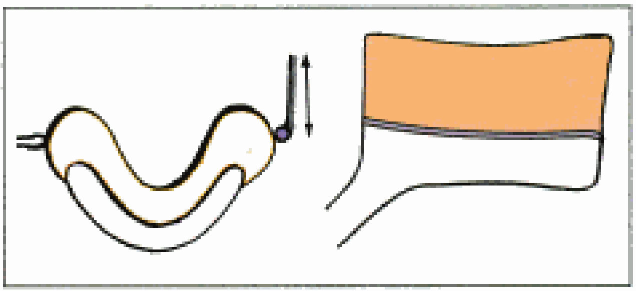
Fig. 8.2b: The wax sheet used to box the tongue space should be fused 3 mm above the depth of the lingual flange

- The beading wax is adapted 3-4 mm below the height of contour of the impression flanges. The beading should be at least 4 mm wide. Width of the beading wax should be even all around the impression. Improperly-shaped or placed beading can lead to the formation of thin, high borders in the cast. Additional thickness should be added to the posterior regions of the mandibular impressions (Fig. 8.3).



Figs 8.3a and b: Beading is done all around the impression using blue beading wax 3 mm above the depth of the labial and buccal flanges

- The beading wax should be sealed on both-sides (above and below) to the impression (Fig. 8.4).



Figs 8.4a and b: Boxing the impression

- The beaded impression is positioned on the table. A strip of boxing wax about 15 mm wide is heated and adapted around the beaded impression to form the base of the cast. The ends of the boxing wax are joined accurately and the entire boxing wax is sealed to the beading wax on both sides (above and below).
- Water should be poured into the boxed impression to check for leakages. Leakages can be sealed by adding additional wax.
- Dental stone is poured into the boxed impression using the three-pour technique as described for a diagnostic cast.
- The cast is easily separated by peeling of the wax. Overextended borders of the impression should be trimmed to an appropriate level.

Plaster and Pumice Boxing

It is indicated for rubber base impressions as they do not adhere to wax. The impression is invested before boxing. The investment functions as the beading. A mixture of pumice and plaster is used as the investing medium.

Procedure

- A 1:1 mixture of plaster and pumice plater is placed on a glass slab.
- The impression with the tray is invested on the plaster pumice mix.
- The investing medium is contoured 3-4 mm below the border of the impression. If the mix extends more than that height, it should be trimmed away carefully using a BP blade. Excess investing medium can also be removed using a brush (Fig. 8.5).
- The investing medium should be carefully trimmed to the shape of the base of a cast.

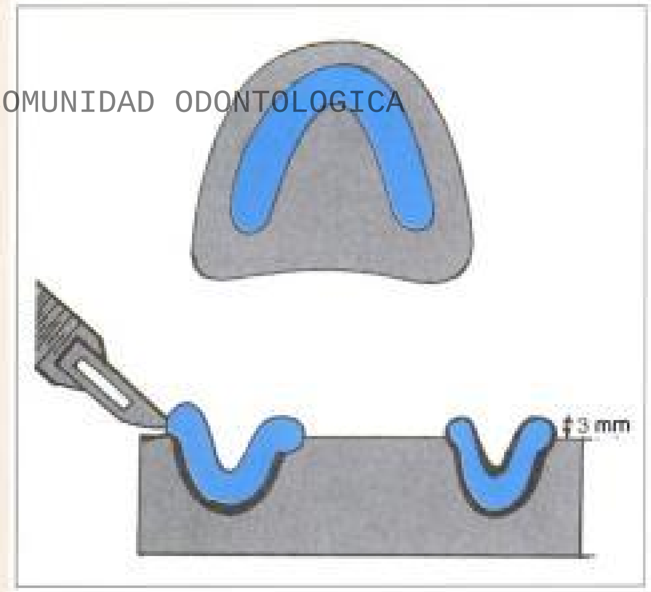


Fig. 8.5: After investing the impression in a plaster pumice mix, the level of the investment should be scrapped to about 3 mm below the height of the flange

- A separating medium is applied all over the plaster pumice mix.
- Boxing wax is adapted around the plaster pumice investment.
- A fine mix of dental stone is poured into the boxed impression (Fig. 8.6).
- The impression is separated an hour later. It should be smoothened and finished as required.

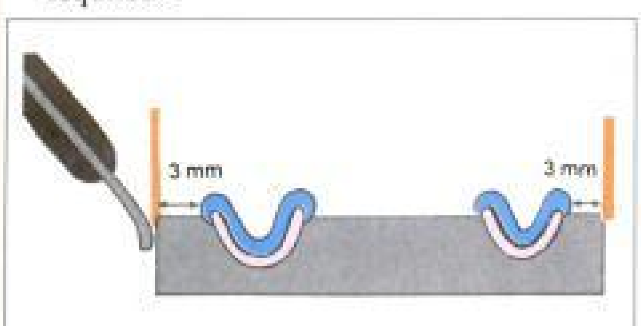


Fig. 8.6: Boxing the plaster pumice investment

Caulking Compound and Paddle Boxing Method

This method is best suited for zinc oxide eugenol impressions. Beading is done using caulking compound and boxing is done using a metal strip. The boxed impression is attached/supported with a table tennis paddle while pouring the cast.

Procedure

- Caulking compound is adapted as a beading 3-4 mm below the height of contour of the impression flange. Additional material can be added to increase the thickness of the caulking compound. After adaptation the compound is fused to the impression (Fig. 8.7).

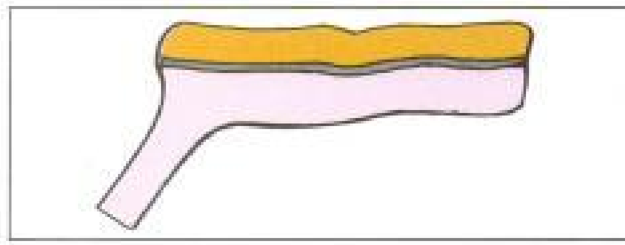


Fig. 8.7: Adapting the caulking compound to the impression

- Metal strip is boxed around the caulking compound and stabilized using a rubber band. The compound should be fused to the metal strip too. Till this stage this technique resembles wax boxing (Fig. 8.8).

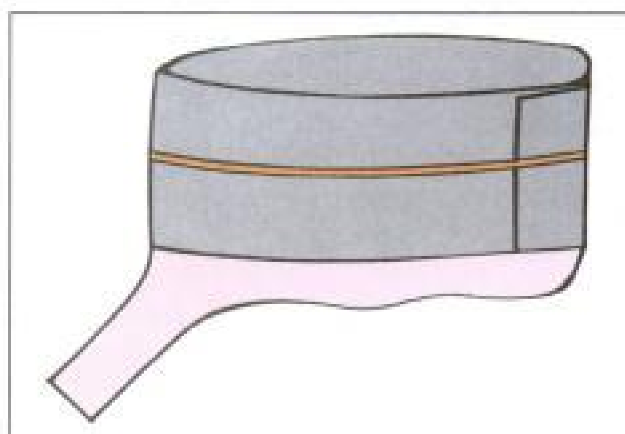


Fig. 8.8: Boxing the impression using a metal strip

- A table tennis racket is modified by attaching a metal rim at its borders so that it can hold wax (Fig. 8.9).
- The boxed impression should be placed into the paddle for additional stabilization and proper positioning. The paddle is also helpful

Fig. 8.9: A table tennis paddle modified with a metal strip wall should be filled with scrap wax

in positioning the impression on the vibrator while pouring the cast (Fig. 8.10).

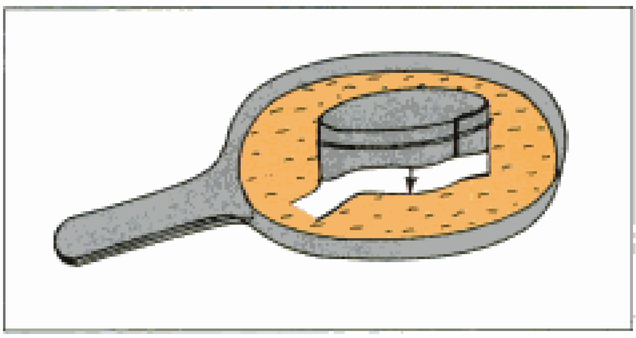


Fig. 8.10: The boxed impression should be immersed in the scrap wax for stabilisation

- Scrap wax is melted and poured in to the paddle.
- Once the scrap wax cools, the boxed impression can be poured with dental stone using the three-pour technique.
- The cast should be separated and finished as described previously.
- Additional care and storage for the cast is similar to that described for the primary and diagnostic casts.

Pouring the Master Cast

After beading and boxing the master cast is poured with dental stone using the three-pour technique as described for a diagnostic cast. The master cast should be finished as described in Chapter 3.

INDEXING THE MASTER CAST

Indexing the master cast should be done to accurately remount the casts in an articulator in a proper position. It is nothing but creating some reference markings on the cast. Master casts are remounted to refine the occlusion of the prosthesis. Commonly used methods for indexing include grooving, notching using metal and plastic remounting plates.

Remounting is done:

- To accurately reproduce the relationships of the casts at rest and function.
- To verify jaw relation records using split cast method.
- To correct the processing errors and refine occlusion after curing the denture.

Requirements of an Index:

An index is usually made according to the following requisites:

- It should not weaken the cast.
- It should not form an undercut, which can get mechanically interlocked with the mounting plaster making it difficult to remove.
- It should be functional even if the cast is trimmed during flasking.
- It should be quick and easy to fabricate.
- It should provide a positive three-dimensional fit between the cast and the mounting plaster.
- It should permit easy removal and accurate replacement.

Indexing can be done by grooving or notching or with the help of split remounting plates.

Groove Indexing Method

In this method, V-shaped grooves are made on the cast for indexing. The advantages of this method include, the functionality of the index even after the cast is trimmed and the ability to modify/relocate the grooves to avoid weakening certain casts.

Procedure

- Mark two lines perpendicular to one another passing through the centre of the cast base.

One line is drawn sagitally and another line is drawn transversely (Fig. 8.11).

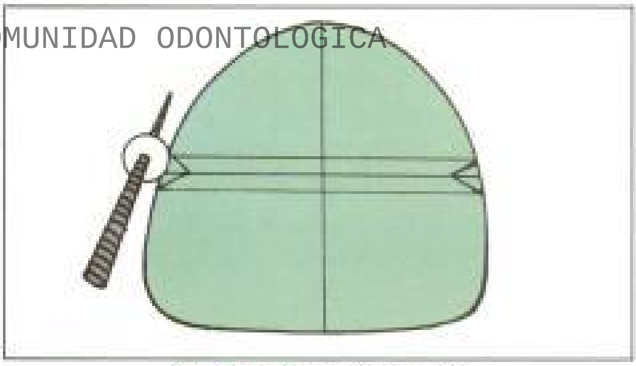


Fig. 8.11: Groove indexing

- In case of mandibular casts, the lines should be marked under the thickest area. These lines are usually marked on the base under the areas of the ridges.
- A lathe-mounted wheel with a *trueing stone* is used to cut 5 mm deep grooves along the markings made on the cast.

Notch-indexing Method

In this method, notches are placed at the edges of the cast. The disadvantage of this method is that the indexing is easily lost during trimming. The procedure is simple, wherein three 'V' shaped notches are marked on the three corners of the cast (one anterior and two posterior). The notches are cut, using a lathe mounted wheel or a sharp knife. This method is indicated for casts with deep sulci where grooves cannot be placed (Fig. 8.12).

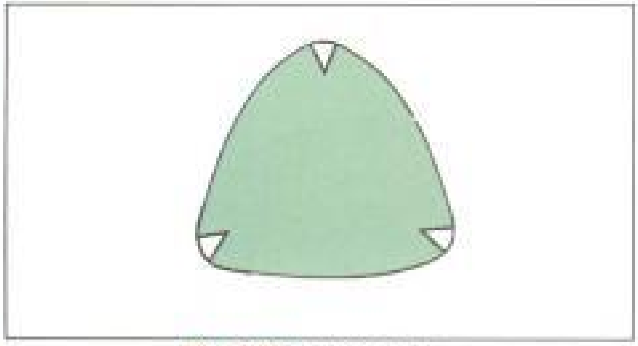


Fig. 8.12: Notch indexing

Split Remounting Plates for Indexing

It is the most preferable indexing method. Remounting plates are commercially available as metal or plastic kits for articulation. A remounting kit consists of two plates (male and female), which precisely fit to one another and can be locked with a locking pin. One plate is embedded into the cast and another into the mounting plaster during articulation. The plates are disassembled and reassembled easily without any difficulty.

Procedure

- The male mounting plate is fused to a 0.5-inch thick sheet of plexiglass. This is done to avoid stone contact (Fig. 8.13).

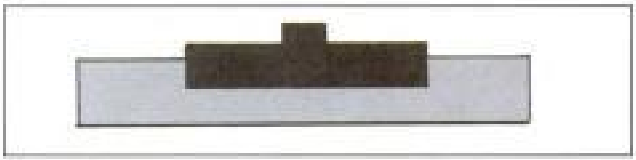


Fig. 8.13: Fusing the male mounting plate on a plexiglass

- The female plate is locked to the male plate with a locking pin (Fig. 8.14).

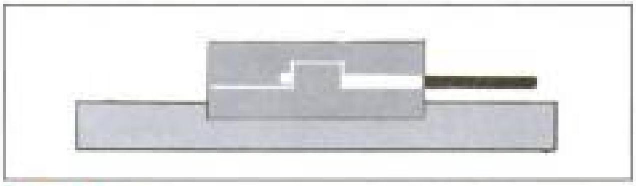
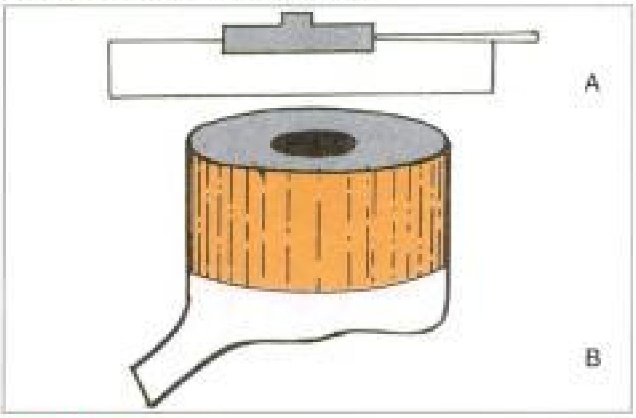


Fig. 8.14: The female mounting plate should be attached to the male mounting plate

- The master impression is beaded, boxed and poured .
- Before the stone is set, the plexiglass with the remounting plates is inverted and placed on the boxing (Fig. 8.15). The unset stone is allowed to fuse with the female remounting plate.
- Once the stone sets the locking pin is removed and the male remounting plate is separated from the master cast (Fig. 8.16).
- The female remounting plate remains fixed to the cast.
- During articulation the male plate is attached to the female plate embedded on the cast.
- The mounting/articulating plaster is contoured over the male plate alone. After the

Fig. 8.15: The plexiglass with the mounting plate is placed over the setting cast such that the female mounting plate gets immersed into the setting cast



Figs 8.16a and b: Separated mounting plates after the cast has set. (a) shows the male mounting plate attached to the plexiglass and (b) shows the female plate attached to the set cast

mounting plaster is set, the master cast can be detached and reattached by unlocking and locking the plates as required (Fig. 8.17).

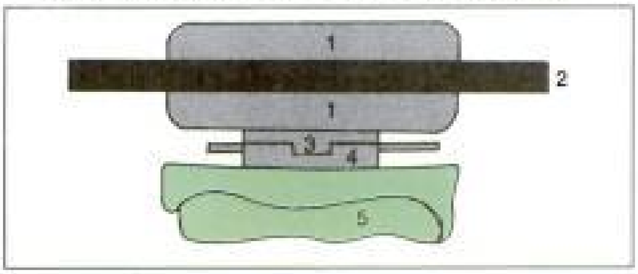


Fig. 8.17: During articulation, the remounting plates are assembled together and the mounting plaster is contoured over the male mounting plate

Key: (1) Mounting plaster (2) Upper member of the articulator. (3) Male mounting plate (4) Female mounting plate (5) Maxillary master cast

FABRICATING THE TEMPORARY DENTURE BASE

After indexing the master cast the temporary denture base is fabricated.

A temporary denture base is defined as, *"A temporary substance representing the base of a denture which is used for making maxillomandibular (jaw) relation records and for arrangement of teeth"*- GPT.

It is commonly known as base plate, temporary base, record base, and trial base. It acts as a basal seat to support the occlusal rims and the artificial teeth for clinical procedures like jaw relation and try-in.

The base plate also gives a clear idea about the contour, extent and aesthetics of the denture. Some base plates are lined with plastic materials for increased adaptation and stability. These base plates are called *stabilized base plates.*

Ideal Requirements: Elder (1955)

- It should adapt to the tissues like a finished denture.
- The extent and the shape of the borders should resemble a finished denture.
- It should be strong enough to withstand occlusal loads.
- It should be dimensionally stable.
- It should be suitable to allow teeth-arrangement.
- It should have a pleasant colour, which should be contrasting enough to be clearly demark the borders in the oral cavity.
- It should not be very thick. It should be rigid even in thin sections.
- It should not be reactive with the tissues.
- **Tucker** in 1966 stated that the base plate should not abrade the surface of the cast during removal and placement. He also said that the base plate should bond to the material used to blockout undercuts so that the undercut material along with the base plate material form one single temporary denture base.

Materials used for Making Base Plates

The common materials used to fabricate a denture base include:

- Auto-polymerising resins
- Heat cure resins
- Thermoplastic resins
- Shellac
- Base plate wax.

Base plates can be stabilized using the following materials:

- Zinc oxide eugenol impression materials
- Elastomeric impression materials
- Soft and hard curing resins.

Base plate stabilization materials are used to increase the adaptability and stability of the temporary denture base. These materials also extend into the undercuts without producing any difficulty in removing the base plate.

The technique for fabrication of a base plate varies for each material. In the following section, we shall discuss in detail about the technique for each material.

Auto-polymerising Resin Base Plate

The fabrication of the base plate is similar to that described for special tray. It differs from the special tray in that it does not have a spacer. The denture base extends till the depth of the sulcus. Auto-polymerising resins can be manipulated using the following techniques.

1. Sprinkle on
2. Dough:
   - Finger-adapted dough technique.
   - Stone-mould dough technique.
   - Wax- confined dough technique.

Finger-adapted technique was described in detail under special tray fabrication. Here, we shall discuss the remaining techniques.

Stone-Mould Dough Technique: (By Assad Zedic and Yarmound (1975))

- One or two sheets of base plate wax is adapted over the primary cast.
- The margins of the wax are fused to fill the sulcus (Fig. 8.18).
- Small conical depressions are made in the land area of the cast, which will act like indices. Separating medium is applied over the cast and a surface tension reducing agent is applied over the wax (Fig. 8.19).

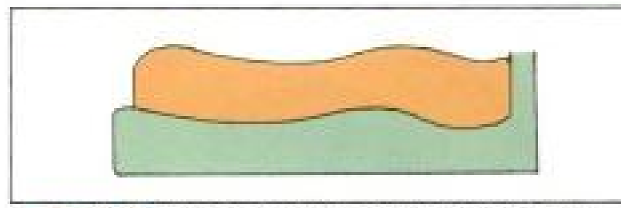


Fig. 8.18: Two sheets of wax adapted over the cast.

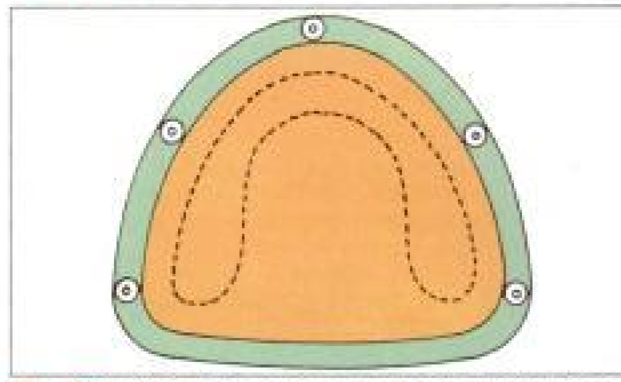


Fig. 8.19: Conical depressions are made in the land area of the cast

- The cast is boxed with boxing or modelling wax. It should be at least 15 mm high (Fig. 8.20).

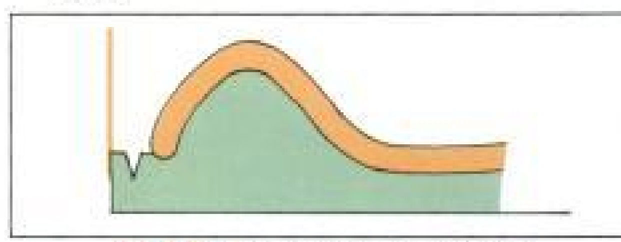


Fig. 8.20: The cast is boxed to the wax

- A proper mix of dental plaster is poured into the boxed cast. This plaster is known as the *boxed plaster* (Fig. 8.21).

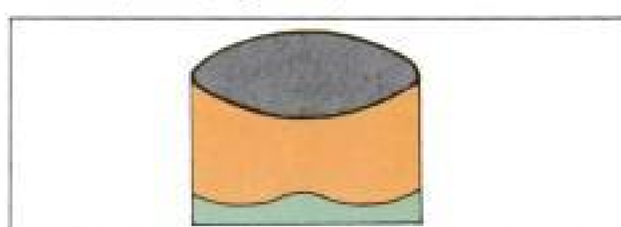


Fig. 8.21: The boxing is filled with dental plaster

- After the boxed plaster sets, it is carefully removed from the cast (Fig. 8.22).

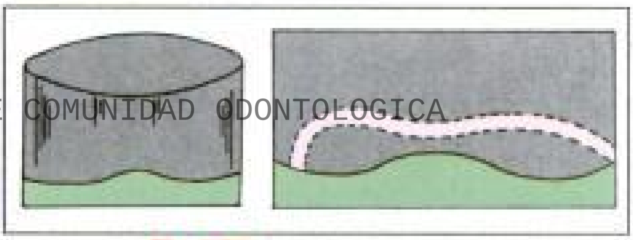


Fig. 8.22: Cast and box plaster

- The base plate wax is softened in a water bath and gently peeled off the cast (Fig. 8.23).

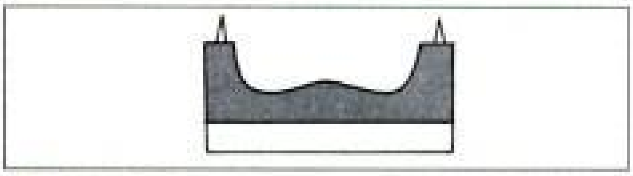


Fig. 8.23a: Box plaster showing conical projections with respect to the land area of the cast

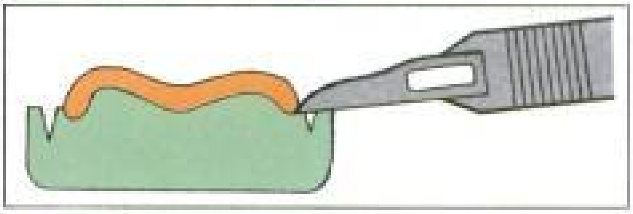


Fig. 8.23b: The adapted wax is removed from the cast using a B.P. blade

- The cast is cleaned with a gentle stream of hot water or soap solution. Sometimes wax solvents are used instead of soap to dissolve any residual wax.
- The boxed plaster and the cast are stored in slurry water as a preserving measure.
- Cold mould seal (separating medium) is applied over the cast and the boxed plaster using a soft brush.
- Auto-polymerising resin is mixed in an airtight mixing jar. If the lid of the mixing jar does not produce a tight seal, a polythene sheet can be used to seal the lid.
- Undercuts in the cast should be filled with self-cure acrylic resin. The acrylic in the mixing jar is kneaded and rolled into a sheet using a roller.
- The sheet is placed on the cast and the boxed plaster is fit into the cast such that the indexing projections coincide with the depressions in the land area of the cast (Fig. 8.24).

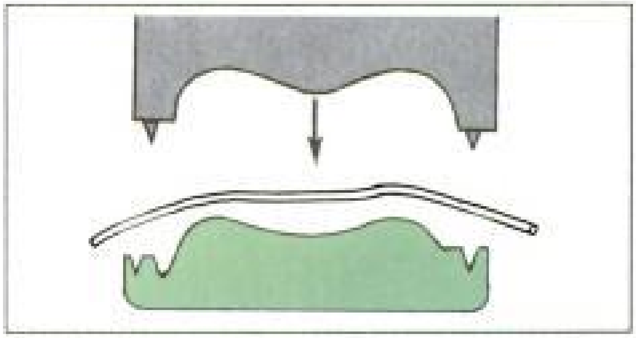


Fig. 8.24: A sheet of acrylic in its dough stage is packed between the case and the boxed plaster

- The resin is allowed to polymerise in a pressure pot for 20 min under 20 psi pressure. This helps to reduce porosities.
- Once the resin is polymerised it is carefully removed from the cast by using a sharp instrument, trimmed and polished. Care should be taken not to overtrim the resin below the depth of the sulcus.

Wax-confined dough technique Laver and Freda described this technique. Here, acrylic resin is used along with base plate wax to form a temporary denture base.

Advantages

- Base plate wax on the outer surface gives a better finish.
- Acrylic on the inner surface gives higher detail.

Procedure

- Three layers of cold-mould seal are applied over the cast. The separating medium is allowed to set for 10 minutes.
- Medium or hard base plate wax is used to blockout the undercuts.
- A sheet of base plate wax is adapted over the entire cast (Fig. 8.25).
- 2 mm relief should be given in the sulcus area.
- A thin mix of auto-polymerising resin is mixed with a ratio of 2:1 by volume.
- A small amount of the mixed resin should be added along the sulcus of the cast.
- The remaining resin is added onto the tissue surface of the adapted base plate wax (Fig. 8.26).

Fig. 8.25: Sheet of base plate wax adapted over the cast

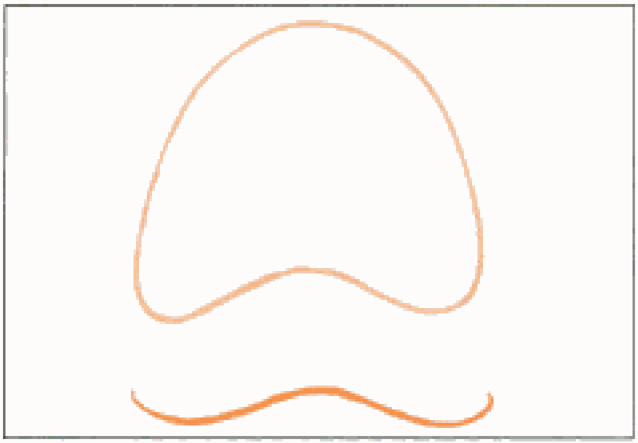


Fig. 8.26: Thin mix of resin is added to the tissue surface of the wax

- The base plate wax with the unpolymerised resin are inverted and then placed on the cast and compressed evenly till the resin attains a thickness of 2 mm.
- Excess of auto-polymerising resin escapes out while pressing the base plate on the cast.
- This excess material is contoured over the sulcus area of the cast to form a thick-rounded border (Fig. 8.27).

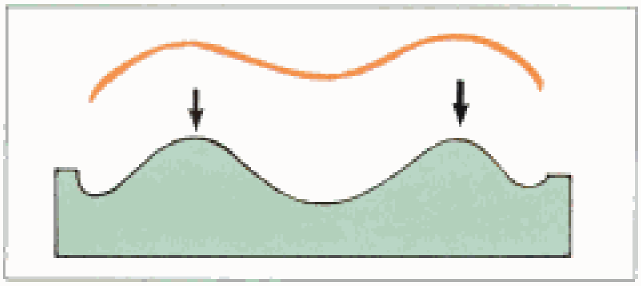


Fig. 8.27: The wax with a resin is compressed over the cast. The excess resin is rounded over the margin of the wax

- The resin is allowed to cure within a rubber-bowl in order to decrease the amount of surface porosity.
- Once polymerisation is complete, the borders are trimmed and polished.

Heat Cure Resins: (Bruver in 1962)

They are not commonly used for making temporary denture bases due to the tedious procedures involved in fabrication. It is usually used during the fabrication of complete dentures with balanced occlusion. Heat cure resins are commonly used permanent denture bases.

Procedure

A duplicate cast is prepared by duplicating the master cast.

- A layer of base plate wax is adapted over the duplicate cast.
- The borders of the wax should extend till the depth of the sulcus.
- The duplicate cast is invested and flasked using a three-pour technique (Described in Flasking Chapter 12).
- The base plate wax is removed by de-waxing (discussed in Flasking).
- Polymerization is done as described in compression moulding technique (Chapter 12).

Fluid Resin Base Plates

This material is rarely used. It was first described by **Browning** in 1973. The technique is similar to that of heat cure resin except for the flasking procedure. A separate injection-moulding flask is used. A wax pattern is invested with a sprue in this flask. After de-waxing the injection moulded resin is injected into the flask and cured.

Thermoplastic Resins: (By Terry and Wahlberg)

- **Wahlberg** (1966) stated that vacuum adaptation was superior to manual adaptation.
- In 1968 **Alfred** described a technique using vacuum moulded thermoplastic resins. This material is available in the form of sheets.
- The technique for manipulation is similar to the one described for Polystyrene special trays.

Shellac Base Plate: (Greener, Harcourt and Cautenschlager (1972)

- This material is derived from the resinous exudate of a scale insect.

- It is naturally brown in colour. Some manufactures bleach and stain it to a light pink colour.

- It is available in separate shapes for maxillary and mandibular ridges.

Procedure

It is similar to the preparation of shellac special trays.

- The cast is coated with talc.
- The base plate is placed in a centered position over the cast.
- Next, it is softened by running a Bunsen flame over it.
- Care should be taken not to overheat the base plate to prevent leaching of resins from the material.
- The base plate is adapted by applying pressure with a wet cotton swab. The material should be adapted from the center to the periphery. This prevents the occurrence of folds.
- An alcohol torch (Blowtorch) can be used to soften and readapt localized areas of the base plate. The borders of the base plate are softened with a blowtorch and adapted upto the depth of the sulcus using a blunt spatula.
- The excess material should not be filed as described in the fabrication of a special tray. Instead, the excess material is folded and fused with the base plate (Roll-on technique) (Fig. 8.28).

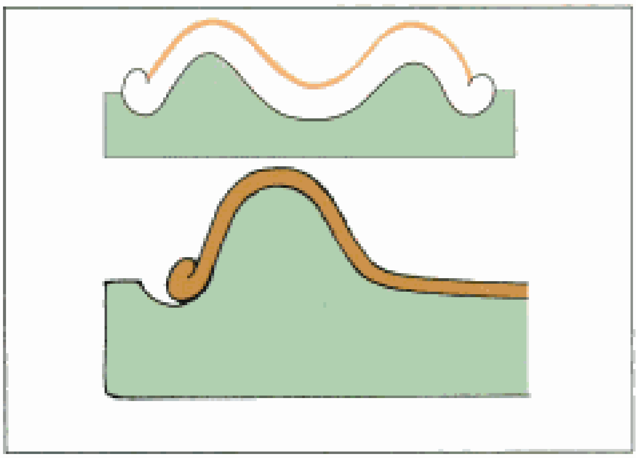


Fig. 8.28: Roll-on technique of adapting shellac

- Some professionals prefer to file away the excess material instead of following the roll-on technique.
- The borders of the base plate are smoothed using arbor band.
- The base plate is examined for close adaptation by gently tapping it to check for rocking.
- Presence of glossy tissue surface shows improper adaptation.

Wax Base Plate

Boucher, Hickey and Zarg (1975) described a technique for making wax base plates. The methods of fabrication are similar to that of Shellac base plate. They are not commonly used.

Metal Base Plates

They are used as permanent denture base. That is the 'teeth arrangement' is done over this metal framework, which is acrylised over it. A metal denture base is prepared over which the occlusal rim is fabricated to carry out jaw relations. After Jaw relation, teeth arrangement is done. After try-in the denture is processed with acrylic resin along with (without replacing) the metal denture base. (Heat-cure acrylic can also be used instead of metal as a permanent denture base material).

Advantages

- No warpage
- More strength even at thin sections
- More accurate
- Produce less tissue reaction
- Easy to maintain
- Good thermal conductivity.

Disadvantages

- Expensive
- Difficult to reline or rebase
- Time consuming laborious procedure.

Materials used

- Gold alloys
- Chrome base alloys
- Aluminium alloys.
- Titanium and its alloys

Technical considerations

Borders and the extent of the denture base should be similar to that of the final denture. Method of fabrication is similar to the fabrication of a removable partial denture framework (Refer RPD framework fabrication).

STABILIZING THE BASE PLATES

Since shellac is not very strong or stable material, it should be reinforced or stabilized when used as a temporary denture base. Shellac can be reinforced using double layers, wires, paper clips and stabilized using zinc oxide eugenol or elastomeric impression materials.

Reinforcing Shellac Trays

- It is usually done using paper clip wires.
- For mandibular base plates, it is adapted in the anterior region, whereas in the maxilla it is adapted in posterior palatal seal area.
- A paper clip wire is adapted along the contour of the cast and fused with the base plate.
- Two layers of shellac can be adapted for reinforcement.

Stabilization of Shellac Base Plates

Shellac base plates are stabilized to prevent Warpage. Fletcher (1951), Boos (1956), Freeze (1956), Jamieson (1956), Kapoor and Yurkstas (1957), Hall (1958), Bodine (1964) and Malson (1964) described different methods for stabilization.

Generally, shellac base plates are stabilized using zinc oxide eugenol impression paste, elastomeric impression materials or auto-polymerizing resins. These materials are lined on the tissue surface of the base plate.

Stabilization using Zinc Oxide Eugenol Impression Paste

It was described by Fletcher (1951), Jamieson (1956) Kapoor and Yurkstas (1957). Using zinc oxide eugenol impression paste, gives adequate adaptation and rigidity to the base plate. The disadvantage of this technique is that it cannot extend into undercuts.

Procedure A shellac base plate is adapted on the cast as described before

- Undercuts should be blocked with plaster-pumice mix or wax.
- A 0.001 inch thick tin foil is adapted on the cast. Excess tin foil should *not* be trimmed off (Fig. 8.29).

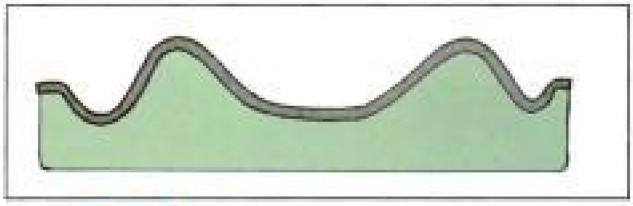


Fig. 8.29: Adapting a tin foil over the cast

- A modified pencil eraser or a toothbrush handle can be used to improve adaptation.
- A well-mixed zinc oxide eugenol impression Paste is loaded on the shellac base plate (Fig. 8.30).

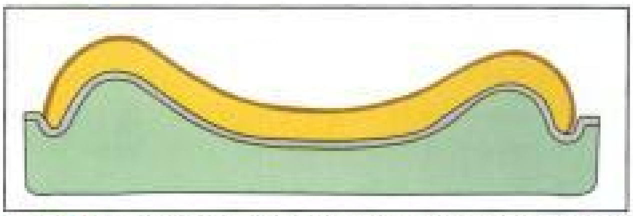


Fig. 8.30: Shellac base plate is stablised using zinc oxide eugenol and compressed over the cast

- The shellac base plate with the loaded material is inverted and placed on the tin foil cast and pressed till the impression material is around 1 mm thick (relief holes should be drilled into the tray for excess material to flow away).
- Before the impression material sets, the excess tin foil is rolled over the shellac special tray (Fig. 8.31).

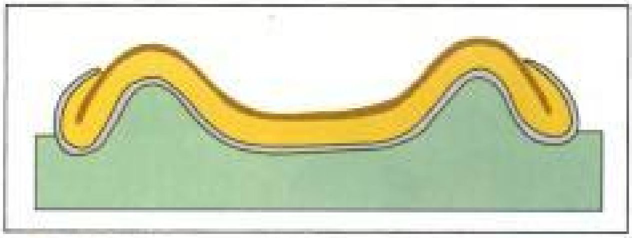


Fig. 8.31: The excess tin foil is rolled over towards the base plate inorder to confine the stablizing material

Stabilization with Elastomeric Impression Materials

It was described by Freese (1956), Bodine (1964) and Malson (1964). The procedure is similar to the stabilization with zinc oxide eugenol impression paste except for some additional before loading the impression material steps:

- Numerous perforations are made on the shellac tray for mechanical retention.
- A layer of (tray adhesive) adhesive is painted on the shellac tray before loading the impression material. After the material is set, the tin foil can be retained or peeled away.

Advantages
The material can be used to extend into minor undercuts (Severe undercuts require blockout).

Disadvantages

- Expensive
- Excessive thickness of the stabilization material.

Base Plate Stabilized with Auto-polymerising Resins

It was described by Boos (1956), Jamieson (1956) and Hall (1958).

The disadvantage of this technique is that acrylic tends to warp. The technique is similar to that of zinc oxide eugenol impression material (More relief holes should be given on the shellac base plate for escapement of acrylic).

FABRICATION OF OCCLUSAL RIMS

An *occlusal rim* (occlusion rim) is defined as "*Occluding surfaces built on temporary or permanent denture bases for the purpose of making maxillo-mandibular relation records and arranging teeth.*" - GPT.

It is also defined as a "*wax form used to establish accurate maxillomandibular relation and for arranging artificial teeth to form the trial denture.*"

Occlusal rims are fabricated to record various maxillomandibular relations, lip lines, vertical and horizontal overlaps, etc. They are usually fabricated to a larger size so that they can be reduced as needed.

Factors Controlling the Form of an Occlusal Rims

The basic factors that should be considered for the proper fabrication are:

- Relationship of the natural teeth to the alveolar bone.
- Relationship of the occlusal rim to the edentulous ridge
- Standard dimensions used to fabricate an occlusal rim.
- Technique of fabrication
- Clinical guidelines.

Relationship of the Natural Teeth to the Alveolar Bone

The occlusal rim should be fabricated such that it is parallel to the long axis of the tooth to be replaced. The maxillary anteriors are labially inclined, hence, the occlusal rim in that area should also be labially inclined. All the posterior teeth are placed vertically, hence, the occlusal rim should also be fabricated vertical in this region.

Relationship of the Occlusal Rims to the Edentulous Ridge

- Residual ridge resorption changes the apex of the edentulous ridge.
- The occlusal rim should be fabricated such that the midline of the occlusal plane (in cross-section) passes through the apex of the edentulous ridge.

Dimensions used to Fabricate a Standard Occlusal Rim

Maxillary occlusal rim (Fig. 8.32) The maxillary occlusal rim should be fabricated to the following dimensions:

- It should be 22 mm high from the depth of the sulcus at the region of the canine eminence
- The anterior edge of the occlusal rim at the midline should be about 8 mm away from the incisive papilla.
- It should be 4 to 6 mm wide in the anterior region.

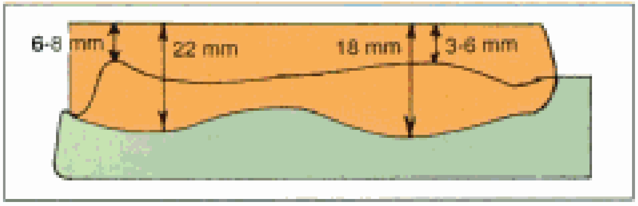


Fig. 8.32a: Ideal measurements required for maxillary occlusal rim (lateral view)

Figs 8.32b and c: (b) Occlusal view (c) Cross–sectional view

- The occlusal table should be 10 to 12 mm above the crest of the alveolar ridge in the anterior region.
- The occlusal table should be 18 mm high when measured from the depth of the sulcus in the posterior region.
- The occlusal table should be 5 to 7 mm high when measured from the crest of the ridge in the posterior region. The occlusal table should be 8 to 12 mm wide in the posterior region.

Mandibular occlusal rim (Fig. 8.33) The following measurements should be maintained while making a mandibular occlusal rim:

- It should be 6 to 8 mm high when measured from the crest of the ridge in the anterior region.

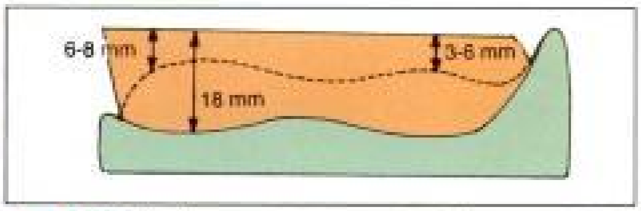


Fig. 8.33a: Ideal measurements required for a mandibular occlusal rim (lateral view)

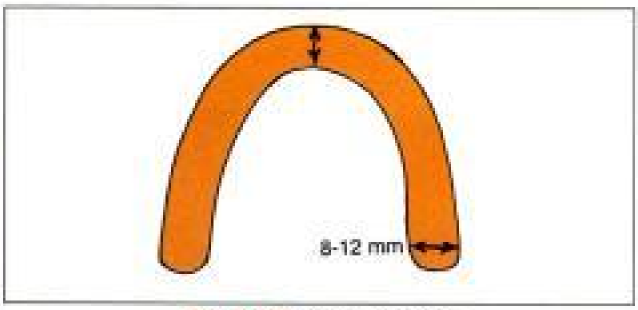


Fig. 8.33b: Occlusal view

- It should be 18 mm high when measured from the depth of the sulcus in the canine eminence region.
- It should be 3 to 6 mm high when measured from the crest of the ridge in the posterior region.
- The occlusal plane should flush to two-third height of the retromolar pad in the posterior region.
- The width of the occlusal table should be 4 to 6 mm in the anterior region and 8 to 12 mm in the posterior region.

Clinical Guidelines for Determining the Shape of the Occlusal Rim (Fig. 8.34)

The standard size occlusal rim should be reshaped for the patient according to the following clinical guidelines.

- Maxillary anterior edge should be 0-2 mm below the upper lip at rest. The level of the upper lip in relation to the occlusal rim shows the lower lip line. But this can vary according to the age of the patient.
- Maxillary posterior occlusal plane should be 1/4th inch below the opening of the Stenson's or parotid duct.
- Mandibular incisal edge should be at the level of the lower lip and about 2 mm behind the maxillary incisal edge.
- Canine eminence of the lower occlusal rim should be located at the corner of the mouth.

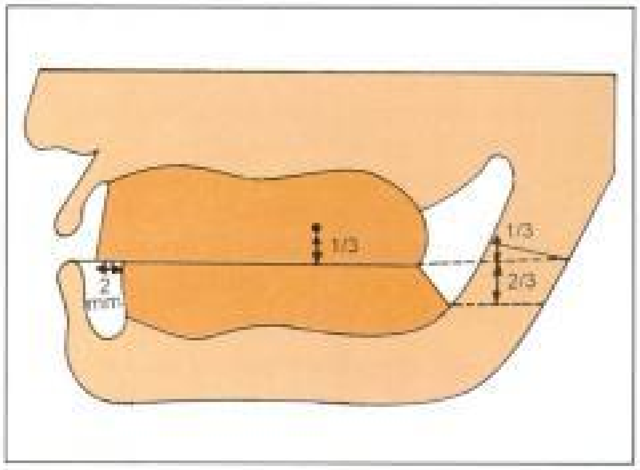


Fig. 8.34: Clinical guide lines for checking the occlusal rims

- Posterior part of the lower occlusal plane should extend to two-third the height of the retromolar pad.

- Anterior maxillary occlusal plane should be parallel to the inter-pupillary line. The antero-posterior occlusal plane should be parallel to the ala-tragus line or the *Camper's line* or *Bromel's line*.

Technique of Fabrication of Occlusal Rim

Occlusal rims can be fabricated by using the following techniques
- Rolled wax technique.
- Metal occlusal rim former.
- Pre-formed occlusal rim.

Rolled wax technique

- This is the most commonly used technique. A sheet of base plate wax is taken and one end of the sheets is softened over the flame and rolled to a width of 4 mm (Fig. 8.35).

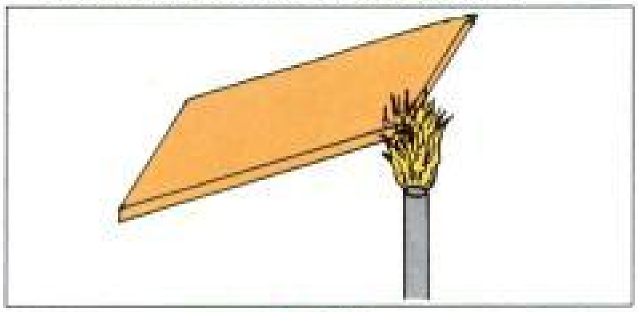


Fig. 8.35

- The wax should be softened adequately and rolled carefully to avoid the entry of air bubbles.
- The roll is again heated over the flame and consecutive rolls are made to form a single thick cylinder of wax (Fig. 8.36).

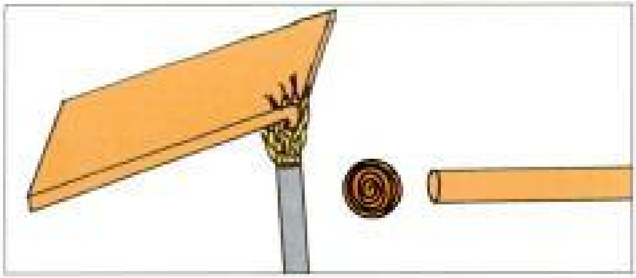
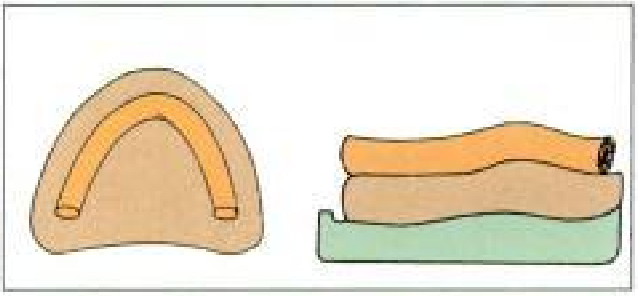


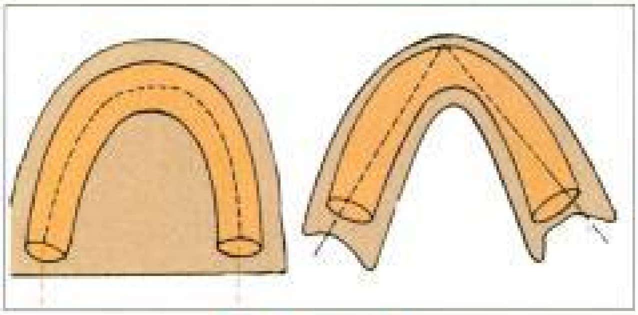
Fig. 8.36

- The rolled cylinder of wax is adapted over the base plate such that it follows the arch curvature (Fig. 8.37).



Figs 8.37a and b

- Maxillary occlusal rims are usually 'U' shaped and mandibular occlusal rims are 'V' shaped or a less wider 'U' (Fig. 8.38).



Figs 8.38a and b

- The adapted wax is sealed to the base plate on the lingual/palatal surface using a hot wax knife (Fig. 8.39). Molten sticky wax can also be used for the same purpose.

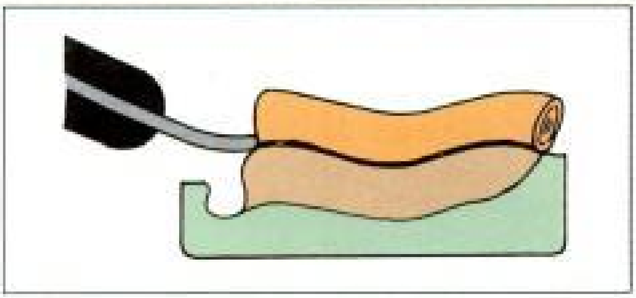
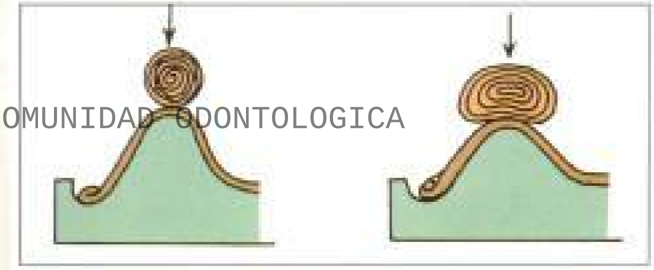


Fig. 8.39

- Mild pressure is applied on the wax to make it oval in cross-section so that it overhangs a little labially (Fig. 8.40).



Figs 8.40a and b

- The depression created below the over hanging wax on the labial and buccal surface should be filled with wax (Fig. 8.41).
- The outer surfaces of the occlusal rim are shaped with the aid of the tail end of a hot wax knife. The lingual surface is also shaped similarly (Fig. 8.42).

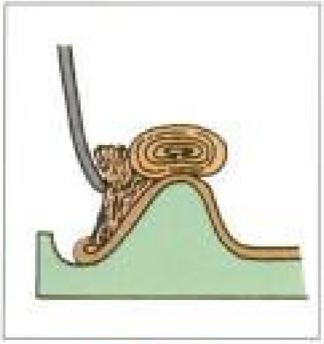


Fig. 8.41

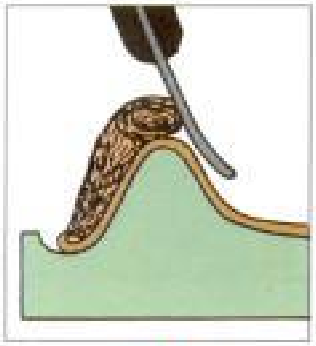


Fig. 8.42

- The occlusal rim should be shaped such that it tapers towards the occlusal plane with a trapezoidal cross-section (Fig. 8.43).
- The occlusal plane is shaped by marking the height and removing the excess wax using a hotplate.
- The measurements are checked and wax is added wherever there is deficiency before polishing the occlusal rim.
- Polishing is done by swiftly flaming the occlusal rim followed by wiping it gently with a loose mass of wet cotton under running water.

Fabrication of occlusal rims using metal occlusal rim formers

Scrap wax or base plate wax should be rolled to a cylinder as described in the rolled wax technique.

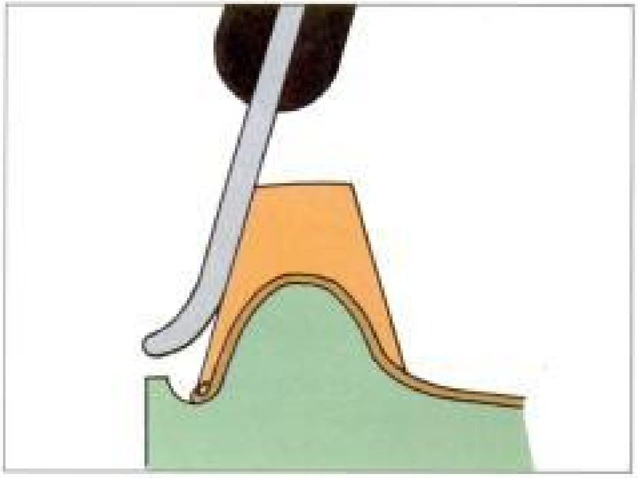


Fig. 8.43

The cylinder of wax is then shaped using a metal occlusal rim former and stored for later use. The formed occlusal rims should be adapted on the denture base, sealed and finished as described in the previous technique (Fig. 8.44).

Preformed occlusal rims They are commercially available in standard sizes separately for the maxilla and mandible. They are fabricated using

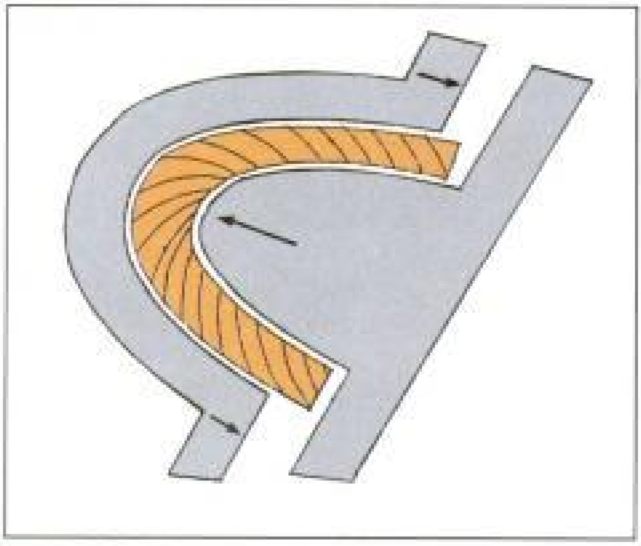


Fig. 8.44: Scrap wax should be placed between the components of a metal occlusal rim former and compressed to form the occlusal rim

the same technique described for metal occlusal rim former.

Chapter 9
Maxillomandibular Relations

- Mandibular Movements
- Customizing the Occlusal Rims
- Orientation of the Plane of the Occlusal Rim
- Jaw Relation
- Vertical Jaw Relation
- Horizontal Jaw Relation
- Methods of Recording the Centric Jaw Relation

9 Maxillomandibular Relations

MANDIBULAR MOVEMENTS

- Introduction
- Structure and function of the temporomandibular joint
- Factors that control the mandibular movements
- Types of mandibular movements

Introduction

Before studying about the relationship of the jaws, it is mandatory to know in depth about the various movements possible between them.

Mandibular movements occur around the temporomandibular joint, which is capable of making complex movements. The maxillomandibular relationship varies every second during mandibular movements. There are two basic mandibular movements.

- Functional movements.
- Parafunctional movements.

Functional mandibular movements are natural and characteristic movements that occur during mastication, speech and yawning. Unnatural and non-characteristic movements like clenching, tapping and grinding are considered as *Parafunctional movements.*

A thorough knowledge about the various movements of the mandible is essential before recording the jaw relation. The complete denture fabricated for each patient should function in harmony with the functional mandibular movements. To understand the various concepts involved in the movements of the mandible the structure and function of the temporomandibular joint should be studied.

Structure and Function of the Temporomandibular Joint

The temporomandibular joint is a *bilateral diarthroidal synovial hinge joint*. The joint cannot function independently on each side. Their movements are synchronized and act together to produce the various mandibular movements.

The joint has a capsule and an articulating disc. The glenoid fossa of the temporal bone and the condyle of the mandible form the articulating surfaces. The joint cavity is divided into the upper and lower compartments by the articular disc. It is considered as a compound joint *(a compound joint is one with more than two bones articulating).* In this case, the articular disc acts like the third bone. Each compartment acts as a saparate joint during function.

Hence, the joint exhibits two types of movements namely, rotation (hinge movement) and translation (gliding movement). The upper compartment shows anteroposterior gliding movement. When this movement takes place, the condyle and the disc move as a single unit against the glenoid fossa. The lower compartment shows hinge movement. During hinge movement the condyle moves against the articular disc and the glenoid fossa, which together act as a single unit. The structure of the temporomandibular joint is complex and is capable of functional and parafunctional movements (Fig. 9.1).

The basic movements of the joint and the bone are similar in dentulous and edentulous patients. Occlusion in a complete denture should be in harmony with these movements.

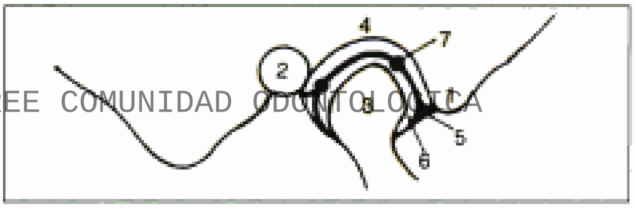


Fig. 9.1: Temporomandibular joint
Key: (1) Articular eminence, (2) External auditory meatus, (3) Condyle, (4) Glenoid fossa, (5) Articular disc, (6) Inferior joint space, (7) Superior joint space

Determinants of Mandibular Movements

The major factors that determine the mandibular movements in general are:

- Condylar guidance
- Incisal guidance
- Neuromuscular factors.

Condylar Guidance (Posterior Determinant)

Condylar guidance can be defined as, *"Mandibular guidance generated by the condyle and articular disc traversing the contour of the glenoid fossa"*—GPT. It is nothing but the path of movement taken by the condyle in the glenoid fossa. The glenoid fossa and the condyle are the articulating surfaces of the temporomandibular joint. The condyle moves along the surface of glenoid fossa during mandibular movement. Hence, the surface of the glenoid fossa determines the path of movement of the condyle. The slope of the glenoid fossa is not straight, instead it is a 'S' bend (Fig. 9.2). Hence the condyle also moves along a 'S' shaped path. This shape of the glenoid fossa, which determines the path of movement of the condyle, is called the *condylar guidance*. The condylar guidance can be measured using a protrusive interocclusal record.

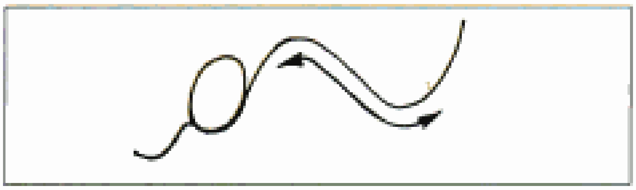


Fig. 9.2: The posterior slope of the articular eminence forms the condylar guidance

Incisal Guidance (Anterior Determinant)

It is defined as, *"The influence of the contacting surfaces of the mandibular and maxillary anterior teeth during mandibular movements"* - GPT.

When the mandible is brought forward (protrusion), the incisal edge of the lower anteriors slide along the slope of the lingual surface of the upper anterior teeth before reaching edge to edge contact. The slopes of the lingual surface of the upper anterior teeth determine the path along which the mandible moves during protrusive movement. In other words, the lingual surface of the maxillary anteriors guide the mandible during protrusive movement and is called the *Incisal guidance* (Fig. 9.3).

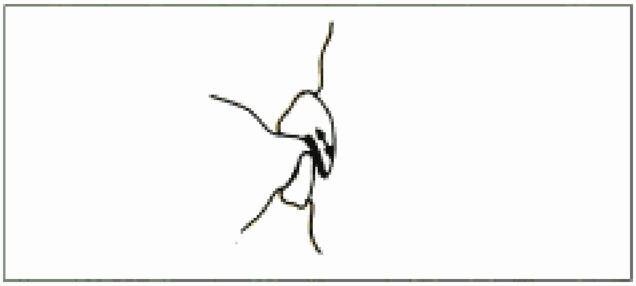


Fig. 9.3: The palatal slope of the incisors gives the incisal guidance

The angle formed between the long axis of the upper and lower anteriors is called the *incisal guide angle*. It is defined as, *"The angle formed in the horizontal plane by drawing a line in the sagittal plane between the incisal edges of the maxillary and mandibular central incisors when the teeth are in centric occlusion"* - GPT.

The incisal guidance is absent in a completely edentulous patient. It is reproduced in the complete denture by arbitrarily setting the anteriors using a standard incisal guide value and modifying them to suit the patient during aesthetic anterior try-in.

Neuromuscular Factors

The muscles of mastication are the most important determinants of mandibular movements. In a normal patient, the muscles function in a coordinated smooth manner. But when there is hypertrophy or dysfunction of one group of muscles, the movement of the mandible is uncoordinated and asymmetrical. Similarly, the tone of the muscle also determines the freedom of movement. Muscular dysfunction should be evaluated before performing jaw relation. Many neurological disorders like Parkinsonism produce muscle dysfunction.

Each muscle has a specific action on the mandible. The movement of the mandible in any direction is predominantly controlled by one particular muscle and is coordinated by the remaining. For example, the lateral pterygoid controls protrusion, the medial pterygoid and the masseter control the lateral movements and the temporalis controls retraction and closure of the mandible.

Types of Mandibular Movements

Mandibular movements can be classified as follows:

- Based on the dimension involved in the movement.
  — Rotation around the transverse or hinge axis.
  — Rotation around the anteroposterior or sagittal axis.
  — Rotation around the vertical axis
  — Translation in time
- Based on the type of movement.
  — Hinge movement.
  — Protrusive movement
  — Retrusive movement
  — Lateral movement
    - Lateral rotation or laterotrusion (Right and left lateral movement).
    - Lateral translation or Bennett movement
      - Immediate side shift
      - Precurrent side shift
      - Progressive side shift
- Based on the extent of movement
  — Border movements
    - Extreme movements in the horizontal plane
    - Extreme movements in the sagittal plane
    - Extreme movements in the coronal plane
    - Envelope of motion
  — Intra-border movements.
    - Functional movements
      - Chewing cycle
      - Swallowing
      - Yawning
      - Speech
    - Para-functional movements
      - Clenching
      - Bruxism
      - Other habitual movements.

Based on the Dimension Involved in the Movements

Most mandibular movements occur around three principal dimensions. They include, the transverse, vertical and sagittal axes. Sometimes a fourth dimension is also involved and this is '*time*'. The fourth dimension is only significant in the Bennett movement (discussed later). Now we shall discuss about the movement of the mandible in each principal axis.

Rotation around the Transverse or Hinge Axis (Fig. 9.4)

The transverse axis runs horizontally from the right side of the mandible to the left. Rotation around this axis is seen during protrusive

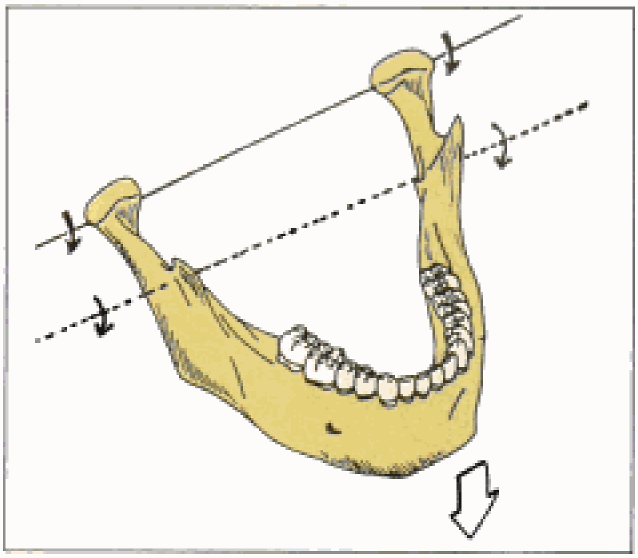


Fig. 9.4: Rotation around the transverse or hinge axis

movement. The transverse axis of rotation varies during different phases of protrusive movement. During initial mouth opening, the transverse axis passes through the head of the condyle. During the later stages of mouth opening, the transverse axis passes through the mandibular foramen.

The rotation of the mandible in each transverse axis is discussed in detail under protrusive movements.

Rotation around the Anteroposterior or Sagittal Axis (Fig. 9.5)

The anteroposterior axis is an imaginary axis running along the mid-sagittal plane. The mandible shows slight rotation around this axis. During the movement, the condyle on one side moves downward and medially along the slope of the entoglenoid process (medial slope of the glenoid fossa) and the condyle of the opposite side moves upward and laterally. This type of movement is usualy seen in association with lateral movements.

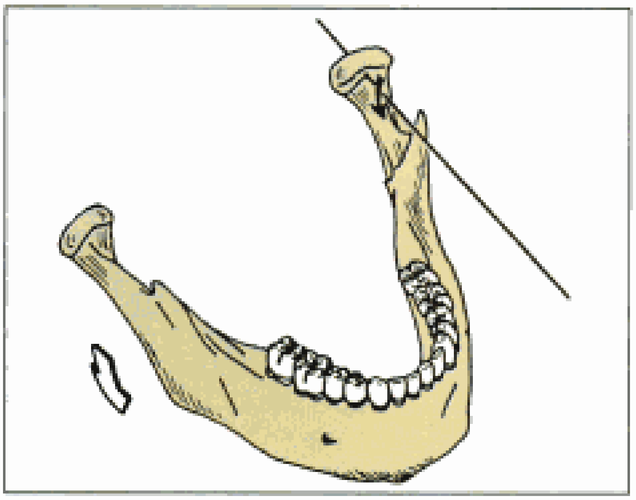


Fig. 9.5: Rotation around the anteroposterior or sagittal axis

Rotation Around the Vertical Axis (Fig. 9.6)

The vertical axis runs through the condyle and the posterior border of the ramus of the mandible. The mandible rotates around this vertical axis during the lateral movements. If the patient moves his mandible towards the right, the vertical axis of rotation will pass through the right condyle and vice versa.

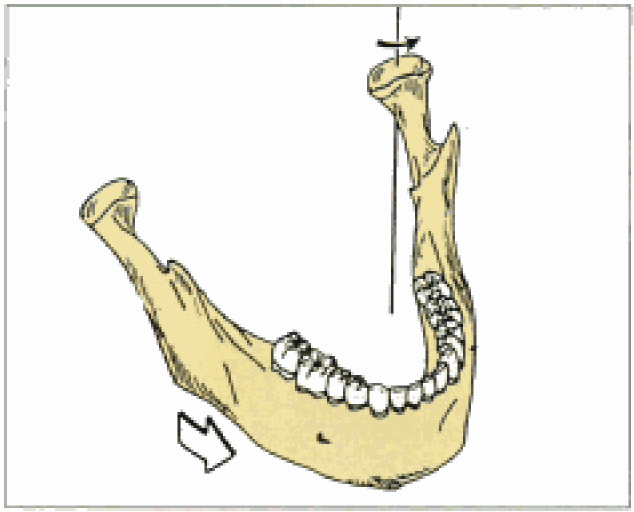


Fig. 9.6: Rotation around the vertical axis

Translation in Time

As mentioned before, time is the fourth dimension and movement of the mandible in this dimension occurs during Bennett movement. During Bennett movement, the mandible does not rotate around an axis, instead it shifts "*en masse*" in time.

Based on the Type of Movement

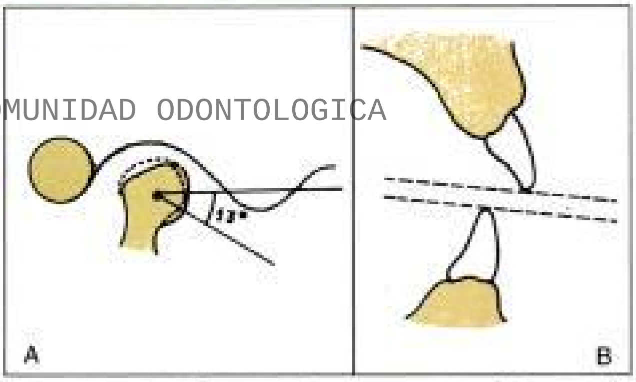
Based on the type of movements, mandibular movements can be broadly classified into hinge, protrusive and lateral movements.

Hinge Movement

This is a purely rotational movement of the joint, which takes place around a horizontal axis till the patient opens his mouth to about 20 to 25 mm.

The presence of a transverse or terminal hinge axis was proposed by McCollum and verified by Kohno. They proposed the presence of a hinge axis based on the fact that the hinge movement occurs when there is a 10° to 13° rotation of the condyle in the temporomandibular joint, which provides a jaw separation of 20 to 25 mm in the incisal region (Fig. 9.7).

This kind of movement usually occurs while crushing food or taking in food. The condyle begins to glide after a certain amount of mouth opening (beyond 13° rotation) and this is not



Figs 9.7a and b: Pure rotational movement of the condyle (12° or 20-25 mm incisal separation)

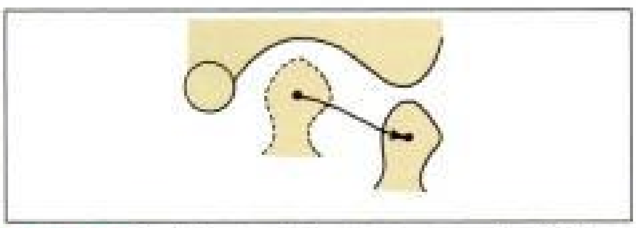


Fig. 9.8: Condylar translation that occurs after 13° of rotation

considered as a hinge movement (Fig. 9.8). The hinge movement is produced by the action of the lateral pterygoid and suprahyoid muscles and is aided by gravity.

Protrusive Movements

This type of movement occurs while incising and grasping food. This movement occurs after the condyles rotate for more than 13° in the temporomandibular joint. Once the condylar rotation exceeds 13° the transverse hinge axis mentioned above shifts to the level of the mandibular foramen. The mandible moves forwards and downwards while rotating in its new hinge axis (Fig. 9.9).

When the mandible slides forwards and the mandibular and maxillary anterior teeth are in an edge-to-edge relation, the protrusive movement is said to be complete. Usually the mandible is guided by the anterior teeth during protrusive movement, which is followed by complete disocclusion (separation) of the posterior teeth (Fig. 9.10). This characteristic posterior separation seen during anterior protrusion is called *Christenson's phenomenon*.

Retrusive Movement

This occurs when the mandible is forcefully moved behind its centric relation. It is achieved by the fibres of the temporalis, digastric and the

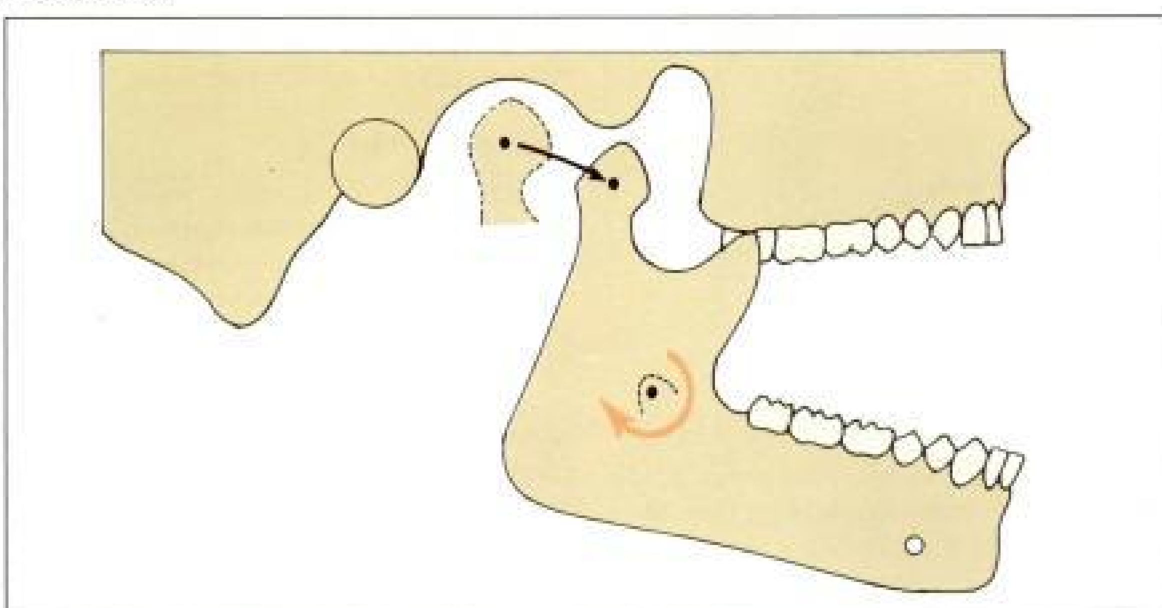


Fig. 9.9: As the mandible opens and protrudes to grasp the food, the axis of rotation shifts from the condyle to the mandibular foramen

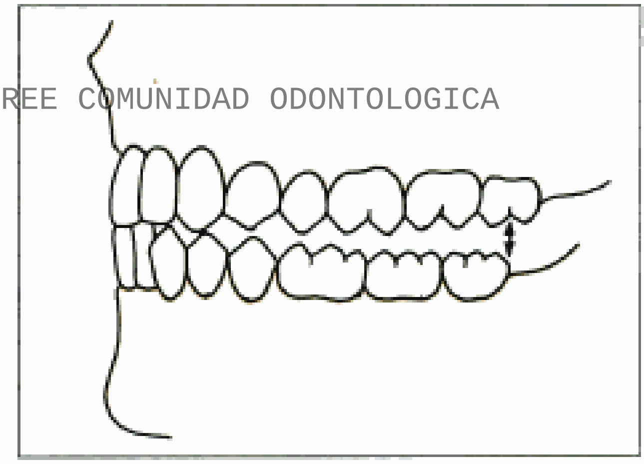


Fig. 9.10: Posterior separation seen during anterior protrusion (Christenson's phenomenon)

deeper fibres of the masseter. The magnitude of this movement is very meagre (about 0.5 mm) and the resultant position obtained by the mandible is a strained position. The fibres of the bilamina and the temporomandibular ligament, and the contour of the posterior slope (tympanic plate) of the glenoid fossa determine this movement. It is usually not a common movement and the patient cannot voluntarily reproduce it.

Lateral Movements

Lateral movements are of two types namely, *lateral rotation and Bennett Shift*. Lateral rotation is the rotation of the mandible to any one side and Bennett is the shift of the mandible towards the side of laterotrusion.

Lateral Rotation or Laterotrusion

Lateral rotation is said to occur when the mandible moves away from the mid-sagittal plane. These movements can occur on the right or the left side. Lateral movements usually take place while chewing food.

Some basic concepts should be understood about lateral movements. That is, when the mandible moves laterally, the condyles on both sides do not share the same path of movement.

Consider the mandible is moved towards the right side. The right condyle is considered as the *working or laterotrusive condyle* and the left condyle

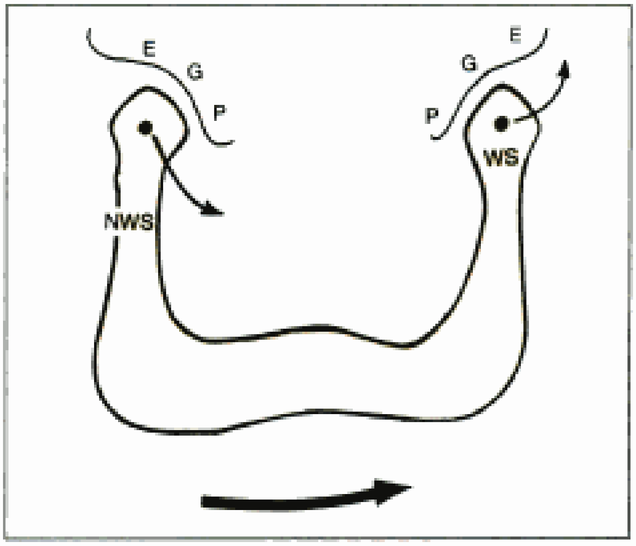


Fig. 9.11: Schematic diagram showing the working and non-working sides of the mandible in relation to the direction of movement. EGP—Entoglenoid process, WS—Working side, NWS—Non-working side

(opposite side) is called the non-working or *mediotrusive or balancing condyle* (Fig. 9.11).

The working side is not limited by any anatomical structure other than the temporomandibular ligament. Hence, it can take any one of the five different paths. If the working condyle moves laterally outward, it's called laterotrusion. If the working condyle moves laterally and upward, it's called laterosurtrusion. If the working condyle moves laterally and downward, it's called laterodetrusion. If the working condyle moves laterally and forward, it's called *lateroprotrusion*. If the working condyle moves laterally backward, it's called *lateroretrusion* (Figs 9.12a and b).

The non-working condyle will move along an arc forward, downward and medially as determined by the entoglenoid process of the glenoid fossa.

Bennett Movement

It is defined as, "*The bodily lateral movement or lateral shift of the mandible resulting from the movements of the condyles along the lateral inclines along the mandibular fossae in lateral jaw movements*"—GPT.

It is the bodily side shift (lateral translation) of the mandible which, when it occurs may be

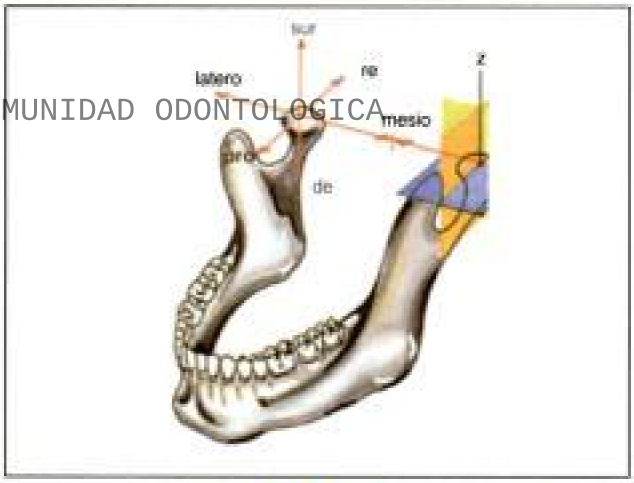


Fig. 9.12a

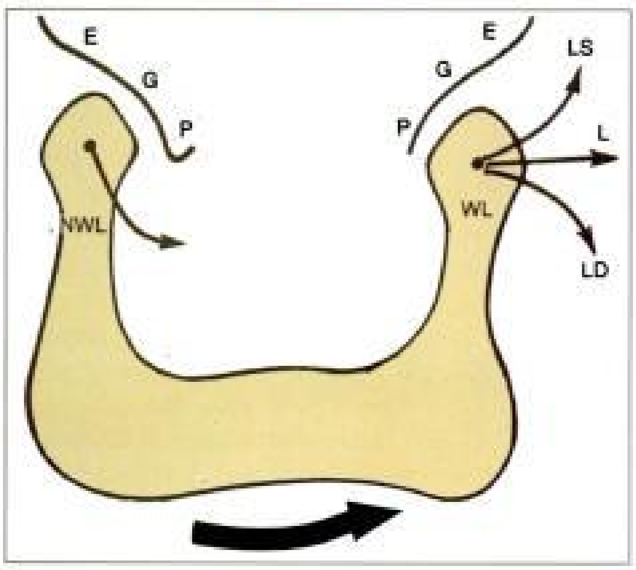


Fig. 9.12b: Schematic diagram showing the paths of the mediotrusive and laterotrusive condyles (anterior view). M—Mediotrusion, L—Laterotrusion, LS—Laterosurtrusion, LD—Laterodetrusion, WC—Working condyle, NWC—Non-working condyle, EGP—Entoglenoid process

recorded in the region of the translating condyle of the non-working side. During lateral movement, the mandible shifts (as a whole) by 1 to 4 mm towards the working side (Fig. 9.13). This shift is called Bennett movement. This shift is not associated with laterotrusion and may occur before or along with laterotrusion (Fig. 9.13).

This lateral translatory motion is measured against time, which is considered as the fourth dimension of mandibular movements. Bennett

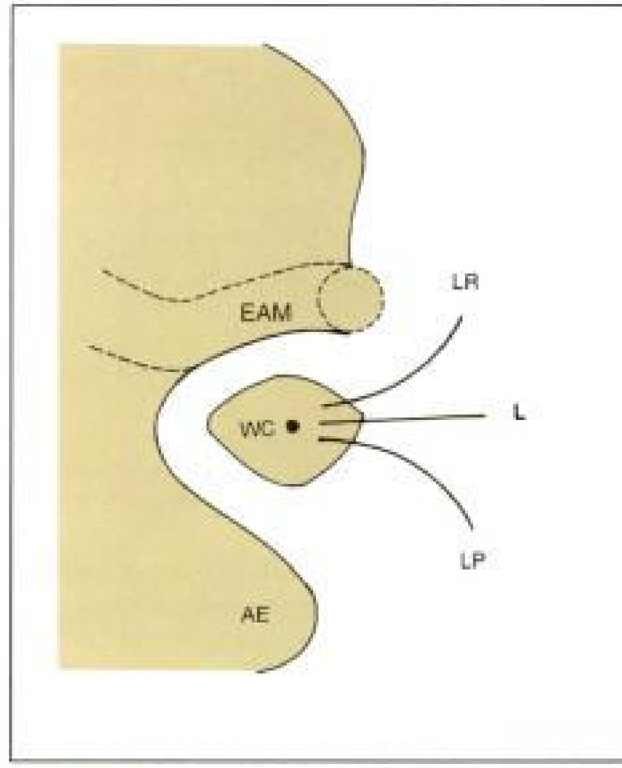


Fig. 9.12c: Superior view of the working condyle. EAM—External auditory meatus, AE—Articular eminence, WC—Working condyle, L—Laterotrusion, LP—Lateroprotrusion, LR—Lateroretrusion

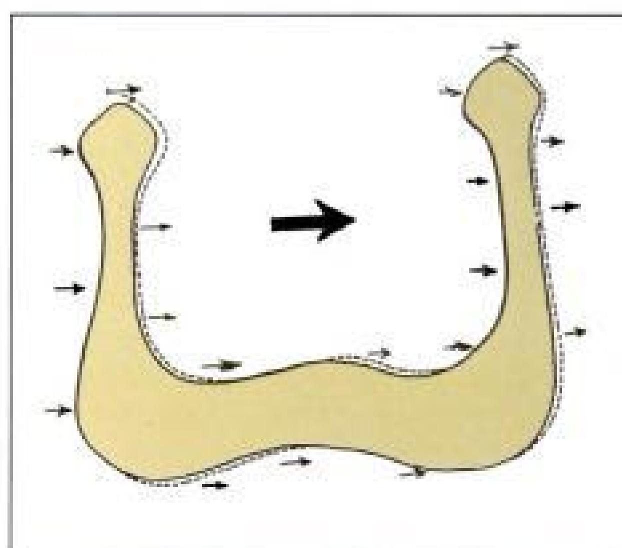


Fig. 9.13: Schematic diagram showing Bennett shift movement

movement can be classified based on the time at which they occur in relation to laterotrusion. We know that during laterotrusion, the non-working condyle arcs foward and medially. Hence, Bennett movement is classified based on the timing of the shift in relation to the forward movement of the nonworking condyle:

- *Immediate side shift:* Lateral translation occurs before forward movement of the non-working condyle (Fig. 9.14).
- *Precurrent side shift:* Major quotient of the lateral translation occurs during the first 2-3 mm of forward movement of the non-working condyle (Fig. 9.15).
- *Progressive side shift or Bennett side shift:* Lateral translation that continues linearly after 2-3 mm of forward movement of the non-working condyle (Fig. 9.16).

In some patients there may be laterotrusion without lateral shift of the mandible. Similarly in

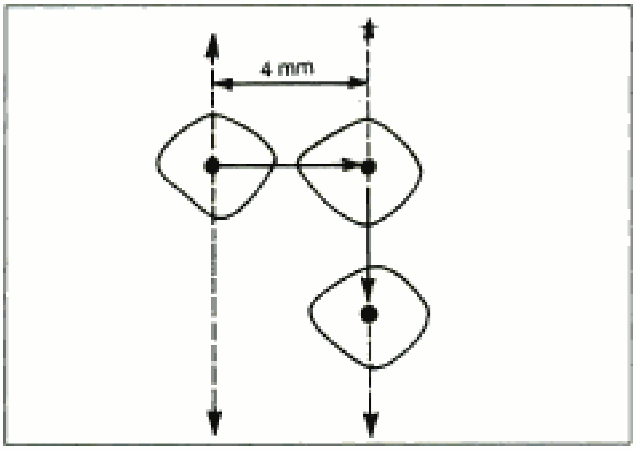


Fig. 9.14: Immediate side shift

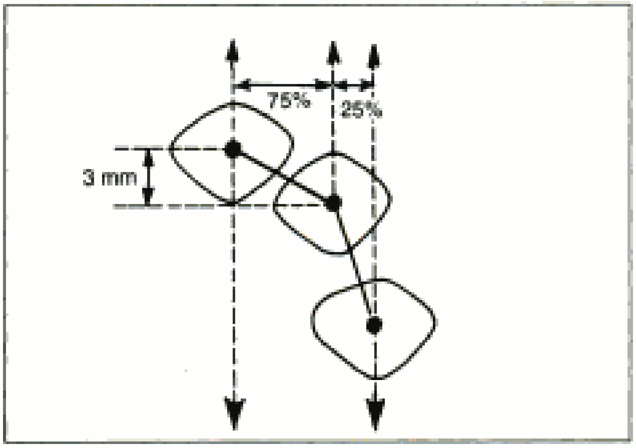


Fig. 9.15: Precurrent side shift. 75% of the shift takes places during the first 3 mm of anterior movement of the condyle

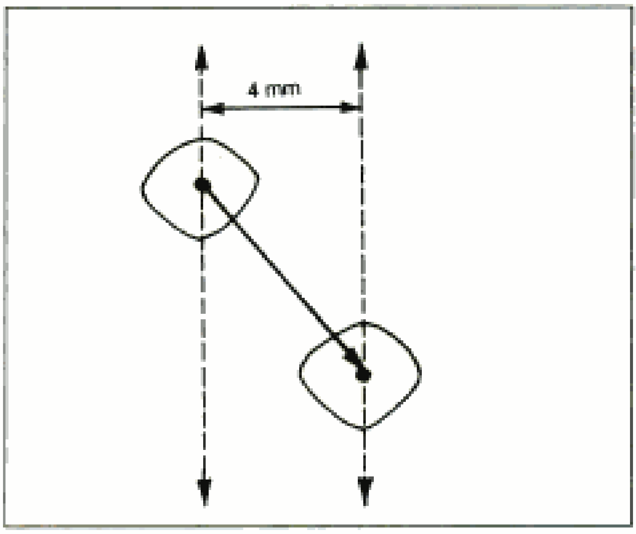


Fig. 9.16: Progressive side shift

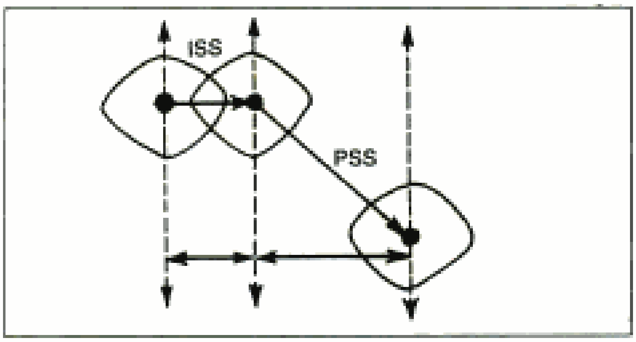


Fig. 9.17: Combined movement. There is immediate side shift (ISS) followed by progressive side shift (PSS)

some patients there may be a combination of immediate and progressive side shift (Fig. 9.17). Accordingly, the tracing of the pattern will also vary. Bennett movement can be measured both in the working and non-working condyles, but it is usually done in relation to the non-working condyle.

Immediate Side Shift Bennett Movement

Here the mandible shifts before the forward movement of the non-working condyle occurs. This movement occurs in 86% of the condyles studied. This shift ranges 1 to rarely 4 mm (average 0.75 mm) in dimension (Fig. 9.14).

Precurrent Side Shift (Fig. 9.15)

This is the lateral translation that occurs during the first 2 to 3 mm of forward movement of the non-working condyle. The mandible begins to shift rapidly during the first 2-3 mm (lateral movement) and then continues to shift in a less rapid fashion. If the major quotient of the Bennett movement occurs during the first 4 mm of anterior movement of the non-working condyle, then its called *Distributed side shift*.

Progressive Side Shift or Bennett Side Shift Movement (Fig. 9.16)

This is the lateral translation (shift) that occurs after 2 to 3 mm of forward movement of the non-working condyle. The shift of the mandible is gradual and does not change with time.

In most patients, the progressive side shift scales gradually and linearly along with laterotrusion. But in some patients, there may be immediate side shift for about 1 mm before lateral movement followed by progressive side shift along with lateral movement (Fig. 9.17).

Bennett Angle

It is defined as, "The *angle formed by the sagittal plane and the path of the advancing condyle during lateral mandibular movements as viewed in the horizontal plane*"—GPT.

This is the angle formed between the path of the non-working condyle and the sagittal plane.

Studies have shown that variations in the direction of progressive lateral translation or Bennett angle to be about 7.5 to 12.8° (Fig. 9.18). This Bennett angle is used in articulators with immediate lateral translation capability. To calculate the Bennett angle in a Hanau's articulator, Hanau proposed the following equation:

Bennett angle (L) = (H/8) + 12. Where it is the horizontal condylar inclination.

The validity of this equation is questionable.

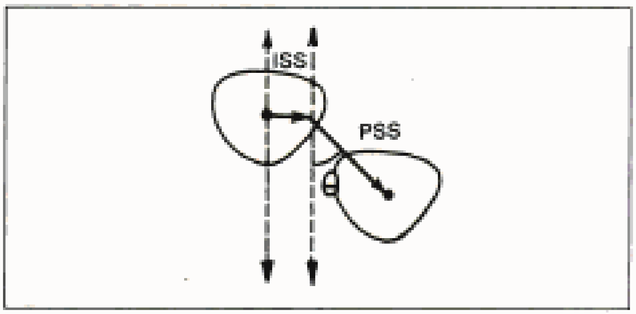


Fig. 9.18: Bennett angle (Note the angle formed only between the progressive lateral path and the sagittal plane)

Based on the Extent of Movement

Based on the extent of movement, mandibular movements can be classified as border and intra-border movements. Border movements are extreme movements occurring in all three planes and intra-border movements are all possible movements of the mandible that occur within the border envelope.

Border Movements

Border movement is defined as, "*mandibular movement at the limits dictated by anatomic structures, as viewed in a given plane*"—GPT. As the definition suggests border movements are recorded in three different planes. A pantograph is required to record all border movements. The pantograph is an extraoral tracing device, which has six sets of styli and flags (four posterior and two anterior). The styli are designed to draw tracings on their respective flags as the patient moves his mandible. A detailed description of the pantograph is given in Chapter 27.

In order to achieve a clear understanding of the border movements, the individual extreme movements of the mandible should be studied.

Extreme Movements in the Horizontal Plane

Border movements recorded in the horizontal plane produced a characteristic '*Diamond tracing*' (Fig. 9.19). While recording the tracing, the patient is instructed to move his mandible from the centric relation position (CR) to the maximum right lateral (MRL) position to the maximum protrusive (MP) position, to the maximum left lateral (MLL) position and return to centric.

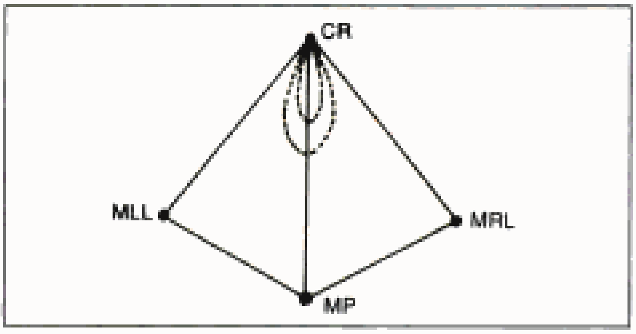


Fig. 9.19: Diamond tracing. Border movement recorded in the horizontal plane

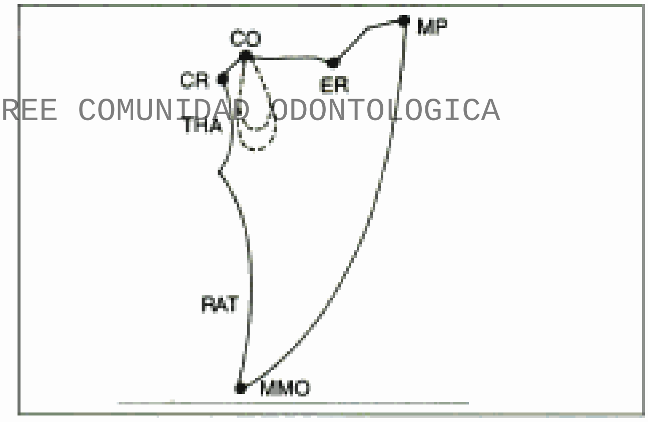


Fig. 9.20: Beak tracing. Borders movements recorded in the sagittal plane

An arrow point tracing formed using Gothic arch tracers should and will coincide with this pattern.

Extreme Movements in the Sagittal Plane

A characteristic '*Beak tracing*' (Fig. 9.20) is formed while recording border movements in the sagittal plane. Here, the patient is instructed to move the mandible from centric relation (CR) to centric occlusion (CO), then to the edge to edge relationship (ER) guided by the incisal guidance, progress further forward to the maximum protrusive (MP) position and then arc downward to the maximum mouth opening (MMO) position. Once this position is reached the operator should guide the mandible backward and close the mouth. While closing the mouth the mandible arcs upward (RAT-rotation after translation) around a transverse axis passing through the mandibular foramen. Consecutively the condyle translates back to the centric relation position where the mandible continues to arc upwards around the true hinge axis passing through the condyle (THA).

Extreme Movements in the Coronal Plane

Border movements produced in this plane produce a characteristic 'shield tracing' (Fig. 9.21). Here the patient is instructed to move his mandible from centric occlusion (CO) to canine-guided disocclusion on the right side (RD) and then to the maximum right lateral position (MRL) then arc downwards to the maximum mouth opening position (MMO). From this position, the patient

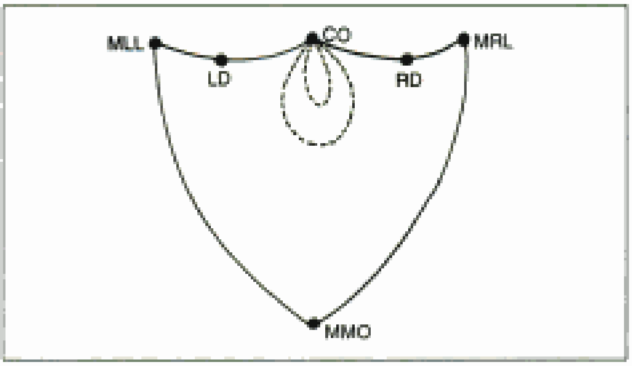


Fig. 9.21: Shield tracing. Border movements recorded in the coronal plane

is instructed to arc upward to the maximum left lateral position (MLL), return medially to canine guided disocclusion on the left side (LD) and then return to centric occlusion (CO).

Envelope of Motion

When we combine the border movements of all the three planes, we get a three-dimensional space within which mandibular movement is possible. This three-dimensional limiting space is called the *envelope of motion* (Fig. 9.22). It was first described by Posselt in 1952. The envelope of motion is longest and widest superiorly and narrows down to a point near the maximum mouth opening (MMO) position. Hence, as the jaw separation increases, space for movement decreases to a zero at the maximum mouth opening (MMO) position.

Intra-border Movements

Intra-border movements occur within the envelope of motion. They are of two types namely

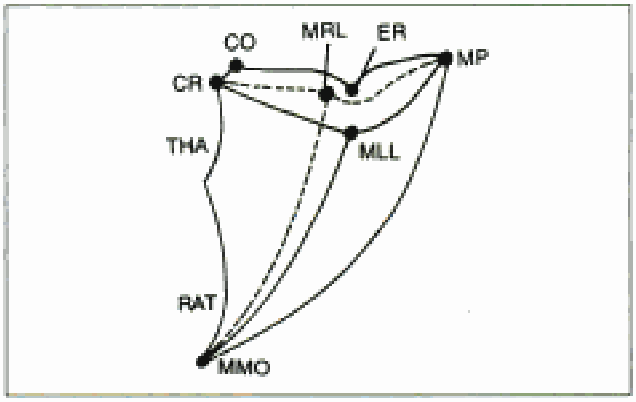


Fig. 9.22: Envelope of motion. Combination of border movements in all three planes

Functional and para-functional movements. Functional movements include chewing, speech, swallowing and yawning.

Chewing Cycle

Murphy summarised six phases in the chewing cycle. They are:

- *Preparatory phase:* In this phase the tongue positions the food within the oral cavity and the mandible deviates towards the chewing side.
- *Food contact phase:* This is a phase of momentary hesitation in movement that occurs due to triggering of sensory receptors due to food contact.
- *Crushing phase:* This starts with high velocity and slows down as food gets crushed. Gibbs in 1969 observed that when the central incisor is about 5 mm from closure, the jaw motion is stabilised at the working condyle and the following final closing stroke is guided by this 'braced' condyle.
- *Phase of tooth contact:* With slight change in direction without delay: Here all the reflex muscular adjustments for tooth contact are made.
- *Grinding phase:* In this phase, there is grinding movement guided by the maxillary and mandibular occlusal tables.
- *Centric occlusion:* The mandible returns to a single terminal point before it goes into the preparatory phase.

  Masticatory frequency is variable. It is usually one to two strokes per second. When the chewing cycle is recorded in the sagittal plane using a pantograph, a characteristic '*teardrop tracing*' is obtained (Fig. 9.23a). When the mandible moves along the posterior incline (PI) of the teardrop, food is sliced by the cuspal inclines. The apex of the tracing is formed when the opposing teeth are in cusp to fossa relationship (CO) and trituration of food occurs. Finally as the mandible moves to make the anterior incline (AI) of the teardrop, dispersion of churned food along the sluiceways occur.

Speech

Mandibular movement during speech is variable according to the syllables used, accent and speed.

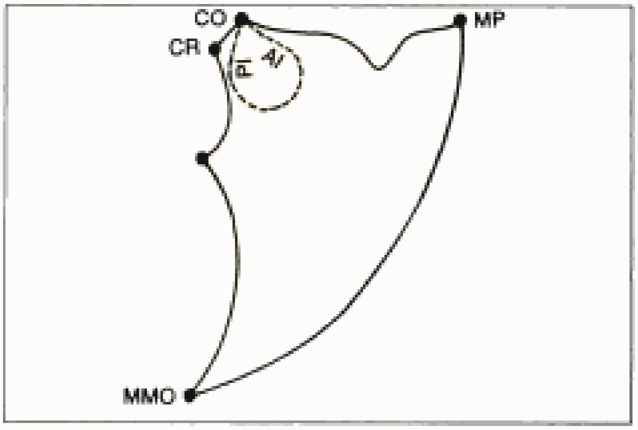


Fig. 9.23a: Teardrop tracing obtained while recording the chewing cycle. AI—Anterior incline of the chewing cycle, PI—Posterior incline of chewing cycle, CO—Centric occlusion

Definitive repeatable jaw writings are difficult to record during speech.

Swallowing

The mandible always returns to the centric relation position during swallowing. And immediately after swallowing, there is a pause in movement followed by movement to the resting position. The tongue functions to seal the palate so that the bolus can move only posteriorly. This movement of the tongue helps to move the mandible posteriorly and superiorly.

Yawning

While yawning the mandible **may** move forward and downward up to the maximum mouth opening position. The magnitude of this movement is also variable. The condition of the elastic fibres of the temporomandibular ligaments determine the movement of the condyle during yawning.

Para-functional Movements

Para-functional movements include movements during clenching, bruxism and other habitual movements. These movements should be recorded and studied in order to fabricate an appropriate prosthesis that functions in harmony with these movements. Brewer reported that during these non-productive, habitual, unnecessary movements, a perfect balanced occlusion in the removable prosthesis is necessary. This is becasue the total duration of these para-functional movements is much greater (4 hours/day) than that of all functional movements (10-15 minutes/day).

Clinically, the Ney's mandibular excursion guide can be used to train the mandible to perform mandibular movements (Fig. 9.23b).

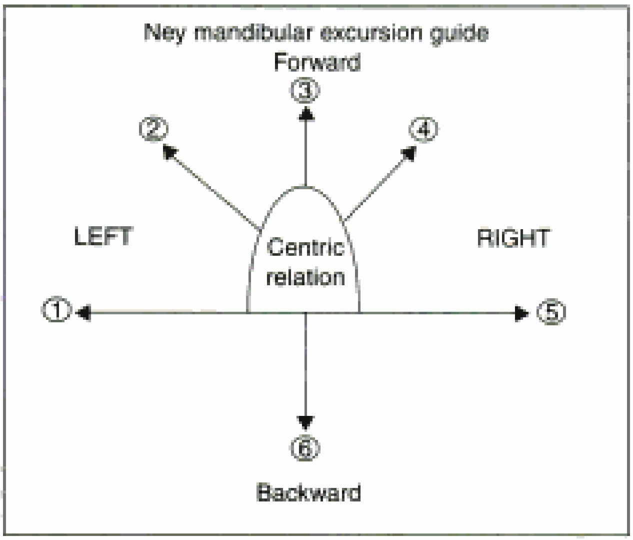


Fig. 9.23b: The Ney excursion guide can be used to train the patient to perform mandibular movements. Movements should be performed in the numerical order labelled in the diagram

CUSTOMIZING THE OCCLUSAL RIMS

In the previous chapter we read in detail about the fabrication of an occlusal rim. Hence, we know that all occlusal rims are prepared using standard dimensions. Most patients require modifications in the occlusal rim to suit the patient. These alterations should be done before recording the jaw relation. Even orientation jaw relation should not be recorded without completing this procedure. Please refer clinical guidelines in the fabrication of an occlusal rim discussed in the previous chapter.

The occlusal rims are inserted into the patient's mouth and the following factors are checked:

- Lip support and labial fullness
- Overjet
- Cheek support and buccal fullness
- Level of the occlusal plane
- Orientation of plane of occlusion

Lip Support and Labial Fullness

The occlusal rim should provide adequate lip support. Inadequate or excessive labial support will seriously affect the aesthetics of the denture (Figs 9.24a and b).

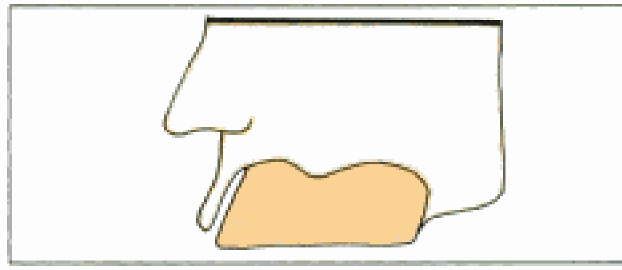


Fig. 9.24a: Good lip support

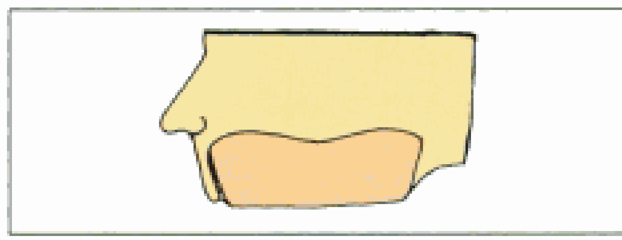


Fig. 9.24b: Poor lip support

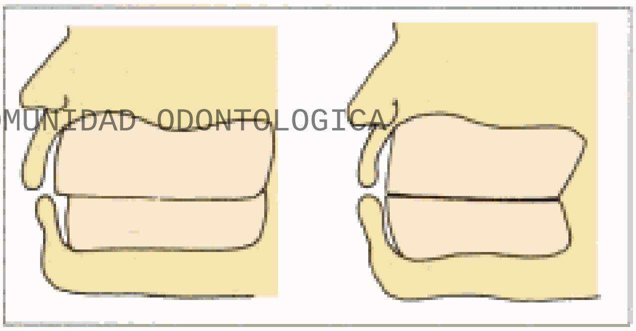
Removing or adding wax in the labial surface of the occlusal rim can correct excessive or inadequate lip support. The wax in the flange area is responsible for the labial fullness. The amount of wax in the incisal edge of the occlusal rim determines the lip support.

Overjet

The incisal edge of the maxillary occlusal rim should be around 2 mm in front of the incisal edge of the mandibular occlusal rim. The overjet can be brought to a flush in cases with class III malocclusion and can be increased in cases with class II malocclusion (Figs 9.25a to c).

Cheek Support and Buccal Fullness

The occlusal rims should be designed to be within the neutral zone. This is important because if the occlusal rims have excess wax buccally, the buccal musculature will produce displacement of the occlusal rim. Apart from that, the teeth arranged buccally produce frequent cheek biting (Fig. 9.26).



Figs 9.25a and b: (a) Normal horizontal overlap (b) Edge to edge relation in class III cases

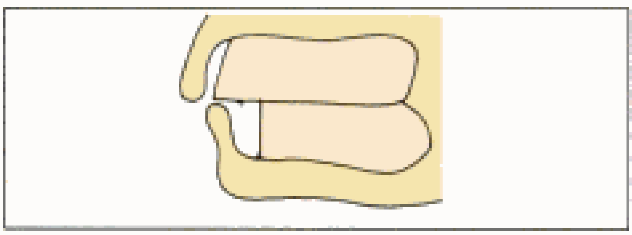


Fig. 9.25c: Excessive overjet in class II cases

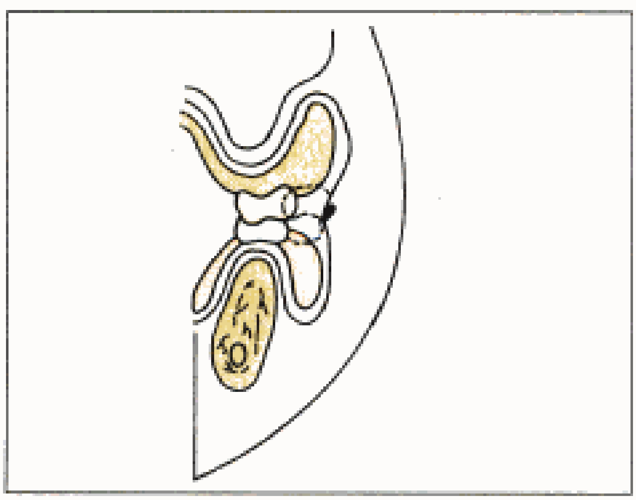


Fig. 9.26: Buccally arranged teeth may produce cheek biting

Though buccal fullness is not as important as labial fullness, it does contribute significantly to the appearance of the patient.

Level of the Occlusal Plane

The occlusal plane should be located at the mid-point of the interarch distance. The upper occlusal rim should be reduced upto or 2 mm below the level of the upper lip during speech. The lower occlusal rim should be at the level of the lower lip and the angle of the mouth. Posteriorly it should be two-third the height of the retromolar pad. The posterior part of the upper occlusal plane should be one-fourth an inch below the level of the opening of the Stensen's duct (Fig. 9.27).

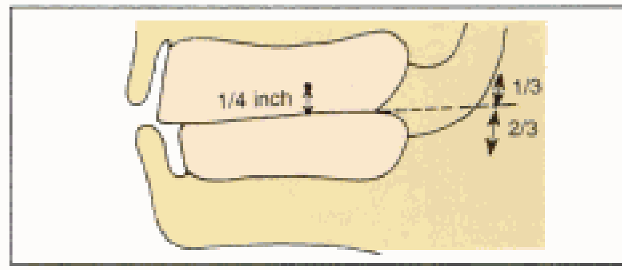


Fig. 9.27: Relationship of the occlusal plane to the opening of the Stensen's duct and the retromolar pad area

ORIENTATION OF THE PLANE OF THE OCCLUSAL RIM

The plane of the occlusal rim should be parallel to the plane of the maxilla. It should not be confused with the orientation of the occlusal rim (discussed in orientation jaw relation), which denotes the orientation of the maxilla to the base of the skull.

The plane of the maxilla is determined anteriorly by inter-pupillary line and posteriorly by the *Camper's line* or the ala tragus line. This line extends from the upper border of the tragus of the ear to the lower border of the alae of the nose (Fig. 9.28).

The maxillary occlusal plane can be verified using a *Fox plane*. The fox plane has an inner rim or inner rim and an outer rim. The inner rim should be placed in contact of the plane of the occlusal rim. The outer rim will show the facial level of the occlusal plane (Fig. 9.29). Anteriorly it should be parallel to the interpupillary line and posteriorly to the ala-tragus line.

Procedure

- The ala-tragus line is marked on the patient's face using a thread dipped in dental plaster or pumice (Fig. 9.30).

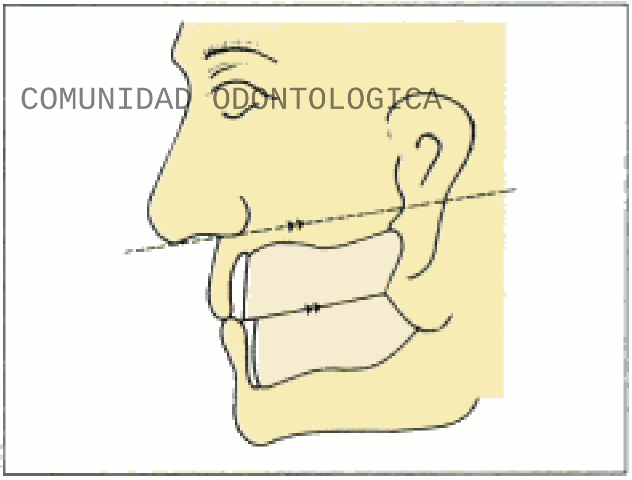


Fig. 9.28: Occlusal plane should be parallel to the ala – tragus line

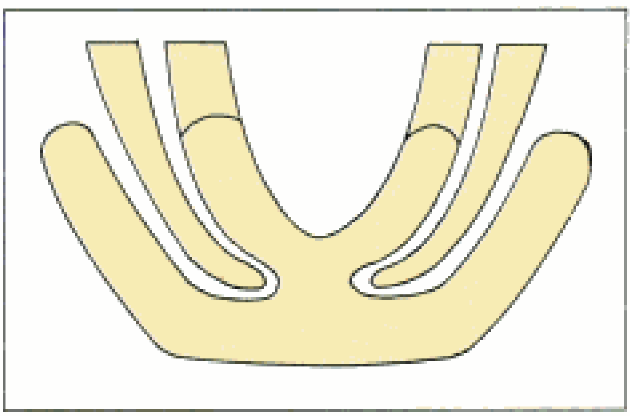


Fig. 9.29: A fox plane used to denote the plane of occlusion

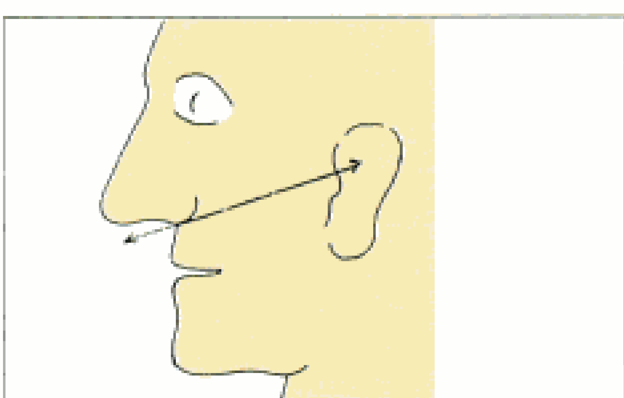


Fig. 9.30: The ala-tragus line should be marked on the patients face using a thread dipped in dental plaster

- The maxillary occlusal rim is inserted into the patient's mouth.
- The bite fork of the fox plane is inserted into the mouth and positioned at the level of the occlusal plane of the occlusal rim (Fig. 9.31).
- The level of the outer rim is compared with the ala-tragus line.
- The occlusal rim is removed and altered using a hot plate.
- The procedure is done till the outer rim of the fox plane is parallel the ala tragus line.

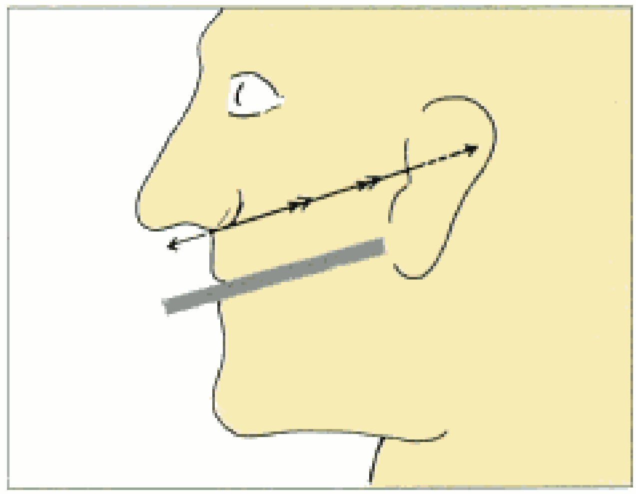


Fig. 9.31: The occlusal rim should be reduced till the outer arm of the fox plane is parallel to the ala tragus line

JAW RELATION

- Orientation jaw relation
- Vertical jaw relation
- Horizontal jaw relation

Jaw relation is defined as, "*Any relation of the mandible to the maxilla*"-GPT. We must realise that we are placing dentures between two bones and that the function of the denture totally depends upon the joint between the two bones.

Imagine we are tying a stick to the hand. If the stick is tied with the elbow relaxed there is not much discomfort but if the same stick is tied tightly, overextending the elbow there will be severe discomfort (Fig. 9.32).

Similarly if we fabricate a denture which is not in harmony with the movements of the temporomandibular joint, there will be severe discomfort. Jaw relation is recorded to measure the extensibility and the movements permissible by the patient's temporomandibular joint.

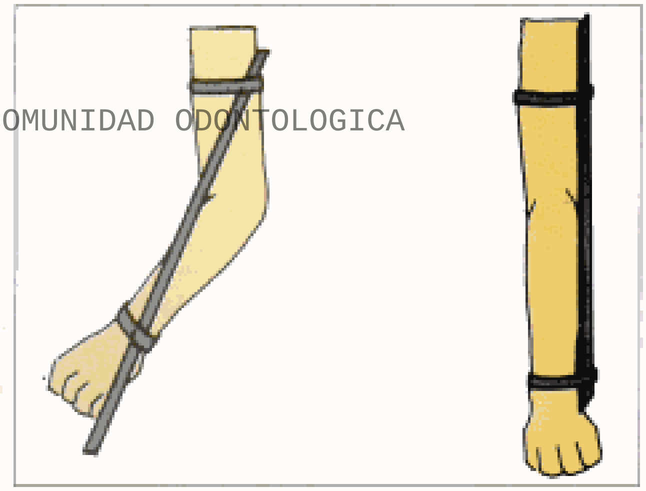


Fig. 9.32

There are three different types of jaw relations they are listed in order of the procedure:

- Orientation jaw relation.
- Vertical jaw relation.
- Horizontal jaw relation.

Various Terms Used in Jaw Relation

Orientation relation "The mandible which is kept at its most posterior portion, it can rotate in the sagittal plane around an imaginary transverse axis passing through or near the condyles".

Vertical relation "The amount of separation between the maxilla and mandible in the frontal plane"

Horizontal relation "Maxillomandibular relationship in which the condyles articulate with the thinnest avascular portion of their respective discs with the complex in the anterosuperior direction against the slopes of articular eminence."

Centric jaw relation "The most posterior relation of the mandible to the maxillae at the established vertical dimension" –GPT.

Eccentric jaw relation "Any jaw relation other than centric jaw relation" –GPT.

Median jaw relation "Any jaw relation when the mandible is in the median sagittal plane"-GPT.

Posterior border jaw relation: "The most posterior relation of the mandible to the maxillae at any specific vertical relation"- GPT.

Protrusive jaw relation "A jaw relation resulting from a protrusion of the mandible"- GPT.

Rest jaw relation "The habitual postural jaw relation when the patient is resting comfortably in an upright position and the condyles are in an neutral, unrestrained position in the glenoid fossa"- GPT.

Unstrained jaw relation "The relation of the mandible to the skull when a state of balanced tonus exists among all the muscles involved". "Any jaw relation that is attained without undue or unnatural force and which causes no undue distortion of the tissues of the temporomandibular joint" –GPT.

Jaw relation record "A registration of any positional relationship of the mandible in reference to the maxilla. These records may be any of the many vertical, horizontal, orientation relations." -GPT.

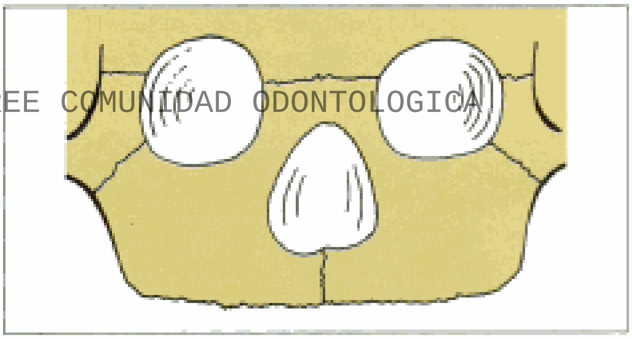
Terminal jaw relation record "A record of the relationship of the mandible to the maxilla made at the vertical dimension of occlusion and at the centric relation."-GPT.

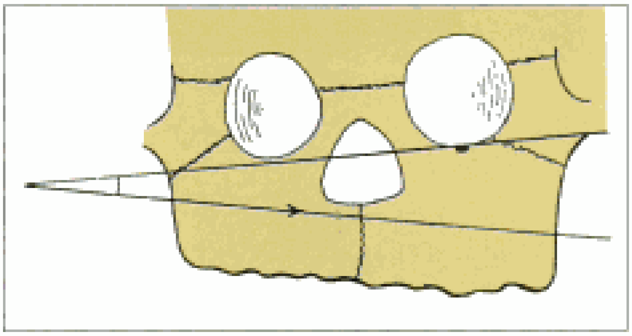
Jaw repositioning "The changing of any relative position of the mandible to the maxilla, usually by altering the occlusion of the natural or artificial teeth." –GPT.

Orientation Jaw Relation

It is defined as *"the jaw relation when the mandible is kept in its most posterior position, it can rotate in the sagittal plane around an imaginary transverse axis passing through or near the condyles"*—GPT.

This record gives the angulation of the maxilla in relation to the base of the skull. The plane of the maxilla may be tilted in some patients, in such cases, the plane of the mandible will not be altered because it articulates with the base of the skull. Hence, a maxillary tilt will alter the relationship of the maxilla to mandible during different movements. It will also affect the level of the plane of occlusion of the denture. It is necessary to do orientation jaw relation before carrying out





Figs 9.33a and b: Schematic diagram showing the orientation of the maxilla in relation to the base of the skull

other jaw relations. Orientation jaw relation can be recorded with a face-bow. (Figs 9.33a and b).

Face-bow (Snow 1802) It is defined as, "A caliper-like device which is used to record the relationship of the maxillae and/or the mandible to the temporomandibular joints". "A caliper like device which is used to record the relationship of the jaws to the temporomandibular joints and to orient the casts on the articulator to the relationship of the opening axis of the temporo-mandibular joint"- GPT.

The structure and functioning of the face-bow should be thoroughly learned to perform accurate orientation jaw relation. The face-bow basically contains three sections. One section represents the plane of the cranium (U-frame), the second section represents the plane of the maxilla (bite fork) and the third section locks the first two sections without altering their plane (locking device) (Fig. 9.34).

Parts of a Face-bow

The component parts of a face-bow are:

- U-shaped frame

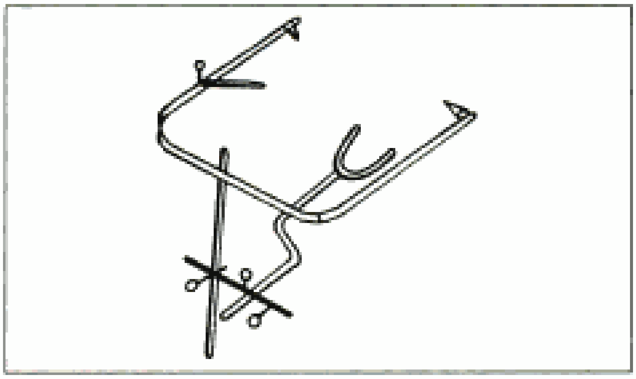


Fig. 9.34: Diagramatic representation of a face-bow

- Condylar rods
- Bite fork
- Locking device
- Orbital pointer with clamp

Here, we have described these component parts with reference to the widely used Hanau spring bow.

U-shaped Frame

It is a U-shaped metallic bar that forms the main frame of the face-bow. All other components are attached to the frame with the help of clamps. This assembly is large enough to extend from the region of the TMJ to at least 2 to 3 inches anterior to the face and wide enough to avoid contact with the sides of the face. This records the plane of the cranium (Fig. 9.35).

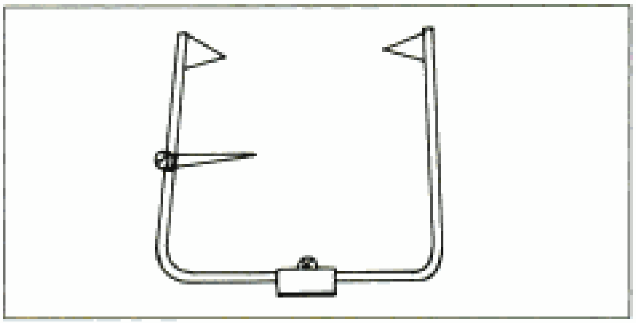


Fig. 9.35: ' U ' shape frame of a face-bow

Condylar Rods

These are two small metallic rods on either side of the free end of the U-shaped frame that contacts the skin over the TMJ. They help to locate the hinge axis or the opening axis of the temporomandibular joint. They transfer the hinge axis of the TMJ by attaching to the condylar shaft in the articulator. Certain face-bows do not have a condylar rod. Instead they have an earpiece which fits into the external auditory meatus. Face-bows that have a condylar rod, to record the true hinge axis (centre of the condyle), are called *Kinematic face-bows*. Earpiece face-bows do not record the true hinge axis and hence they are called *Arbitrary face-bows* (Figs 9.36a and b).

Note: Arbitrary face-bows may also have condylar rods (facia type).

But facia type face bows do not record the true hinge axis and are grouped under arbitrary face-bows.

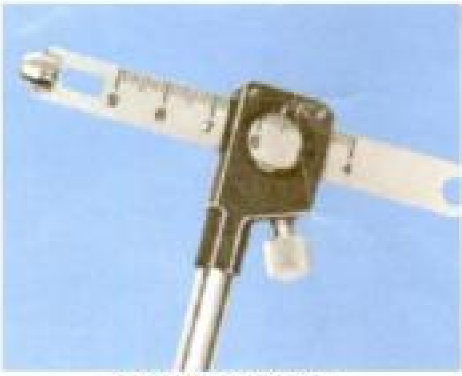


Fig. 9.36a: Earpiece

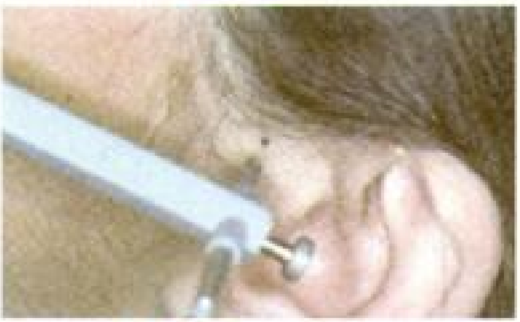


Fig. 9.36b: Condylar rod

Bite Fork

This is a U-shaped plate, which is attached to the occlusal rims while recording the orientation relation. It is attached to the frame with the help of a rod called the *stem*. The bite fork should be inserted about 3 mm below the occlusal surface within the occlusal rim. Some suggest that the bite fork can be inserted in any depth. Sometimes the bite fork is attached to the occlusal surface of the occlusal rim using impression compound in order to preserve the occlusal rim (Fig. 9.37).

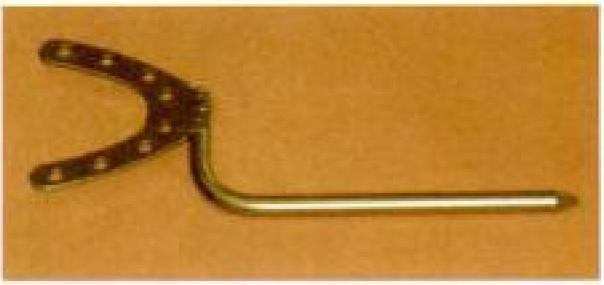


Fig. 9.37: Bite fork

Locking Device

This part of the face-bow helps to attach the bite fork to the U-shaped frame. This also supports the face-bow, occlusal rims and the casts during articulation. It consists of a *transfer rod* and a *transverse rod*. The 'U'-shaped frame is attached to the vertical transfer rod. The position of this transfer rod can be locked with a thumb screw.

The horizontal transverse rod connects the transfer rod with the stem of the bite fork. After positioning the 'U'-shaped frame and the bite fork, the horizontal transverse rod should be positioned. It can be positioned automatically by attaching it to the transfer rod and the bite fork and tapping it. This type of assembly where the transverse rod gets automatically positioned when tapped is called an *auto-adjusting or self-centering assembly* (Fig. 9.38).

Orbital Pointer

It is designed to mark the anterior reference point (infraorbital notch) and can be locked in position with a clamp. It is present only in the arbitrary face-bow (Fig. 9.39).

Types of Face-bows

Face-bows can be classified as follows:

Arbitrary face-bow
- Facia type.
- Earpiece type
- Hanau face-bow (Spring bow)
- Slidematic (Denar)

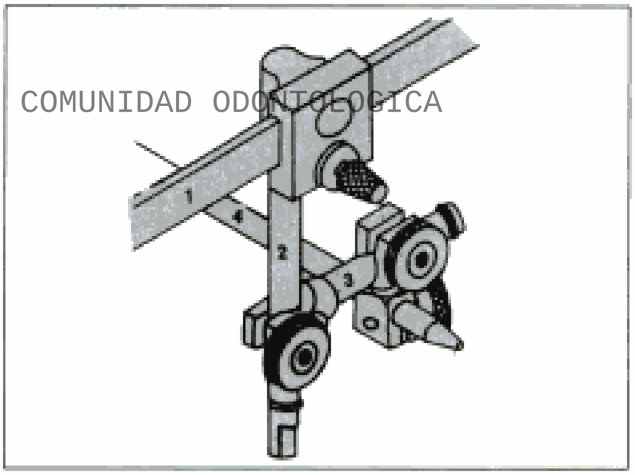


Fig. 9.38: Locking device (1) U-shaped frame, (2) transfer rod, (3) Transverse rod, (4) Stem of the bitefork

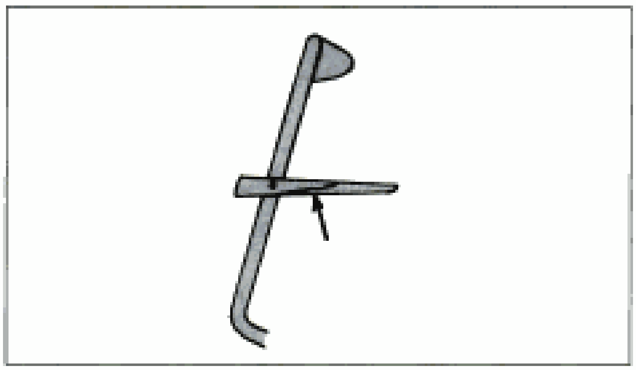


Fig. 9.39: Orbital pointer

- Twirl bow
- Whipmix

Kinematic or hinge bow.

Arbitrary Face-bow

It is the most commonly used face-bow in complete denture construction. The hinge axis is approximately located. The condylar rods are positioned approximately 13 mm anterior to the auditory meatus on a line running from the outer canthus of the eye to the top of the tragus also called the *cantho-tragal line* (Fig. 9.40a). This is done using a *Richey condylar marker*. This is not done for earpiece type face-bows where the earpiece is inserted into the external auditory meatus.

This method generally locates the rods within 5 mm of the true hinge axis of the jaws. As this is an arbitrary hinge axis, errors in jaw relation may

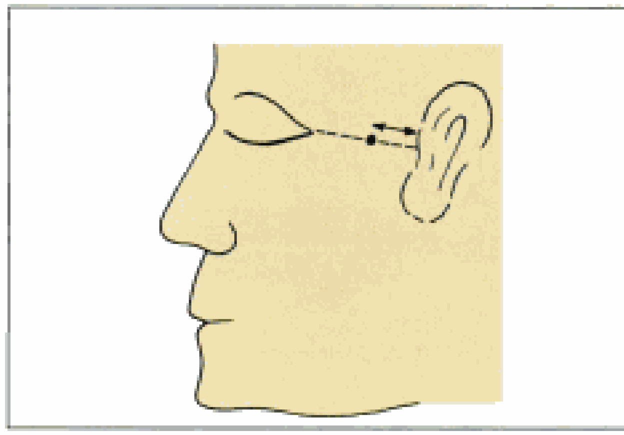


Fig. 9.40a: Locating the hinge axis for a arbitrary face-bow

produce occlusal discrepancies which should be corrected by minor occlusal adjustments during insertion.

Facia type Here, the hinge axis or the posterior reference point is 13 mm anterior to the external auditory meatus and the anterior reference point is the orbitale (midpoint of the lower border of the orbit). The face-bow has a pointer that can be positioned to the posterior reference point.

Earpiece Type The posterior reference point is the external auditory meatus and the anterior reference point is the orbitale. The earpieces engage into the posterior reference points (the external auditory meatus).

Hanau face-bow It is the most commonly used face-bow. A detailed description of recording the arbitrary hinge axis using a Hanau face-bow has been discussed next under face-bow transfer. Arbitrary earpiece type, arbitrary facia type and kinematic face-bows are also available from Hanau.

Slidematic type (Denar) (Fig. 9.40b) This face-bow has an electronic device, which gives the reading that can be seen in the anterior region. This reading denotes one-half of the patient's inter-condylar distance. These face-bows require specific articulators, which accept the reading.

The posterior reference point for this instrument is the external auditory meatus and the anterior reference point is 43 mm superior to the incisal edge of the upper central incisor for dentu-

Fig. 9.40b: Slidematic face-bow

lous patients. In an edentulous patient the anterior reference point is 43 mm superior to the lower border of the upper lip in a relaxed state. This anterior reference point is also used for Whipmix articulators. The anterior reference point can be marked using a Denar reference plane locator. The plane locator is an instrument which resembles a face-bow.

Twirl Bow

It is an arbitrary type of face-bow that does not require any physical attachment to the articulator. It is not commonly used for CD construction. It relates the maxillary arch to the Frankbort's horizontal plane. A mounting guide is used to mount the transfer rod to the articulator. It is easy to manipulate because the face-bow is not needed to mount the maxillary cast in the articulator.

Whipmix Face-bow

These face-bows have a built-in hinge axis locator. It automatically locates the hinge axis when the earpieces are placed in the external auditory meatus. It has a nasion relator assembly with a plastic nosepiece. The nasion relator determines the anterior reference point.

Kinematic Face-bow

This face-bow is generally used for the fabrication of fixed partial denture and full-mouth rehabilitation. It is generally not used for complete denture fabrication because it requires a long and complex procedure to record the orientation jaw relation (Fig. 9.41a).

Fig. 9.41a: Kinematic face-bow

The face-bow helps to orient the cast in the patient's terminal hinge axis. *Hinge axis is the imaginary line around which the condyles can rotate without translation.* A terminal hinge position is the most retruded hinge position and it is learnable, repeatable and recordable. It coincides with the centric relation. A 12-15° pure rotational movement of the joint is possible in this position. The maximal incisal separation in this position is around 20 to 25 mm opening between the incisal edges (Fig. 9.41b).

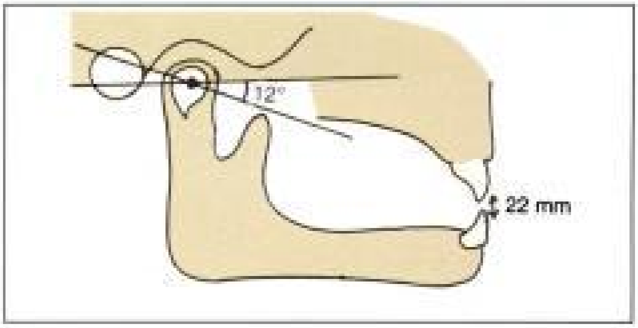


Fig. 9.41b: True condylar rotation. 12° rotation with the maximum incisal separation of 22 mm

The true hinge axis should be located and marked before using the face-bow. The location of the hinge axis is then transferred to the articulator with the face-bow. This face-bow requires a fully adjustable articulator to accept the true hinge axis (THA). Since the patient's hinge axis is transferred to the articulator, the movement of the articulator will simulate the movements of the joint made at the terminal hinge position.

Recording the Orientation Jaw Relation Using an Arbitrary Face-bow (Using a Hanau Face-bow)

- The patient is seated in a comfortable position with his head upright and supported by the headrest.
- A point is marked 13 mm in front of auditory meatus on a line running from the outer canthus to the superior border of the tragus (Fig. 9.42).

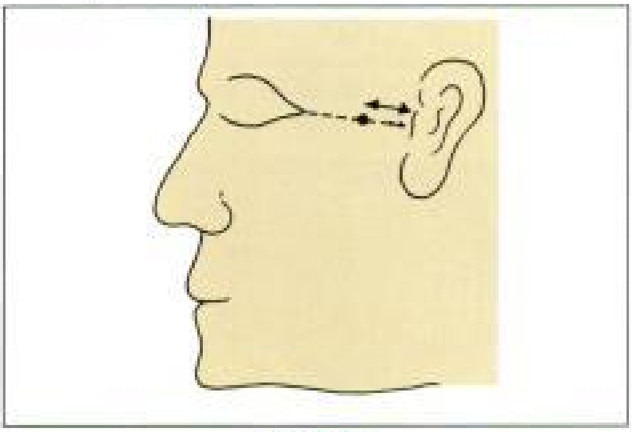


Fig. 9.42

- Guidelines for anterior teeth placement are marked on the maxillary occlusal rim.
- A notch index about 2 mm deep is made in the first molar region. This helps to position the face-bow (Fig. 9.43).

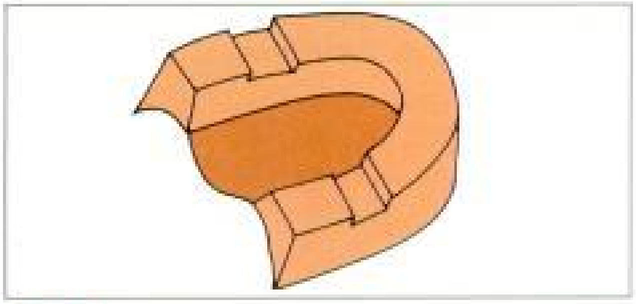


Fig. 9.43: Preparing the occlusal rim to receive a bite fork

- The mandibular occlusal rim is placed in the patient's mouth and reduced such that sufficient space is available between the two rims to accommodate the bite fork (Fig. 9.44).
- The U-shaped frame of the face-bow along with the condylar rods is positioned on the

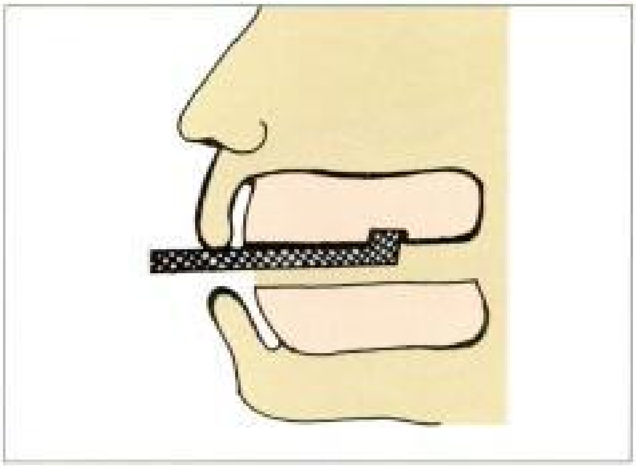


Fig. 9.44: The maxillary occlusal rim attached to the bite fork is inserted into the patients mouth and the mandibular occlusal rim is reduced for clearance

patient. The condylar rods are moved and placed on the posterior reference points marked 13 mm in front of the auditory meatus on the canthotragus line. After positioning the posterior reference points the condylar rods are locked to the U-shaped frame (Fig. 9.45).

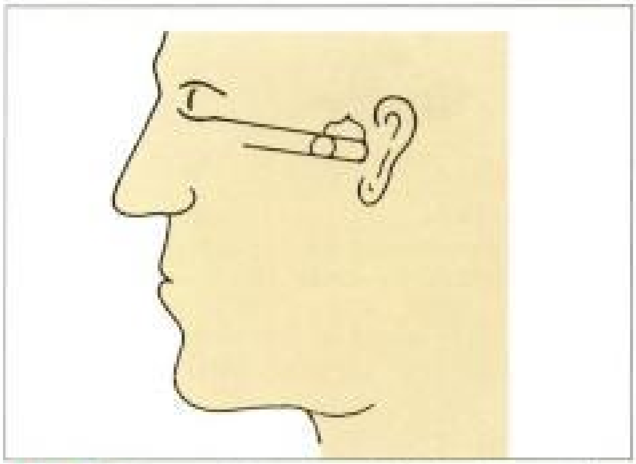


Fig. 9.45: The condylar rods are locked to the posterior reference points

- Aluwax is softened and shaped to the form of a horseshoe. The bite fork is embedded into this soft wax. The thickness of the bite fork and the wax together should not be more than 6 mm (Fig. 9.46).
- A thin layer of petroleum jelly is applied on both the occlusal rims to facilitate easy separation.

Fig. 9.46: The bite fork may be attached to the occlusal rim using alu wax

- The maxillary and mandibular occlusal rims are inserted into the patient's mouth.
- The bite fork with the wax is inserted into the patient's mouth. The midline of the bite fork should coincide with the midline of the maxillary occlusal rim. The stem of the bite fork should be parallel to the sagittal plane (Fig. 9.47).

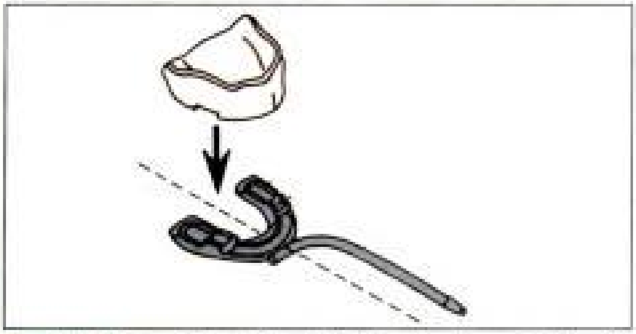


Fig. 9.47: The midline of the bite fork should co-incide with the midline of the occlusal rim. The stem of the bite fork should be parallel to the sagittal plane

- The patient is asked to close his mouth till both the occlusal rims get embedded into the bite fork.
- The stem of the bite fork is locked to the transverse rod of the face-bow (Fig. 9.48).
- Any alterations in the position of the condylar rods should be checked.
- The infraorbital notch is palpated and marked. The orbital pointer is made to touch the infraorbital notch and locked in position to the 'U' frame with an orbital clamp (Fig. 9.49).
- The entire face-bow assembly along with the occlusal rim is removed from the mouth and positioned (transferred) in the articulator. (discussed in detail under articulators).

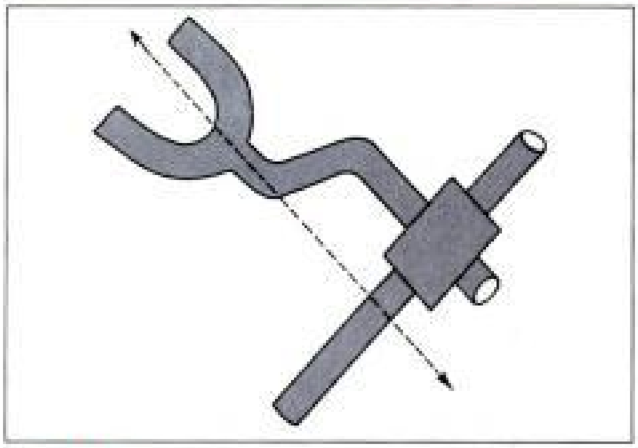


Fig. 9.48: The locking the stem of the bite fork to the transverse rod

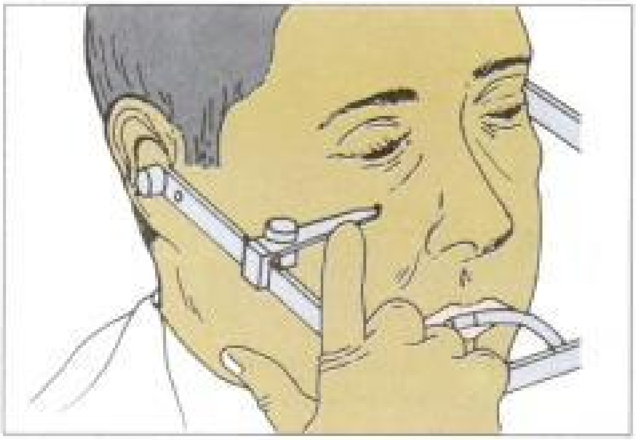


Fig. 9.49: Positioning and locking the orbital pointer

Recording the Orientation Jaw Relation Using A Kinematic Face-bow

The kinematic face-bow is attached to the mandibular occlusal rim and the hinge axis is located based upon the opening movements of the mandible. It is also described in Chapter 27.

Fabrication of the Clutch

The first step involves the fabrication of a clutch. The clutch is a device, which relates the face-bow to the mandibular residual alveolar ridge. It is nothing but an occlusal rim made of impression compound with a bite fork attached to it (Fig. 9.50). For dentulous patients, the clutch resembles a cap splint with a bite fork attached to it. It is usually fabricated and cast in aluminium.

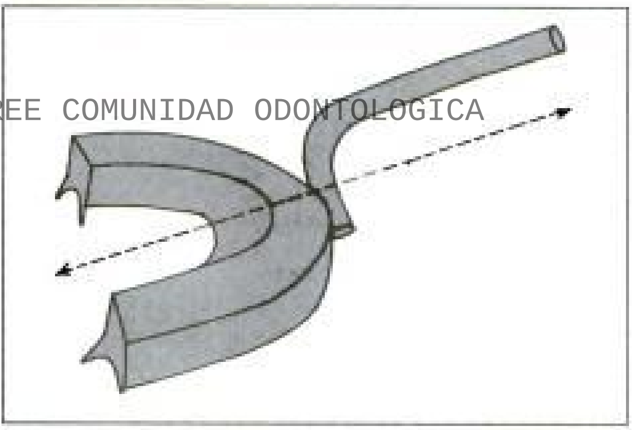


Fig. 9.50: Mandibular clutch

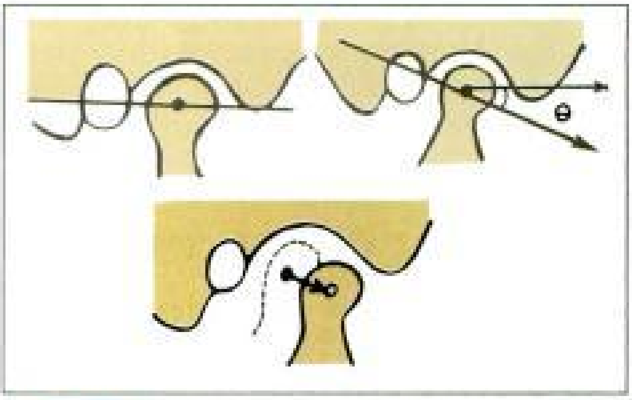


Fig. 9.51: Rotatory and translating movements of the condyle

- A record base is fabricated over the mandibular cast.
- An occlusal rim made of impression compound is built upon the record base.
- The bite fork is attached to this occlusal rim.
- Extending outside from the bite fork is its horizontal stem, which lies parallel to the sagittal (midline) plane.

Clinical Procedure

- The clutch along with the stem is placed in the patient's mouth.
- The hinge bow (kinematic face-bow) is attached to the stem of the bite fork and the condylar rods are located at a point 13 mm in front of the auditory meatus on the cantho-tragus line.
- The patient should be placed in a semi-supine position and his mandible should be guided to produce opening and closing movements, which are purely rotational. The patient should also be asked to make eccentric movements.
- The condylar rods will move (either rotate or translate depending on the movement of the condyle) during the mandibular movements. The point at which the condylar rods show pure rotation indicates the terminal hinge axis (THA). If the patient opens his mouth widely (more than 12°-15° then the condylar rods will move anteriorly (translation) (Fig. 9.51).
- The condylar rods are locked in this position and the face-bow is removed.
- A tatoo representing the THA should be marked on the patient's face for further reference.

VERTICAL JAW RELATION

It is defined as, *"The length of the face as determined by the amount of separation of the jaws"* - GPT. It can also be defined as the amount of separation between the maxilla and mandible in a frontal plane.

This record provides the optimal separation between the maxilla and the mandible. If this record is not measured accurately, the joint will be strained (overextended or underextended). The vertical separation between the mandible and the maxilla depends on the temporomandibular joint and the tone of the muscles of mastication. If the vertical dimension is altered there will be severe discomfort in both the temporomandibular joint and the muscles of mastication.

This relation is easiest to record but is very critical. Errors in vertical dimension are the first to produce discomfort and strain.

Factors Affecting Vertical Jaw Relation

Teeth

These act as occlusal vertical stops and establish the relationship of the mandible to the maxilla in a vertical direction in dentulous patients.

Musculature

The opening and closing muscles tend to be in a state of minimal tonic contraction. This determines the vertical jaw relation.

Muscles that produce elevation of the mandible (closing muscles) and gravity also help to control the tonic balance that maintains the physiologic rest position.

Importance of Vertical Jaw Relation

As mentioned previously the vertical jaw relation is the most critical record because errors in this record produce the first signs of discomfort.

In the following table the effects of altered vertical dimension is enlisted.

Increased vertical dimension	*Decreased vertical dimension*
• Increased trauma to the denture-bearing area.	• Comparatively lesser trauma to the denture-bearing area.
• Increased lower-facial height.	• Decreased lower-facial height.
• Cheek biting.	• Angular chelitis due to folding of the corner of the mouth.
• Difficulty in swallowing and speech.	• Difficulty in swallowing.
• Pain and clicking in the temporomandibular joint.	• Pain, clicking, discomfort of the temporomandibular joint accompanied with headache and neuralgia.
• Stretching of facial muscles	• Loss of lipfullness.
	• Obstruction of the opening of the eustachian tube due to the elevation of the soft palate due to elevation of the tongue/mandible.
	• Loss of muscle tone.
	• Corners of the mouth are turned down.
	• Thinning of the vermilion borders of the lip.
• Increased volume or cubical space of the oral cavity.	• Decreased volume or cubical space of the oral cavity

Vertical Jaw Relation can be Recorded in Two Positions

- Vertical dimension at rest position
- Vertical dimension at occlusion

Both these relations should be recorded. In a normal dentulous patient, the teeth do not maintain contact at rest. The space between the teeth at rest is called the *'free-way space'* (Fig. 9.52).

The free-way space exists only at rest. During occlusion, the teeth come in contact with one another and the space is lost. The same relationship should be produced in the complete denture.

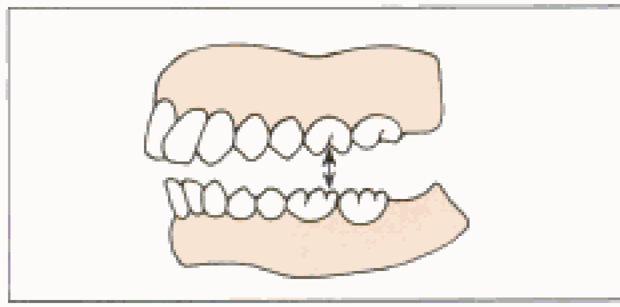


Fig. 9.52: Free-way space

Once the vertical dimension at occlusion is recorded, it should be verified with the vertical dimension at rest (the vertical dimension at occlusion should always be 2-4 mm lesser than the vertical dimension at rest). The denture is fabricated in vertical dimension at occlusion so that the free-way space is formed at rest (Fig. 9.53).

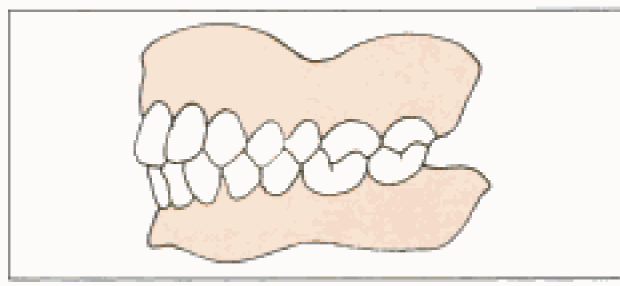


Fig. 9.53: Complete dentures at occlusion

Vertical Dimension at Rest

It is defined as, *"The length of the face when the mandible is in rest position"* -GPT.

This is the position of the mandible in relation to the maxilla when the maxillofacial musculature are in a state of tonic equilibrium. This position is influenced by the muscles of mastication, muscles involved in speech, deglutition and breathing.

It is essential to record the vertical dimension at rest as it acts as a reference point during recording the vertical dimension at occlusion.

VD at rest = VD at occlusion + free-way space.

(VD—Vertical dimension)

The vertical dimension at rest should be recorded at the physiological rest position of the mandible. In patients with prolonged edentulousness, the mandible shifts to a habitual rest position. The complete denture should **not** be fabricated using the habitual rest position. Hence the physiological rest position should be determined in these patients before recording vertical jaw relation.

When functional movements (swallowing, wetting the lips) are performed, the mandible comes to the physiological rest position before going to the habitual rest position.

The physiological rest position is influenced by a number of factors and the following considerations are to be remembered while recording it:

- The position of the mandible is influenced by gravity and the posture of the head. Hence while recording vertical jaw relation the patient should be asked to sit upright, with his/her head upright and eyes looking straight in front. The Reid's base line should be parallel to the floor (Fig. 9.54).
- Since we are recording a physiological rest position, all the muscles affecting this record should be relaxed. Signs like tension, strain, and nervousness can alter the position of the mandible.

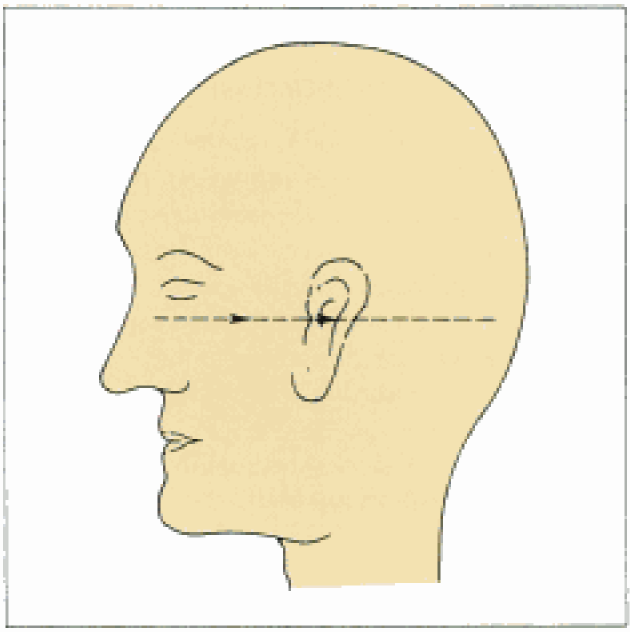


Fig. 9.54: The patient's head should be positioned such that the Reid's base line is parallel to the floor while recording vertical jaw relation

- Presence of any neuromuscular disease in the patient can influence the rest position.
- The patient cannot maintain the physiological rest position for an indefinite period of time. Hence, it should be recorded quickly.
- Incorrect measurement of the rest position can lead to faulty recording of the vertical dimension at occlusion and can lead to injury to the supporting structures and the temporomandibular joint.

The following methods can be used to measure the vertical dimension at rest.

- Facial measurements after swallowing and relaxing
- Tactile sense
- Measurement of anatomic landmarks
- Speech
- Facial expression

Facial Measurements after Swallowing and Relaxing

- The patient is asked to sit upright and relax.
- Two reference points are marked with the help of a triangular piece of adhesive tape on the tip of the nose and the tip of the chin (Fig. 9.55).
- The patient is asked to perform functional movements like wetting his lips and swallowing.

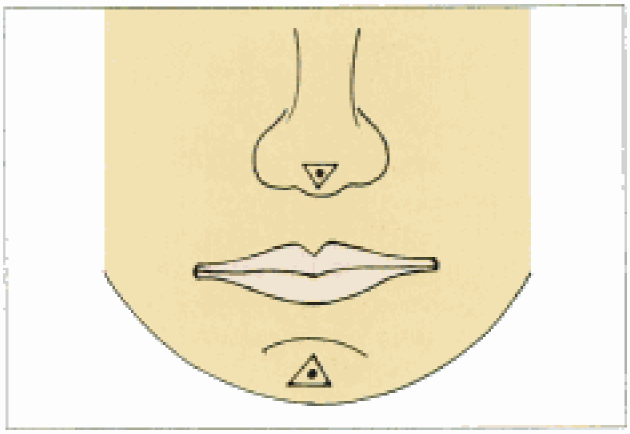


Fig. 9.55: Reference points for vertical jaw relation

- The patient is instructed to relax his shoulders. This is done to relax the supra- and infrahyoid muscles.
- Once the patient performs the above-mentioned movements, his mandible will come to

its physiological rest position before going to its habitual rest position. The distance between the two reference points is measured when the mandible is in its physiological rest position.

Tactile Sensation

- The patient is asked to stand erect and open his mouth wide till he feels discomfort in his muscles of mastication.
- Next, the patient is asked to close his mouth slowly. The patient is instructed to stop closing when he/she feels that his/her muscles are totally relaxed and comfortable.
- The distance between the two reference points is recorded and compared to the measurement recorded by the swallowing method.
- This method relies on patient's perception of relaxation, and will vary for each individual. Hence, at least one additional method should be carried out to confirm these readings.

Anatomic Landmarks

The distance (A) between the pupil of the eye and the rima oris (corners of the mouth) and the (B) distance between the anterior nasal spine and the lower border of the mandible should be measured using a Willis guide. If both these distances are equal, the jaws are considered at rest. Its accuracy is questionable in patients with facial asymmetry (Fig. 9.56).

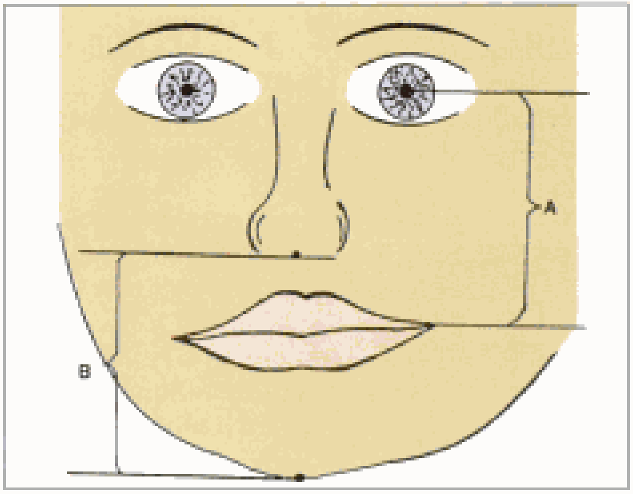


Fig. 9.56: A = B at rest

Speech

There are two methods by which the rest position can be recorded with the help of speech.

In the first method the patient is asked to repeatedly pronounce the letter 'm', a certain number of times and the distance between the two reference points is measured immediately after the patient stops.

In the second method the dentist keeps talking to the patient and he measures the distance between the reference points immediately after the patient stops talking.

Facial Expression

The following facial features indicate that the jaw is in its physiological rest position:

- Skin around the eyes and chin should be relaxed. It should not be stretched, shiny or excessively wrinkled.
- The nostrils are relaxed and breathing should be unobstructed.
- The upper and lower lips should have a slight contact in a single plane. If the mandible is protruded, the lower lip will be in front and without contact. If the mandible is retruded, the upper lip will be in front.

Vertical Dimension at Occlusion

It is defined as, "*The length of the face when the teeth (occlusal rims, central-bearing points, or any other stop) are in contact and the mandible is in centric relation or the teeth are in centric relation*" – GPT.

The vertical dimension at occlusion is a constant position and can be maintained for indefinite time. Unlike vertical dimension at rest, the mandible need not be in centric relation while recording this relation.

Vertical dimension at occlusion can be recorded using the following methods:

Mechanical methods

- Ridge relation
  — Distance from the incisive papilla to mandibular incisors.
  — Parallelism of ridges.

- Pre-extraction records
  - Profile photographs
  - Profile silhouettes
  - Radiography
  - Articulated casts
  - Facial measurements
- Measurement from former dentures

Physiological Methods

- Power point
- Using wax occlusal rims
- Physiological rest position
- Phonetics
- Aesthetics
- Swallowing threshold
- Tactile sense or neuromuscular perception
- Patient's perception of comfort.

Mechanical Methods

These methods are called so because they do not require any functional movement. They are measured using simple mechanical devices.

Ridge relation It is defined as, "*The positional relationship of the mandibular ridge to the maxillary ridge*" – GPT. It can be measured by two methods namely:

- Distance from the incisive papilla to mandibular incisors.
- Parallelism of ridges.

Distance from the incisive papilla to mandibular incisors Incisive papilla is a stable landmark that does not change a lot with the resorption of the alveolar ridge.

The distance of the papilla to the maxillary incisor edge is 6 mm. Usually the vertical overlap between the upper and lower incisors is 2 mm (overbite). Hence the distance between the incisive papilla and the lower incisors will be approximately 4 mm. Based on this value, the vertical dimension at occlusion can be calculated (Fig. 9.57).

Ridge parallelism The mandible is parallel to the maxilla only at occlusion. This factor can be used to determine the vertical dimension at occlusion.

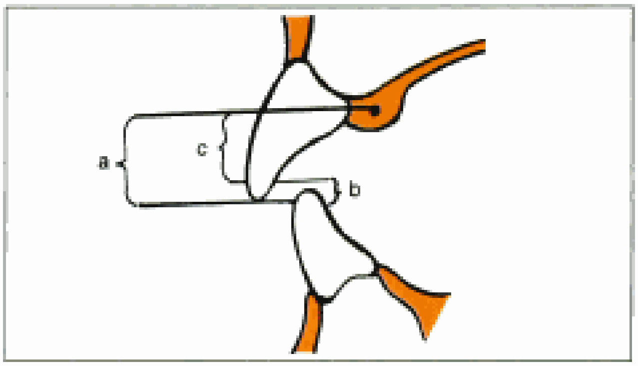


Fig. 9.57: Distance between the incisive papilla of the maxilla and the incisal edge of the lower incisor can be used as a reference to determine vertical jaw relation
Key: a = usually 6 mm, b = usually 2 mm, Hence c = 4 mm

The mandible of the patient is adjusted to be parallel to the maxilla. This position associated with a 5° opening of the jaw in the temporomandibular joint gives a correct amount of jaw separation.

In patients where the upper and lower teeth are extracted together, the upper and lower ridges will be parallel because the length of the clinical crowns of the opposing anterior and posterior teeth will be equal.

This method cannot be taken as a standard in patients who had periodontal disease and in patients who lost their teeth at different periods of time.

Pre-extraction Records

Various pre-extraction records like profile photographs, profile silhouettes, radiographs, articulated casts and facial measurements can be used to record the vertical dimension at occlusion. These records give an idea about the vertical dimension at occlusion of the patient when the teeth were present.

Profile photographs These photographs are made before extraction. They should be taken in maximum occlusion as the patient can easily maintain this position during photographic procedures.

The photographs should be enlarged to the actual size of the patient and the distance between the anatomical landmarks should be measured and compared with that of the patient to avoid errors. The measurements are recorded so that they can be used later.

While measuring the jaw relation, the measurements from the profile photographs are used to determine the vertical dimension at occlusion.

Profile silhouettes The word silhouette means outline. An accurate silhouette is made with cardboard or contoured with wire using the patient's photograph. This silhouette can be used as a template. Since the silhouette is taken from a pre-extraction photograph it shows the vertical dimension at rest. It is positioned on the patient's face while recording the vertical dimension at occlusion. The chin should be at least 2 mm above the level of the lower border of the silhouette (Fig. 9.58).

Radiography Cephalometric profile radiographs and radiographs of the condylar fossa are used to determine the vertical jaw relation. But their use is limited due to the inaccuracy in the technique.

Articulated casts When the patient is dentulous, the maxillary cast is mounted in the articulator using a face-bow transfer. An inter-occlusal record is made in the patient's mouth. This inter-occlusal record is used to articulate the mandibular cast with the maxillary cast. This is used as the pre-extraction record.

After extraction the edentulous casts are articulated in a separate articulator. The inter-arch distance between the edentulous casts is compared with that of the articulated dentulous casts.

Facial measurements Two tattoo points are marked on the upper and lower halves of the face before extraction. The vertical dimension is measured at occlusion and recorded. This measurement is used after extraction.

The distance between the tattoo marks can be measured by recording the distance from the chin to the base of the nose using dividers (or) calipers before teeth are extracted.

Measurement from former dentures Patient's existing denture is a valuable pre-extraction record. A Boley's gauge is used to measure the distance between the border of the maxillary and the mandibular denture when both these den-

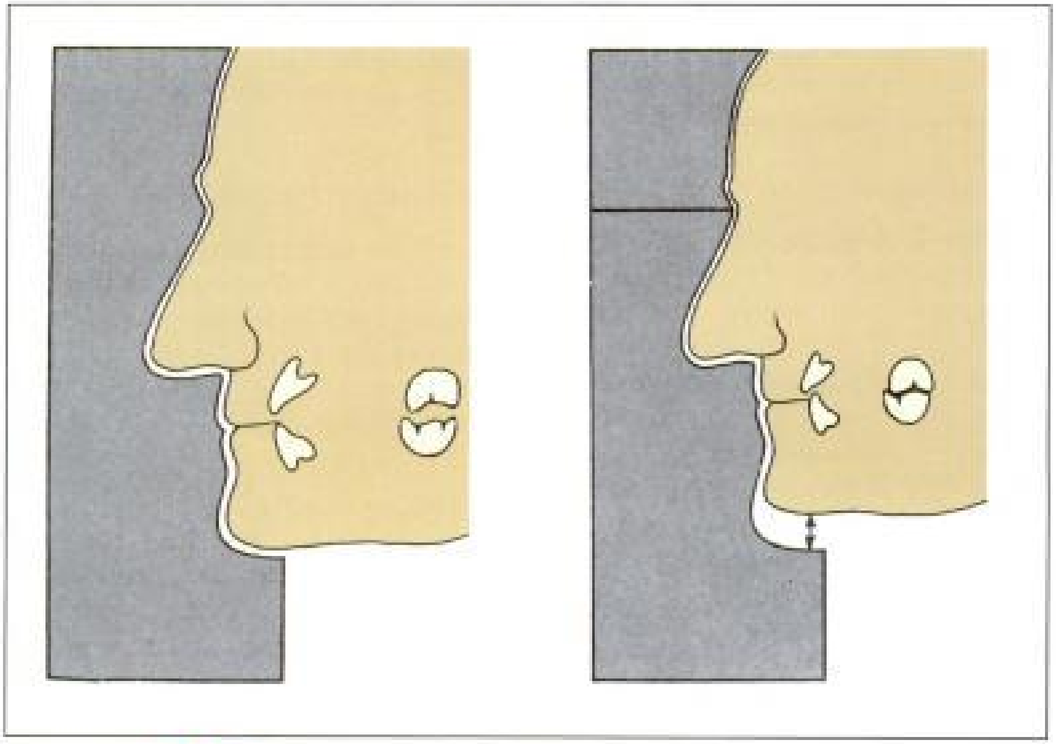


Fig. 9.58: Using profile silhouette to determine vertical jaw relation

tures are in occlusion. This measurement is used to determine the vertical dimension at occlusion.

Physiological Methods

Power Point: (by Boos)

A metal plate (central bearing plate) is attached to the maxillary record base. A bimeter is attached to the mandibular record base. This bimeter has a dial, which shows the amount of pressure acting on it.

The record bases are inserted into the patient's mouth and the patient is asked to bite on the record bases at different degrees of jaw separation. The biting forces are transferred from the central bearing point to the bimeter. The pressure reading in the bimeter is noted. The highest value is called the *Power point*. The bimeter is observed when the power point is reached (Fig. 9.59).

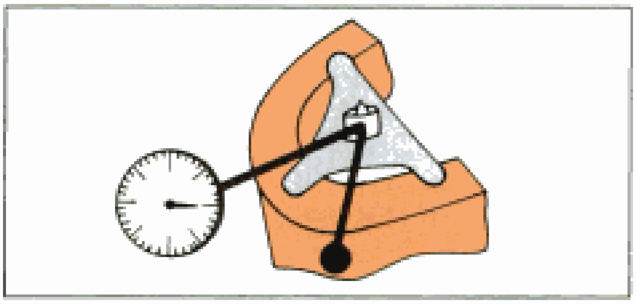


Fig. 9.59: Boos power point method

Using Wax Occlusal Rims

A tentative vertical dimension is measured with occlusal rims and the casts are articulated in a tentative centric relation. A tracing device can be attached to the occlusal rims for a graphic tracing. The facial expression and aesthetics are used for the final value.

Procedure

- The vertical dimension at rest is established and the difference between the reference points (between the nose and chin) is recorded.
- An approximate vertical dimension at occlusion, about 2 to 5 mm less than that of the vertical dimension at rest is considered. The facial expression can also be used as a guide for determining this value.
- The occlusal surface of the maxillary occlusal rim is coated with petrolatum and seated in the mouth. Denture adhesive powder may be used in cases with inadequate retention.
- A thin roll of modeling wax with a triangular cross-section is softened in a water bath at 130° F and placed over the mandibular occlusal rim with its apex towards the maxillary rim (Fig. 9.60).

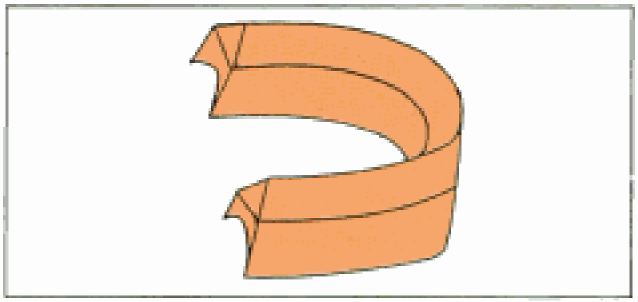


Fig. 9.60: Adding a triangular cross-section of modelling wax to the mandibular occlusal rim

- The added wax is softened again with a Blow-torch and the mandibular rim is seated into the mouth.
- The patient is asked to close his mouth slowly and stop at a comfortable position based on his tactile sensation. This gives the vertical dimension at occlusion.
- The wax is allowed to cool within the patient's mouth.
- It is removed and articulated in a tentative centric relation.

(Note: Do not confuse this method with the "Nick and Notch" method used in centric relation.)

Physiological rest position:
(Niswonger and Thomson in 1934)

This is also called as *Niswonger's method*. It is not considered as an accurate method because it requires patient's cooperation, which is variable, and alterations in jaw position can occur during this procedure.

Procedure

- Patient is asked to sit upright with his head unsupported and the eyes looking straight.

- Upper and lower occlusal rims which were modified according to the clinical guidances (refer occlusal rim fabrication) are inserted and the patient is asked to swallow and relax.

- When the relaxation is obvious, the lips are carefully parted to reveal the space present between the occlusion rims. This space is called the *Free-way space* (Fig. 9.61).

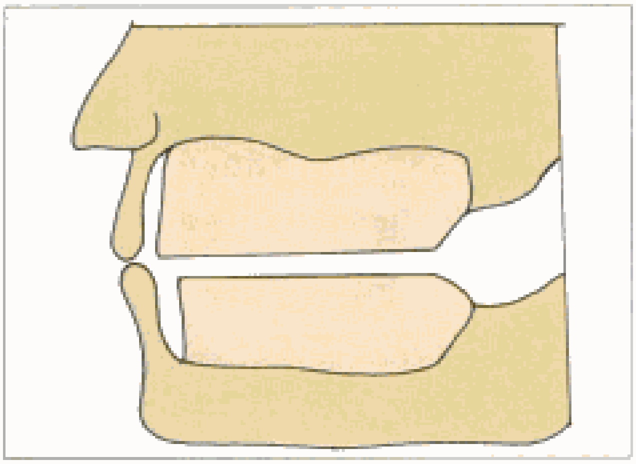


Fig. 9.61: Free-way space

- The space between the occlusal rims should be about 2-4 mm.
- The formula "VD at rest =VD at occlusion + Free-way space" can be used to evaluate the vertical dimension at occlusion (Fig. 9.62).
- If the free-way space is more than 4 mm, the vertical dimension at occlusion is considered to be small and if the space is less than 2 mm, the vertical dimension at occlusion may be too great.

Phonetics This involves observing the movements of the oral tissues during speech and more importantly listening and analyzing the speech of the patient. The maxilla and mandible show a characteristic relationship during speech. This can be used to determine the vertical dimension. There are two common methods in which phonetics is used to determine jaw relation. They are:

- Silverman's closest speaking space.
- The "F" or "V" and "S" speaking anterior tooth relation.

Silverman's Closest Speaking Space

It was first described by Silverman. According to him the closest speaking space measures the vertical dimension when the mandible is in function. This differs from the Niswonger's and Thomson's method in that the Niswonger's method measures the vertical dimension when the muscles controlling the mandible are at rest or physiological tonus where as in this method the muscles are active.

When sounds like *ch, s, j* are pronounced, the upper and lower teeth reach their closest relation without contact. This minimal amount of space between the upper and lower teeth in this position is called the *Silverman's closest speaking space* (Fig. 9.63).

This space indicates the vertical dimension of the patient. In an ideal case, the lower incisor should almost touch the palatal surface of the upper incisor.

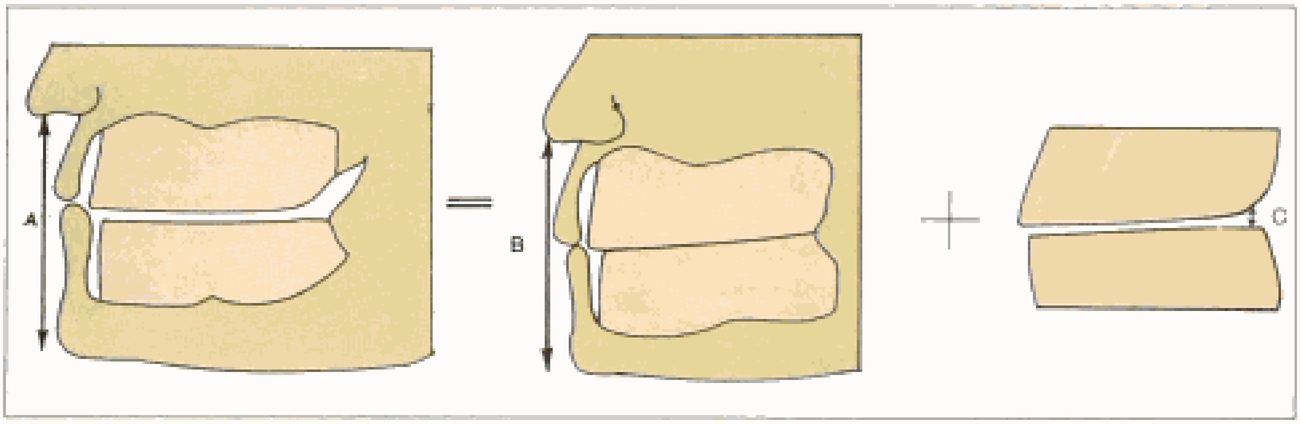


Fig. 9.62: a = b+c. The vertical dimension at rest is equal to the sum of vertical dimension at occlusion and free-way space

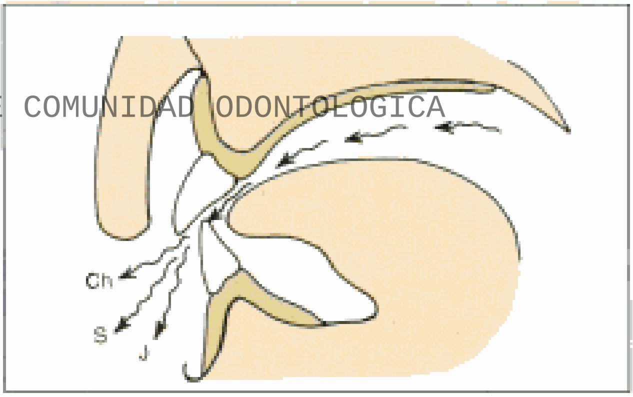


Fig. 9.63: Silverman's closest speaking space

Increase in the free-way space between the upper and lower incisors indicates an inadequate vertical dimension at occlusion. A decrease in the closest speaking space will indicate an excessive vertical dimension at occlusion. Contact of the incisal edges during speech also indicates an excessive vertical dimension at occlusion.

Using the above factors as a guide, the vertical dimension at occlusion can be recorded. If the free way space is increased between the occlusal rims the vertical dimension at occlusion is inadequate. In other words if the occlusal rim has an inadequate height, the free-way space will be increased.

The "F" or "V" and "S" Speaking Anterior Tooth Relation: (Pound and Murrel)

In this method, the incisal guidance is established by arranging the anterior teeth on the occlusal rim before recording the vertical dimension at occlusion. The anterior teeth are arranged on the occlusal rim and modified in the patient's mouth based on the pronounciation of certain alphabets.

The position of the anterior teeth is determined by the position of the maxillae when the patient pronounces words beginning with "F" or "V". The position of the lower anterior teeth is determined by the position of the mandible when the patient pronounces words beginning with the letter "S".

Procedure

- An occlusal rim is fabricated over the maxillary record base. The maxillary occlusal rim is inserted into the patient's mouth.
- The base plate wax in the maxillary occlusal rim is adjusted using a fox plane and made parallel to the Camper's line.
- The patient is asked to repeatedly pronounce the words "fist" and "van". When the patient says these words his upper lip should provide a facial seal. The maxillary occlusal rim should be contoured to obtain the seal. The midline is marked on the occlusal rim.
- The upper central incisors are set in their position and checked in the patient's mouth. The record base is removed from the patient's mouth and the anterior teeth are set. The maxillary record base with the anterior teeth is inserted and corrected.
- 3/4th inch of speaking wax (Beeswax) is added over the occlusal plane of the mandibular occlusal rim. Both record bases are inserted into the patient's mouth.
- The mandibular occlusal rim with the speaking wax is inserted and the patient is asked to pronounce the words "sixty" and "sixty-five". The midline is marked and the record base is removed from the patient's mouth.
- The speaking wax is removed to set the artificial teeth. The mandibular record base is inserted and the setting is verified.
- After verifying the anterior teeth arrangement, soft wax or zinc oxide eugenol (ZnOE) impression paste or impression compound or dental plaster is added as an inter-occlusal record on the posterior part of the occlusal surface of the mandibular occlusal rim.
- The upper and lower record bases are inserted and the patient is asked to close the mouth till the anterior teeth occlude to their proper position. This procedure is repeated to check for errors. The inter-occlusal material placed on the mandibular occlusal rim records the vertical dimension at occlusion (Fig. 9.64).

Aesthetics Aesthetics can be used to aid to determine the correct vertical dimension. This is done by selecting teeth of the same size as the natural teeth and by assessing the amount of residual ridge resorption.

Skin If the vertical dimension is too high the skin of the cheeks will appear very stretched and the

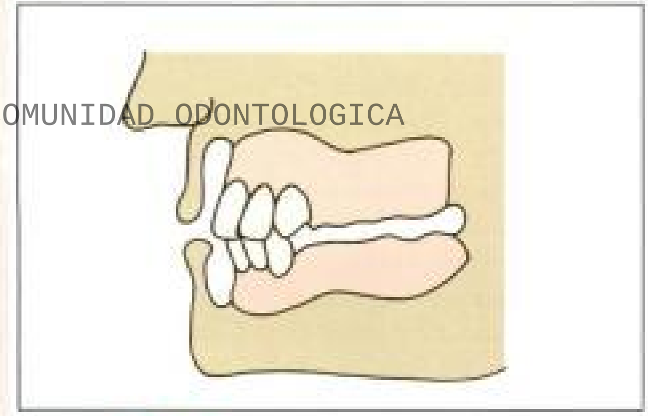


Fig. 9.64: Pound and Murrel's method

nasolabial fold will be obliterated, the nasolabial angle will be increased. The skin on the perioral areas can be compared with skin over other areas of the face for reference. It should also be remembered that there are other factors like the age of the patient, which can influence the appearance of the skin.

Lips The contour and fullness of the lip is affected by the thickness of the labial flange. The occlusal rims should be contoured to aid in lip support. A flattened appearance of the lip indicates lack of lip support. In such cases vertical dimension should not be increased to provide lip support, as it would lead to failure of the denture.

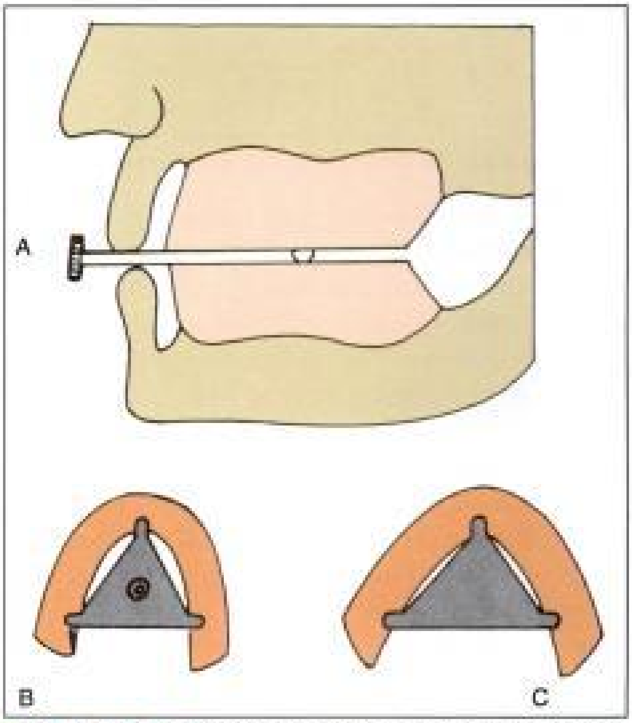
Swallowing Threshold

It is considered that at the beginning of swallowing, the teeth of the upper and lower jaws almost come in contact. This factor can be used as a guide to determine vertical dimension at occlusion.

A conical occlusal rim made of soft wax is fabricated on the mandibular record base. The upper and lower record bases are inserted in the patient's mouth. Salivation is stimulated and the patient is asked to swallow. The height of the conical wax rim is reduced due to the pressure developed while closing the mandible during swallowing. The conical wax rim may also be softened to reduce the resistance to closing.

Tactile Sense or Neuromuscular Perception

Here the patient's tactile sense or sense for comfort is used to asses the vertical dimension at occlusion. In this method a central bearing screw/central bearing plate apparatus is used. The central bearing screw fits into the depression of the central bearing plate. The central bearing plate is attached to the maxillary occlusal rim and the central bearing screw is fixed to the mandibular occlusal rim (Figs 9.65a to c).



Figs 9.65a to c: (a) Tactile sense method of determining vertical jaw relation (b) Central bearing point (c)Central bearing plate

Procedure

- The occlusal rims with the central bearing screw and plate are inserted into the patient's mouth.
- The central bearing screw is progressively tightened. This tightening will bring both the occlusal rims towards each other.
- After a certain limit the patient will feel discomfort in his jaws due to over-tightening. This point is recorded.
- The same procedure is repeated with the central bearing plate in the mandibular rim and the central bearing screw in the maxillary rim.
- The central-bearing point is slowly reduced till the patient indicates a comfortable jaw relationship.

- The procedure is repeated to avoid errors. Disadvantages include foreign body obstruction, etc.

Patient's Perception of Comfort

It is a very simple and easy method of determining the vertical relation. Here, the record bases with excessively tall occlusal rims are inserted in to the patient's mouth and the excess base plate wax is removed stepwise till the patient perceives the occlusal height as comfortable. The disadvantage of this technique is that it depends on the patient's co-operation for accurate readings.

HORIZONTAL JAW RELATION

It is the relationship of the mandible to the maxilla in a horizontal plane. It can also be described as the relationship of the mandible to the maxilla in the anteroposterior direction. Horizontal jaw relation can be of two types namely centric and eccentric jaw relations.

Centric relation denotes the relationship of the mandible to the maxilla when the mandible is at its posterior most position. Eccentric relation denotes the relationship of the mandible to the maxilla when the mandible is at any position other than the centric relation position.

Centric Relation

The glossary of prosthodontic terms (GPT) enumerates seven different definitions for centric relation. They are:

1. *"The maxillomandibular relationship in which the condyles articulate with the thinnest avascular portion of their respective discs with the complex in the anterior-superior position against the slopes of the articular eminences. This position is independent of tooth contact. This position is clinically discernible when the mandible is directed superior and anteriorly. It is restricted to a purely rotary movement about the transverse horizontal axis" (GPT-5)* **(most accepted definition).**
2. *"The most retruded physiologic relation of the mandible to the maxilla to and from which the individual can make lateral movements. It is a condition that can exist at various degrees of jaw separation. It occurs around the terminal hinge axis" (GPT-3)*
3. *"The most retruded relation of the mandible to the maxilla when the condyles are in the most posterior unstrained position in the glenoid fossa from which lateral movements can be made, at any given degree of jaw separation" (GPT-1)*
4. *"The most posterior relation of the lower to the upper jaw from which lateral movements can be made at a given vertical dimension" (Boucher)*
5. *"A maxilla to mandible relationship in which the condyles and discs are thought to be in the midmost, uppermost position. The position has been difficult to define anatomically but is determined clinically by assessing when the jaw can hinge on a fixed terminal axis (up to 25 mm). It is a clinically determined relationship of the mandible to the maxilla when the condyle disc assemblies are positioned in their most superior position in the mandibular fossa and against the distal slope of the articular eminence" (Ash)*
6. *"The relation of the mandible to the maxilla when the condyles are in the uppermost and rearmost position in the glenoid fossae. This position may not be able to be recorded in the presence of dysfunction of the masticatory system" (Lang)*
7. *"A clinically-determined position of the mandible placing both condyles into their anterior uppermost position. This can be determined in patients without pain or derangement in the TMJ" (Ramsfjord 1993).*

GPT-5 definition is commonly used and accepted. Generally speaking, centric relation can be described as the most posterior relation of mandible to the maxilla at the established vertical dimension from which lateral movements could be made. Any position of the mandible other than that of the centric relation is called an eccentric position.

Note: Centric relation is the most posterior relation of the mandible to the maxilla and the antero-superior relation of condyle to the glenoid fossa.

Importance of Centric Relation (Significance)

We know that proprioceptive impulses (impulses of three-dimensional spatial orientation) guide the mandibular movements. In dentulous patients the proprioceptive impulses are obtained from the periodontal ligament.

Edentulous patients do not have any proprioceptive guidance from their teeth to guide their mandibular movements. The source of the proprioceptive impulses for an edentulous patient is transferred to the temporomandibular joint. The centric relation position acts as a **proprioceptive centre to** guide the mandibular movements (Fig. 9.66).

The centric relation has the following salient features:

- It is learnable, repeatable and recordable position which remains constant throughout life.
- It is a definite learned position from which the mandible can move to any eccentric position and return back involuntarily. It acts as a centre from which all movements can be made.
- If the mandible has to move from one eccentric position to another it should go to the centric relation before advancing to the target eccentric position.

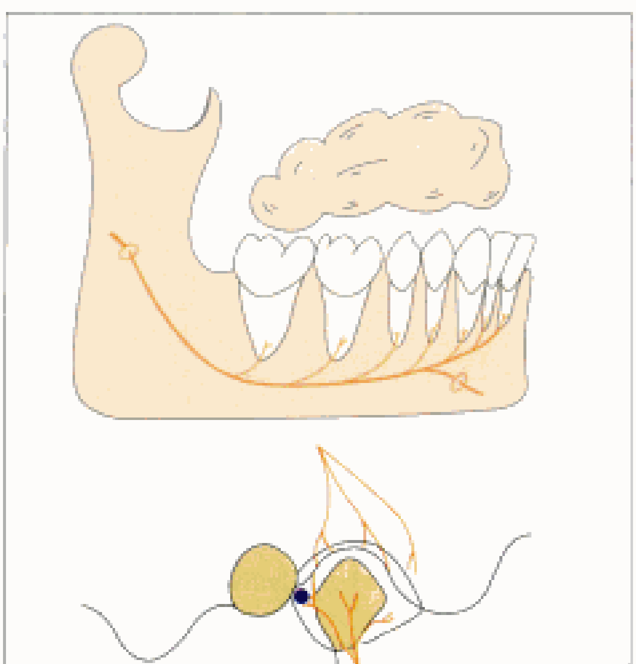


Fig. 9.66: Proprioceptive impulses from the teeth and temporomandibular joint

- Functional movements like chewing and swallowing are performed in this position, because it is the most unstrained position.
- The muscles that act on the temporomandibular joint are arranged in such a way that it is easy to move the mandible to the centric position from where all movements can be made.
- The casts should be mounted in centric relation because it is the point from which all the movements can be made or simulated in the articulator.
- It is helpful in adjusting condylar guidance in an articulator to produce balanced occlusion.
- It is a definite entity, so it is used as a reference point in establishing centric occlusion.

Centric relation is a learned position (not a default position) and the dentist should teach the patient with patience to move his mandible from the centric relation position.

Retruding the Mandible

The mandible should be in its most posterior position while recording centric relation. The mandible should be retruded to it posterior position before recording the centric jaw relation. Some patients may show difficulties in retruding the mandible due to certain systemic conditions. These difficulties can be overcome by conditioning the patient psychologically, using special jaw relating apparatus, etc.

Method of Retruding the Mandible

The following methods can be employed to help the patient to retrude the mandible.

- Relaxing the patient. Making him feel comfortable.
- The patient is asked to try to bring his upper jaw *forward* while occluding on the posterior teeth.
- The patient should be instructed to touch the posterior border of the upper record base with his tongue.
- The mandibular occlusal rim should be tapped gently with a finger. This would automatically make the patient to retrude his mandible.

- The temporalis and the masseter are palpated to relax them.

Difficulties in Retruding Mandible

Difficulties in retruding the mandible can be classified as

- Biological
- Physiological
- Mechanical.

Biological causes

- Lack of co-ordination between groups of opposing muscles when the patient is requested to close the mouth in the retruded position.
- Habitual eccentric jaw relation.

Physiological causes

Inability of the patient to follow the dentist's instructions is one of the major psychophysiological factors, which produce difficulty in retruding the mandible. This is overcome by instituting stretch relax exercises, training the patient to open and close his mouth, etc. Central bearing devices can also be used to retrude the mandible in these patients.

Mechanical causes

Poorly fitting base plates produce difficulty in retruding the mandible. The base plates should be checked using a mouth mirror for proper adaptation.

METHODS OF RECORDING THE CENTRIC JAW RELATION

The various methods to record centric relation are:

Physiological methods:

- Tactile or inter-occlusal check record method
- Pressureless method.
- Pressure method.

Functional method:

- Needleshouse method
- Patterson method

Graphic methods:

- Intraoral
- Extraoral

Radiographic method:

Generally while recording centric relation, the patient is trained to retrude his mandible to centric relation. Once the clinician is satisfied with the patient's training, the centric relation position is recorded on the occlusal rims (using physiological, functional or graphic methods). This record is transferred to the articulator using indexes like nicks and notches, staple pins, etc.

Physiologic Methods

Physiological methods are called so because they are based on

- The proprioceptive impulses of the patient.
- Kinesthetic sense of mandibular movement
- The visual acuity and sense of touch of the dentist.
- No pressure is exerted on the interocclusal record.

Tactile Sense or Inter-occlusal Check Record Method

In this method, tentative centric jaw relation is recorded by asking the patient to retrude the mandible. The casts are articulated based on the tentative jaw relation. Teeth arrangement is done and an inter-occlusal registration is made. The tentative jaw relation is verified with the inter-occlusal record and errors are corrected.

Indications

- Abnormally related jaws.
- Displaceable, flabby tissues.
- Large tongue.
- Uncontrollable mandibular movements.
- It can also be done for patients already using a complete denture.

Factors affecting the success of inter-occlusal record method

- Uniform consistency of the recording material.
- Accurate vertical jaw relation records.
- Stability and fit of the record base.
- Presence of reference points embedded in the record like metal pins or styli.

The commonly used materials for making the inter-occlusal record in this method are waxes, impression compound, ZnOE and impression plaster.

Waxes are technique-sensitive and do not provide uniform resistance to pressure because they do not cool uniformly. The advantage of waxes is that they harden very quickly and the record can be made immediately. Hence, they are used only in patients with poor muscular control.

Impression plaster and ZnOE are usually preferred because they offer uniform resistance to pressure. The disadvantage of these materials is that they take a long time to set and any movement made while the material hardens, can render the inter-occlusal record useless.

Procedure

It involves two steps. First, a tentative centric jaw relation is recorded using wax occlusal rims. In the second step, an inter-occlusal check record is made using the trial denture during try-in (Trial denture is fabricated using the tentative jaw relation).

Tentative Jaw Relation

- The maxillary occlusal rim is inserted into the patient's mouth. A denture adhesive can be used to improve retention.
- The vertical dimension at rest is established and the mandibular rim is reduced further for excess inter-occlusal distance.
- A tentative centric relation is recorded by using one of the previously mentioned methods to retrude the mandible.
- The occlusal rims are articulated using the tentative jaw relations and the artificial teeth are arranged.
- Now the trial dentures are ready for making the inter-occlusal check record.

Making the Inter-occlusal check record

- The upper and lower trial dentures are inserted into the patient's mouth. The artificial teeth are prevented from contacting the opposing members by keeping a piece of cotton inter-occlusally.
- Aluwax is loaded onto the occlusal surface of teeth in the mandibular occlusal rim.
- The patient is asked to slowly retrude the mandible and close on the wax till tooth contact occurs.
- The trial dentures are removed and the wax is allowed to cool.
- Both the maxillary and mandibular trial dentures are placed on their articulated casts.
- Before placing the trial dentures, the horizontal condylar guide locks in the articulator (Refer chapter 10) are unlocked to allow free horizontal movement of the casts.
- The Aluwax on the buccal aspect of mandibular teeth is scraped off and the articulated casts (which are free to move horizontally) are adjusted to fit into the Aluwax check record.
- If the tentative relation record is accurate and is the same as the check record then both the condylar elements of the articulator will contact against the centric stops i.e. the articulated casts need not move to fit into the check records.
- If anyone of the condylar elements *(condylar element represents the condyle in the articulator)* do not contact on the centric stops *(centric stop represents the centric position of the condyle in the glenoid fossa)* it indicates that the tentative recording is inaccurate. (Refer chapter 10 for additional details).
- Occlusal indicator wax can be used instead of Aluwax for recording trial dentures with non-anatomical (cuspless) teeth.

Static or Pressureless Method

The occlusal rims are customized as usual and the patient is trained to close at centric relation position. Once the patient attains the centric relation position, the denture bases with occlusal rims are indexed/sealed in this position. The nick and notch method or the stapler pin method can be used to index/seal the occlusal rims.

Nick and notch method This is the most commonly used method of indexing the recorded centric jaw relation. Here, the final centric jaw relation is carried out after establishing a proper vertical jaw relation. No occlusal check records are performed during try-in. This procedure derives its name from the shape of the indices made on the occlusal rims.

Procedure for recording centric relation using a pressure less method with nick and notch indexing

- The patient is seated in an upright position, as it is easier to retrude the mandible in this position.

- Upto 3 mm of wax is removed on either side of the mandibular occlusal rim from the premolar region till the distal end. This depression created on the occlusal rim due to removal of wax is called *trough* (Fig. 9.67).

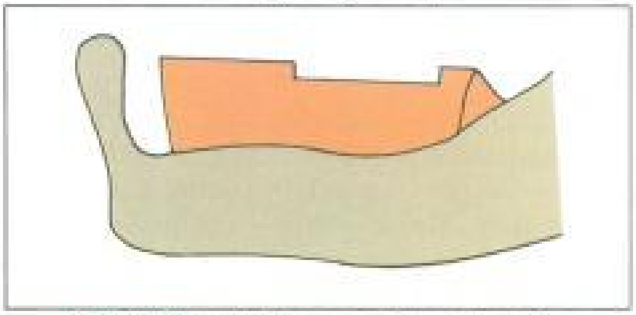


Fig. 9.67: Trough in the mandibular occlusal rim

- One or two notches are cut on the corresponding area on the maxillary occlusal rim. The notch resembles a 'V' shaped valley running totally across the width of the occlusal rim (Fig. 9.68).

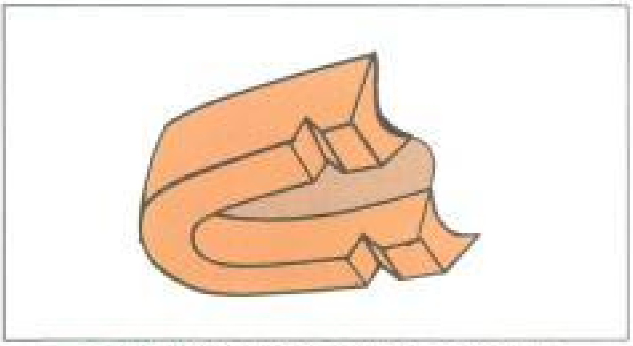


Fig. 9.68: Notch in the maxillary occlusal rim

- One nick is cut anterior to the notch. This is also a 'V' shaped valley but it does not extend throughout the width of the occlusal rim (*nick prevents lateral movement and the notch prevents antero-posterior movement)*.
- The nick and the notch on the maxillary occlusal rim are lubricated with petrolatum (Fig. 9.69).
- The prepared occlusal rims are inserted into the patient's mouth and the patient is taught to close his mandible at the maximum retruded position.
- Since the patient has to learn to close his mouth with his mandible at its most retruded

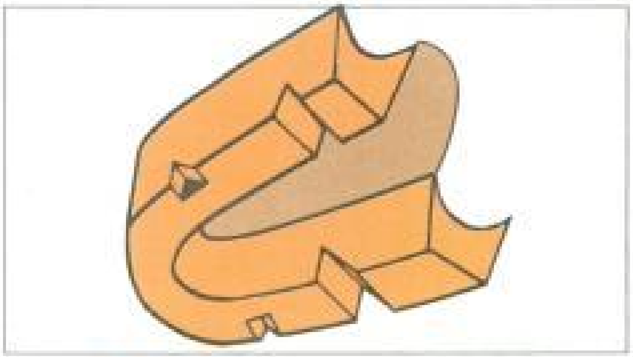


Fig. 9.69: Nick in the maxillary occlusal rim

position, a good deal of cooperation is required from both the patient and the dentist.
- The patient can be taught to close his mouth in centric relation using the following techniques:
  — The dentist can guide the mandible into centric relation manually by keeping the index fingers on the buccal flanges of the mandibular record base and positioning the thumb under the chin.
  The mandible is then guided into position with the index fingers supporting the occlusal rims.
  — Centric relation can also be obtained by asking the patient to swallow. This is because the mandible attains centric relation during the swallowing cycle.
- Once the patient has learned to close his mouth in centric relation, he is asked to repeatedly practice it, till the dentist is satisfied.
- The mandibular occlusal rim is removed from the patient's mouth.
- Aluwax (Aluwax dental products company, Grand Rapids, Michigan) is placed on troughs created in the mandibular rim.
- About 4.5 mm of Aluwax should be placed on the trough so that about 1.5 mm of Aluwax will be projecting above the mandibular occlusal rim. ZOE and impression plaster can also be used as a substitute for Aluwax (Fig. 9.70).
- The mandibular occlusal rim is placed in a water bath to soften the wax and inserted into the patient's mouth.
- The patient is asked to close in centric relation with professional guidance.

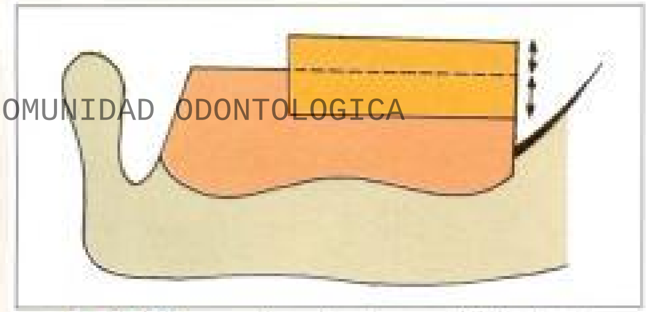


Fig. 9.70: Aluwax placed on the mandibular trough

- The mouth should close such that the anterior parts of the occlusal rims almost touch but not press against each other. The Aluwax projecting above the trough of the mandibular rim will flow into the nick and notches.
- The occlusal rims are removed and placed in a cold-water bath till the wax hardens.
- The excess Aluwax present buccally and lingually should be trimmed. Care should be taken to prevent damage to the occlusal surface of the nick and notch (Fig. 9.71).

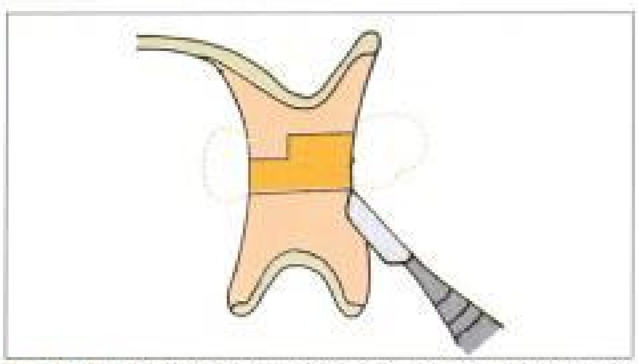


Fig. 9.71: The excess Aluwax should be scrapped out with the help of the wax carver

- Since petrolatum was applied, it will be easy to separate the rims without damaging the index.
- Both the occlusal rims should be placed against each other and checked if the Aluwax extends between the nick and the notch.
- The notches can be placed on the mandibular rim and the Aluwax can be placed on the maxillary rim if necessary.
- The maxillary occlusal rim is placed on the articulated maxillary cast (articulated after orientation jaw relation).
- The articulator with the maxillary cast is placed upside down. The mandibular rim along with the cast is positioned against the maxillary rim such that it coincides with index records (nick and notch).
- After articulation the centric relation can be verified using intraoral or extraoral tracing devices.

Stapler pin method of indexing static centric relation In this method, after recording the centric relation, the occlusal rims are indexed using a bunch of stapler pins. The method is not preferred as centric relation record cannot be verified.

Pressure Method

Here, after establishing the vertical dimension, the upper occlusal rim is inserted into the patient's mouth. The lower occlusal rim is fabricated to be of excess height. The entire lower occlusal rim is softened in a water bath and inserted carefully into the patient's mouth.

The patient is guided to close his mouth in centric relation. The dentist should gently guide the mandible. The patient is asked to close on the soft wax. After the patient closes his mouth till the predetermined vertical dimension, both the occlusal rims are removed, cooled and articulated.

Functional Method or Chew-in Method

These methods utilize the functional movements of the jaws to record the centric relation. The patient is asked to perform border movements such as protrusive and lateral excursive movements in order to identify the most retruded position of the mandible.

The following factors are common to all functional methods:

- In a functional method, a tentative centric relation and vertical dimension are measured for determining an accurate centric relation.
- The occlusal rims for these methods are reduced in excess than that required for the tentative vertical dimension.
- The exact vertical dimension at occlusion is determined only when the patient closes

on the occlusal rims and their attachments (tracers etc).

- The record bases should be very stable while recording centric jaw relation. If the record base gets displaced, the mandible will tend to move into an eccentric position.
- Lack of equalized pressure exerted on the record base can result in inaccuracies in recording centric jaw relation.
- A good neuromuscular coordination is required from the patient.

Needleshouse Method

This is one of the most commonly used functional techniques.

- It involves the fabrication of occlusal rims made from impression compound.
- Four metal beads or styli are embedded into the premolar and molar areas of the maxillary occlusal rim (Fig. 9.72).
- The occlusal rims are inserted into the patient's mouth and all the above-mentioned factors affecting functional centric relation are considered.

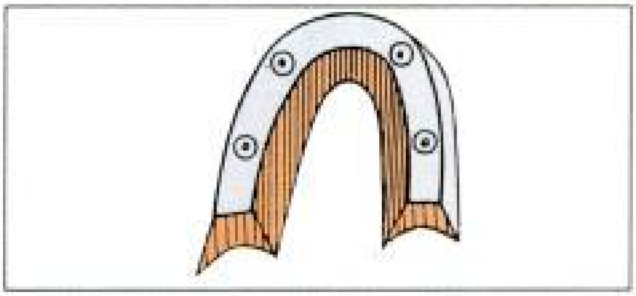


Fig. 9.72a: Maxillary occlusal rim made of impression compound with metal styli

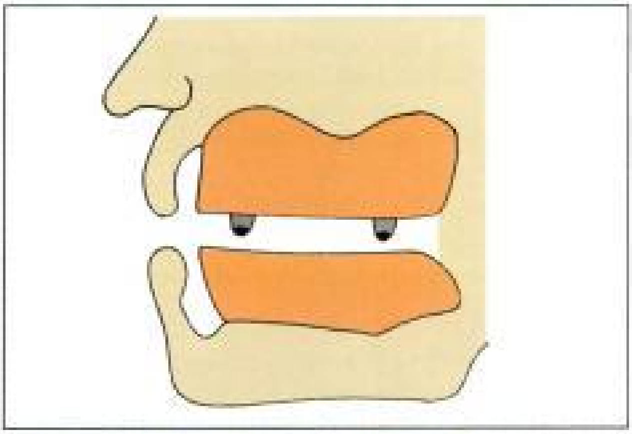
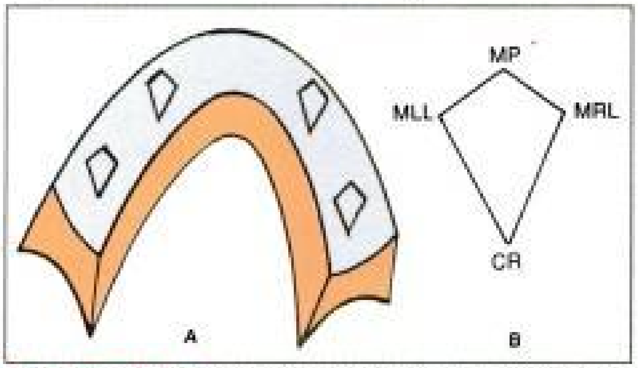


Fig. 9.72b: Recording the mandibular movements

- The patient is asked to close on the occlusal rims and make protrusive, retrusive, right and left lateral movements of the mandible.
- When the patient moves his mandible, the metal styli on the maxillary occlusal rim will create a marking on the mandibular occlusal rim. When all the movements are made, a diamond-shaped marking pattern rather than a line is formed on the mandibular occlusal rim (Fig. 9.73).
- The posterior most point of this diamond pattern indicates the centric jaw relation.



Figs 9.73a and b: Diamond-shaped markings made on the mandibular occlusal rim. (CR = Centric relation, MRL = Maximum right lateral, MLL = Maximum left lateral)

Patterson's Method

- Here occlusal rims made of modelling wax are used.
- A trench or trough is made along the length of the mandibular occlusal rim (Fig. 9.74).
- A 1:1 mixture of carborundum and dental plaster is loaded into the trench (Fig. 9.75).

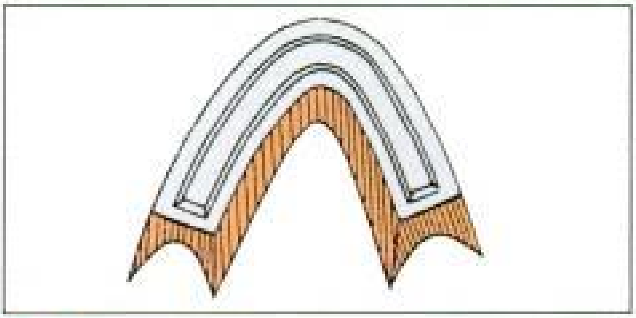


Fig. 9.74: Trench Made in the mandibular occlusal rim for Patterson's method

Fig. 9.75: 1:1 Mixture of carborundum and dental plaster loaded on the trench

- The occlusal rims are inserted and the patient is asked to perform mandibular movements.
- These movements will produce compensating curves on the plaster carborundum mix (Fig. 9.76).

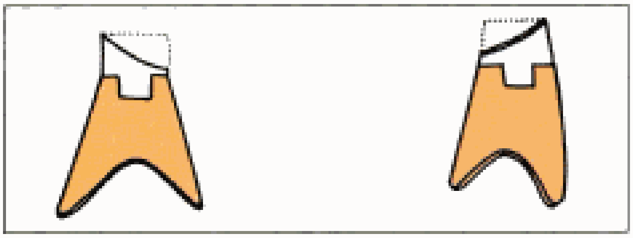


Fig. 9.76a: Lateral compensating curve generated on the plaster-carborundum mix

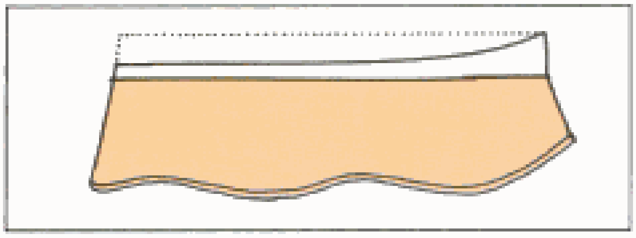


Fig. 9.76b: Antero-posterior compensating curve generated on the plaster-carborundum mix

- As these movements are made, the height of the plaster carborundum mix is also reduced.
- The patient is asked to continue these movements till a predetermined vertical dimension is obtained.
- Finally the patient is asked to retrude his jaw and the occlusal rims are fixed in this position with metal staples.

Graphic Methods

These methods are called so because they use graphs or tracings to record the centric jaw relation. Graphic methods are of two types namely arrow point tracing and the pantograph.

The arrow point tracing is a graphic record measured across a single plane whereas the pantograph is measured three-dimensionally. Before we go into the details of each method we shall discuss the general considerations required while performing a graphic record.

Factors to be Considered while Carrying out Tracing Procedures

The following factors may affect the accuracy of graphic tracing. Precautions should be taken in relation to these factors to avoid any errors in tracing.

- Stability of the denture base.
- Resistance offered by the occlusal rims against occlusal forces.
- Difficulty in placing the central-bearing device in protruded and retruded jaws.
- Presence of flabby tissue and its effect on the denture base.
- Height of the residual alveolar ridge influencing the stability of the record base.
- Interference from the tongue.
- Efficiency of the recording devices during physiological mandibular movements.
- Obtaining a pointed apex in the tracing pattern. (All tracing patterns will have an apex which is a single point from where all patterns appear to arise from) (Fig. 9.77).

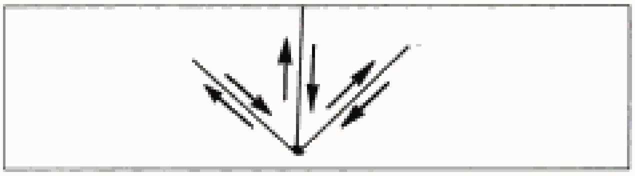


Fig. 9.77: Arrow point tracing formed after recording horizontal functional movements

- Lack of coordinated movement. This can cause double tracing.
- The graphic tracing should harmonize with the centric relation, centric occlusion, bone-to-bone relation and tooth-to-tooth contact.

Arrow-point tracing It is a one-dimensional graphic tracing made using gothic arch tracers. It is usually recorded in the horizontal plane. Arrow-point tracing is done using an arrow-point tracer. The general concept of this technique is that a pen-like pointer is attached to one occlusal rim and a recording plate is placed on the other rim. When the mandible moves the pointer draws characteristic patterns on the recording plate. The pointer is known as the *central-bearing point* and the recording plate is known as the *central bearing plate*.

These parts are called central bearing because they act at the centre of the arch and evenly distribute forces across the supporting structures. The pointer and the plate together are called as the *central-bearing device* (Fig. 9.78).

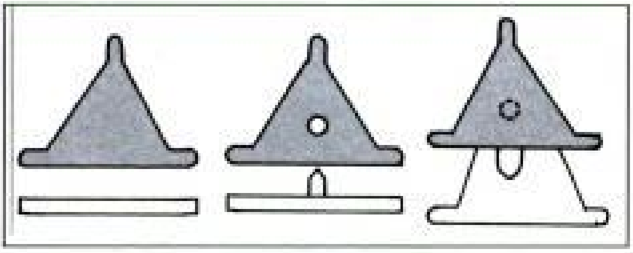


Fig. 9.78: Central bearing device

The characteristic pattern created on the recording plate is called a central arrow-point tracing. It is defined as, *"The pattern obtained on the horizontal plate used with a central-bearing tracing device"* - GPT. (Fig. 9.79). Arrow point tracing is called so because the shape of the tracing pattern resembles an arrow head. The apex of the arrow point tracing gives the centric relation. The apex of the arrow head should be sharp else the tracing is incorrect (Figs 9.80 and 9.81).

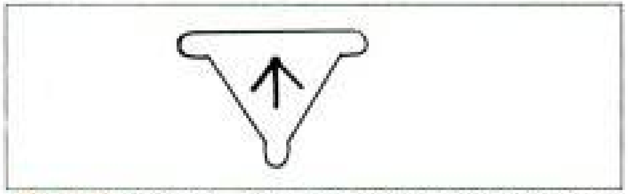


Fig. 9.79: Intraoral – arrow point tracing developed on a central bearing plate

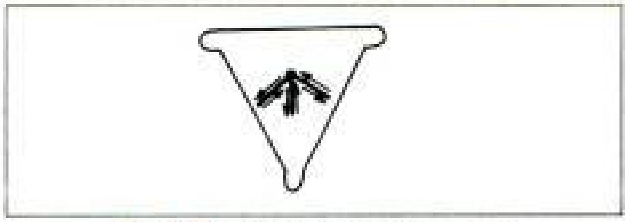


Fig. 9.80: Correct arrow point tracing

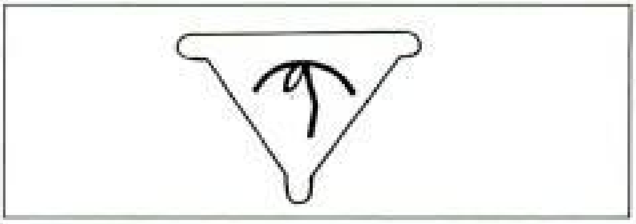


Fig. 9.81: Blunt centric apex developed due to improper tracing

Central-bearing device Central bearing device or central bearing tracing device is defined as, *"A device that provides a central point of bearing or support between the maxillary and mandibular dental arches. It consists of a contacting point attached to one dental arch and a plate attached to the opposing dental arch. The plate provides the surface on which the bearing point rests or moves and on which the tracing of the mandibular movement is recorded. It may be used to distribute the occlusal forces evenly during jaw relation and/or for the correction of disharmonious occlusal contacts. First attributed to Alfred Gysi, Swiss prosthodontist, in 1910"* – GPT.

I guess that huge definition pretty much explains everything. Now, we shall discuss its parts. As mentioned previously a central-bearing device consists of a central-bearing plate and a central-bearing point.

Central bearing point It is defined as, *"The contact point of the central bearing device"* – GPT. It is a triangular plate of metal with extensions provided to attach itself to the occlusal rim. In the centre of the triangle a metal pointer is present. The pointer can be adjusted in height. It is *usually attached to the mandibular occlusal rim* but can also be attached to the maxillary rim (Fig. 9.82).

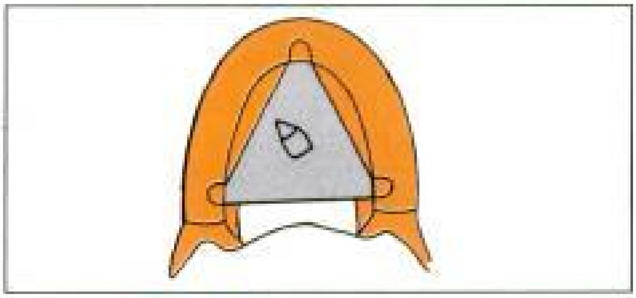
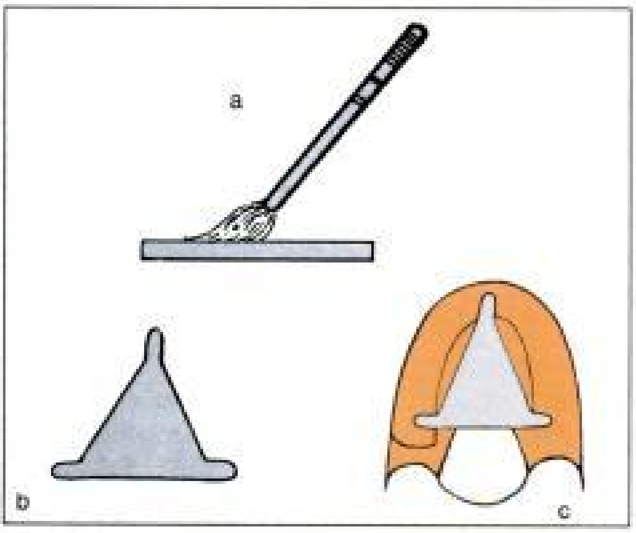


Fig. 9.82: Central bearing point

Since it is placed across the tongue space of the mandibular occlusal rim, it cannot be used in patients who cannot retract the tongue sufficiently and those who have macroglossia.

Central bearing plate It is also a triangular piece of metal with extensions at the three corners provided to attach the plate to the occlusal rim. *It is usually attached to the maxillary occlusal rim.* A mixture of denatured spirit and precipitated chalk is coated on this plate. The spirit dries to leave a fine layer of precipitated chalk. The tracing is marked on this layer of precipitated chalk (Fig. 9.83).



Figs 9.83a to c: (a) Applying precipitated chalk (b) Central bearing plate coated with precipitated chalk. (c) Central bearing plate coated with precipitated chalk attached to the occlusal rim

Types of arrow point tracers: Based on the location of the tracer, arrow-point tracers can be classified as intraoral and extraoral tracers.

Intra-oral arrow-point tracers: The central bearing device is located intra-orally and is more simple compared to the extra-oral arrow point tracers. The tracer is placed within the mouth. The disadvantage of this method is that the tracer is not visible during the procedure and the size of the tracing is very small making it difficult to determine the apex of the tracing.

Procedure

- The record bases attached to the central-bearing point and the central-bearing plate (coated with chalk) are inserted into the patient's mouth.
- The central bearing point is adjusted such that it contacts the central-bearing plate at a predetermined vertical dimension (Fig. 9.84).
- When the patient closes his mouth, the central bearing point contacts the metal plate.

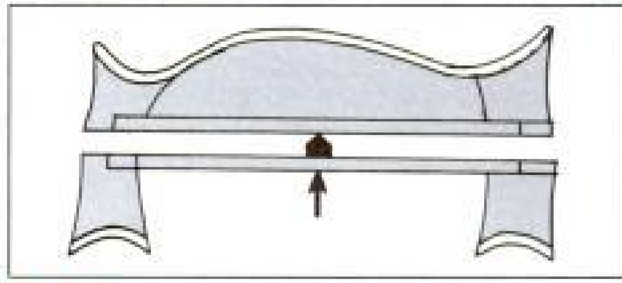


Fig. 9.84: Adjusting the central bearing screw to touch the central bearing plate

- The patient is asked to make anteroposterior and lateral movements. While making these movements, the central-bearing point will draw the tracing pattern on the central-bearing plate.
- After completing the movements, the tracing is removed and examined. The tracing should resemble an arrow point with a sharp apex. If the apex is blunt, the record is discarded and the procedure is freshly repeated.

Extra-oral arrow point tracers: The concept is similar to an intra-oral tracer. These tracers have the same central bearing device attached to the occlusal rims. Additionally, they have attachments that project outside the mouth. An extra-oral tracing pointer and the recording plates are attached to these projections (Figs 9.85a and b).

Since the recording pointer and the plates are situated extra-orally, the tracing can be examined as it is made. The size of the tracing pattern is also larger. Hence, the apex can be identified easily.

Procedure First a tentative vertical dimension should be established. The maxillary cast should be mounted in the articulator using face-bow transfer. The mandibular cast should be positioned against the maxillary counter part in a tentative centric relation (using soft wax) and articulated.

Fig. 9.85a: Extraoral arrow-point stylus

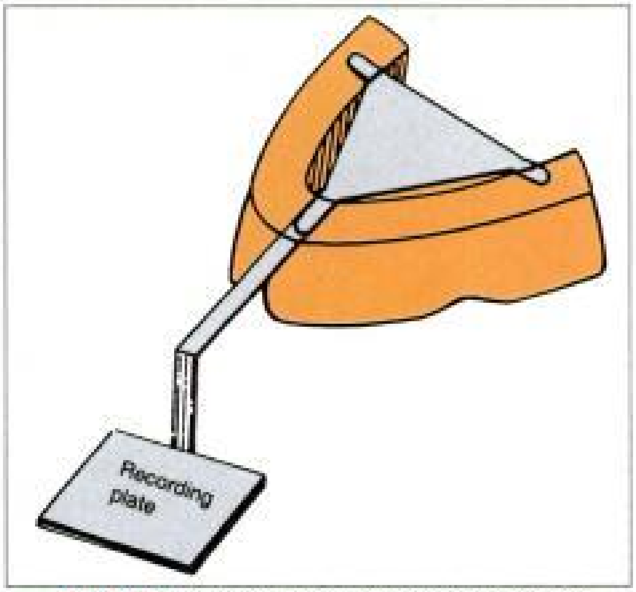


Fig. 9.85b: Extraoral arrow-point recording plate

The mandibular occlusal rim should be reduced to obtain excessive inter-occlusal distance. The recording plate is attached to the mandibular occlusal rim such that it is at the midline. The stylus or the central bearing point is attached to the maxillary occlusal rim (This arrangement can also be reversed if needed).

- The record bases attached to the recording devices are inserted in the patient's mouth.
- The central bearing point is retracted to conduct training exercises. The *Ney excursion guide* (Fig. 9.23b) can be used as an aid to train the patient.
- The recording plate (attached to the mandibular rim), which projects extra-orally, is coated with precipitated chalk and denatured alcohol.
- Intra-orally, the central bearing point is positioned to touch the central bearing plate at the predetermined vertical dimension.
- The patient is asked to perform protrusive, lateral and anteroposterior movements.
- The tracing is made extra-orally by the tracing pointer on the recording plate (Fig. 9.86).
- The tracing is examined for a sharp apex.
- Once the recordings are satisfactory, quick setting plaster is injected between the occlusal rims.
- The assembly is removed and articulated.

This is a tentative relation and should be checked using an inter-occlusal check record.

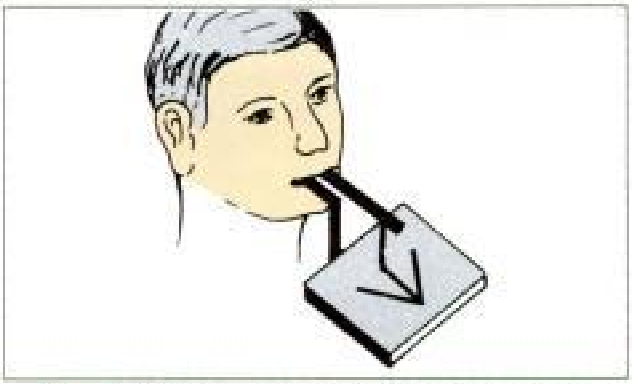


Fig. 9.86: Recording an extraoral arrow point tracing

Pantographic tracing It is defined as, "*A graphic record of mandibular movement in three planes as registered by the styli on the recording tables of a pantograph; tracings of mandibular movement recorded on plates in the horizontal and sagittal planes*" – GPT.

It is a three-dimensional graphic tracer. It is the most accurate method available to record centric jaw relation. Even eccentric jaw relation can be recorded using these instruments. These equipments are very sophisticated and are generally not used in the fabrication of complete dentures. This is because complete dentures have a *realiff factor* that aids to compensate for the minor fabrication errors. These tracers are generally used for full-mouth rehabilitation of dentulous patients.

The instrument used to do a pantographic tracing is called a pantographic tracer. A pantographic tracer is defined as, *"An instrument used to graphically record one or more planes paths of the mandibular movement and to provide information for the programming of the articulator"* – GPT. It resembles a complicated face-bow. The surface over which the tracing is done is called a *flag*. A stylus (tracing pointer) is present for each flag. The styli draw tracing patterns on the flags (Fig. 9.87).

A pantographic tracer has six flags:
- Two flags located perpendicular to one another near the condyles. Totally there are four flags adjacent to the right and left condylar guidances. They locate the actual (true) hinge axis.
- Two flags are placed in the anterior region. They record the anteroposterior movements.

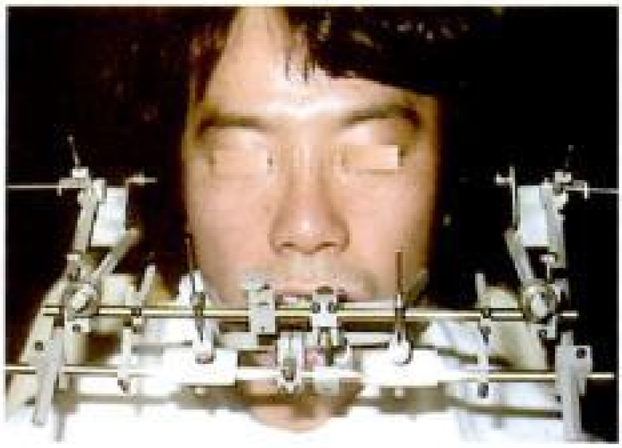


Fig. 9.87a: Pantographic tracer

Other Methods of Recording Centric-Jaw Relation

Other methods of recording centric jaw relation include:
- Making the rims contact fairly and evenly in the mouth at the desired vertical relationship. This usually makes the mandible close at centric relation.
- Strips of celluloid (or) paper are placed between the rims and pulled out. The patient is asked close and restrain the celluloid from slipping away. While doing so the patient's mandible involuntarily goes to centric relation (Fig. 9.88).

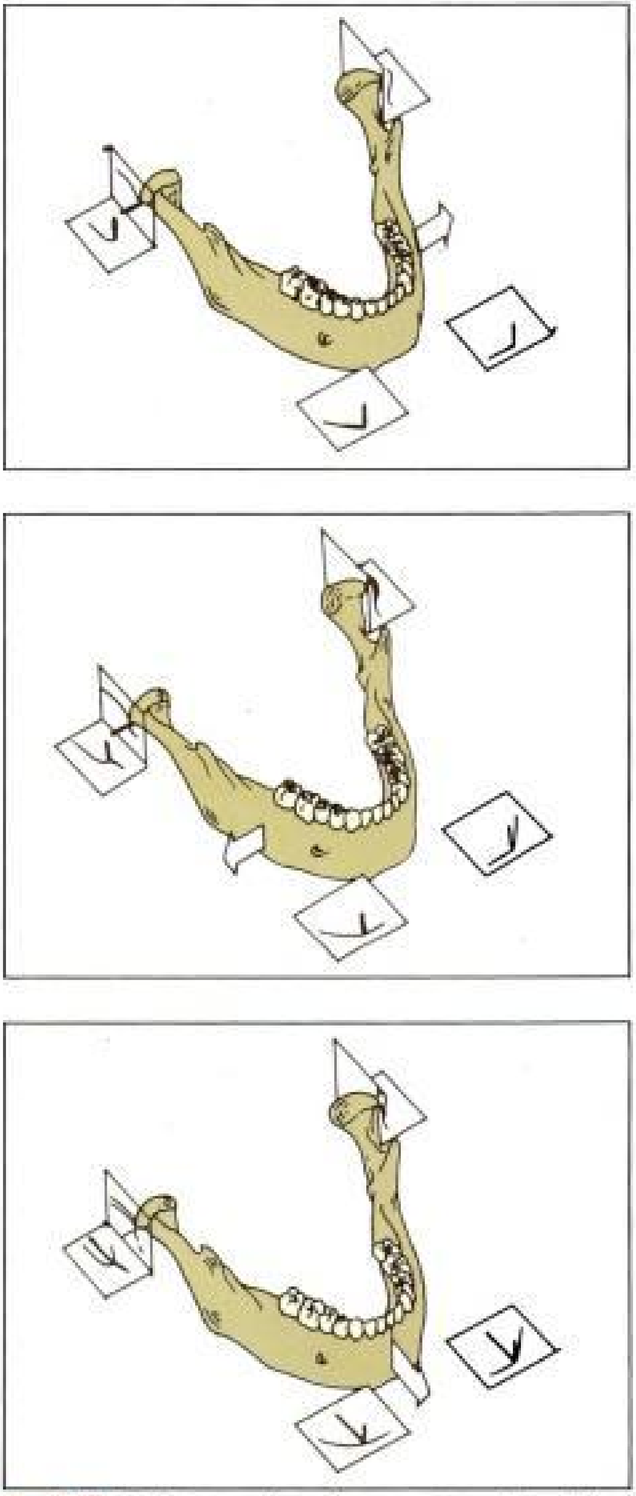


Fig. 9.87b: Tracings are shown for a pantograph in which all recording tables are attached to the mandible and all styli are attached to the maxilla; (a) left lateral excursion (b) right lateral excursion (c) protrusive excursion. Styli are shown in their initial positions

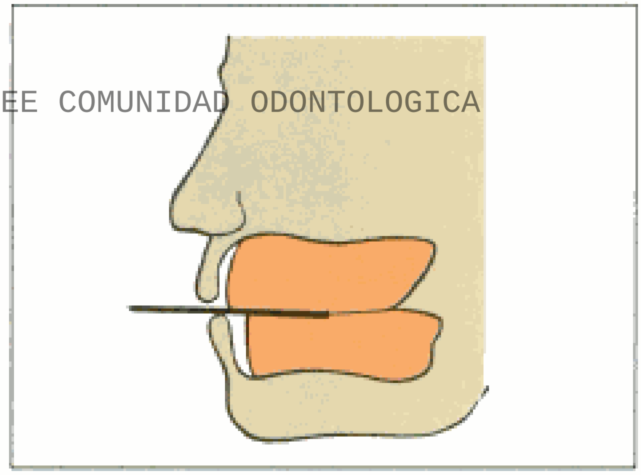


Fig. 9.88: Pulling a strip of celluloid interposed between the occlusal rims will automatically retrude the mandible to centric relation

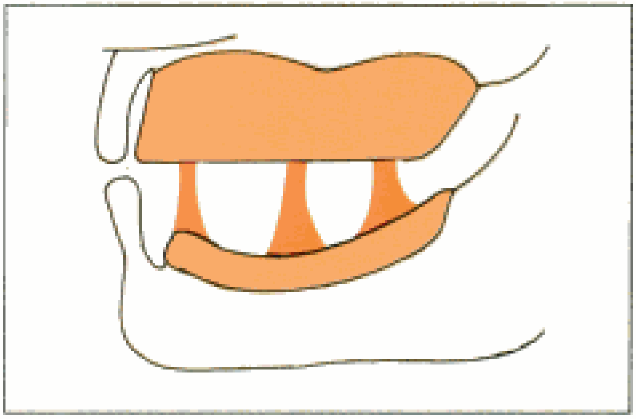


Fig. 9.89: Conical wax blocks used to record centric relation

- Softened wax may be placed on the mandibular occlusal rim and the patient is asked to bite in centric relation.
- Conical blocks of wax can be made on the mandibular record base and the patient is asked to close on them at centric relation (Fig. 9.89).

Eccentric Jaw Relation

Eccentric jaw relation is defined as, *"Any relationship of the mandible to the maxilla other than the centric relation"* –GPT.

It includes protrusive and lateral relations. The main reason in making an eccentric jaw relation record is to adjust the horizontal and lateral condylar inclinations in the articulator. This helps the articulator to reproduce eccentric movements of the mandible and establish balanced occlusion. Eccentric relations can be recorded using functional or tactile methods. Methods of recording eccentric jaw relation are similar to the ones used to record centric relation position.

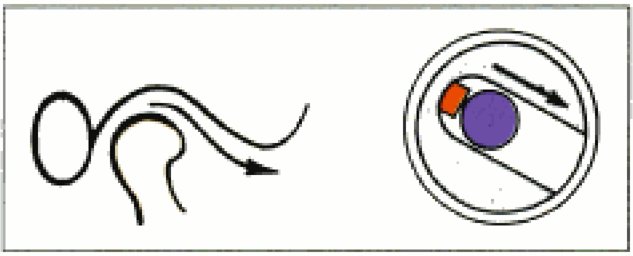


Fig. 9.90: S-shaped condylar guidance in comparison to a straight condylar track in an articulator

Factors to be Considered while Making Eccentric Jaw Relations

- The condylar path cannot be altered.
- The condyles do not travel in straight lines during eccentric jaw movements.
- Semi-adjustable articulators in which the condyles travel on a flat path cannot be used to reproduce eccentric movements (Fig. 9.90).
- Most complete denture articulators do not support lateral records.
- Fully adjustable articulators where the condylar and incisal guidances are fabricated individually with acrylic can travel in the path of the condyle using pantographic tracings (See fully adjustable articulators).

Chapter 10
Lab Procedures Prior to Try-In

- **Articulators and Articulation**
- **Mounting Procedure**
- **Teeth Selection**
- **Occlusion**
- **Arrangement of Artificial Teeth**
- **Wax up**

10

Lab Procedures Prior to Try-In

ARTICULATORS AND ARTICULATION

- Purpose of an articulator.
- Uses of an articulator.
- Requirements of an articulator.
- Advantages of an articulator.
- Limitations of an articulator.
- Classification of articulators.
- Structure of an articulator.

Articulator is defined as, "*A mechanical device which represents the temporomandibular joints and the jaw members to which maxillary and mandibular casts may be attached to simulate jaw movements*"- GPT.

Articulators are mechanical analogues of the temporomandibular joints and the upper and lower dental arches, a device to which maxillary and mandibular casts can be attached, with the intent of simulating the functional and para-functional contact relationships of one arch to the other.

After recording the jaw relation, the occlusal rims should be transferred to an instrument, which will resemble and perform the functions of the maxilla, mandible and temporomandibular joint. The articulator is one such instrument. When the casts are mounted in the articulator, it is very easy to arrange the teeth on the occlusal rims and check for occlusion during different movements of the mandible.

Purpose of an Articulator

- To hold the maxillary and mandibular casts in a determined fixed relationship.
- To simulate the jaw movements like opening and closing.
- To produce border movements (extreme lateral and protrusive movements) and intraborder movements (within the border movement) of the teeth similar to those in the mouth (Fig. 10.1).

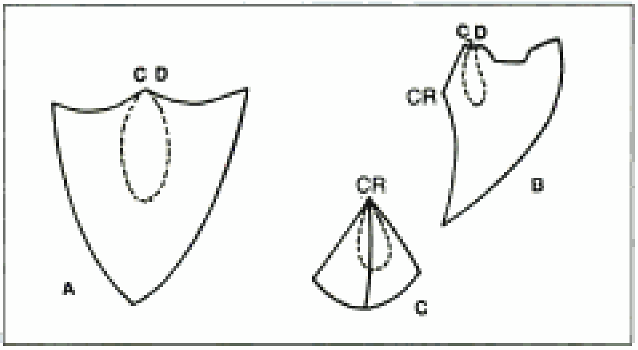


Fig. 10.1: Diagram showing border and intra–border movements. The solid line connects the eccentric position with the most protrusive and lateral positions. The solid line depicts the border movement and the dotted line depicts the intra-border movement
A: Coronal plane. B: sagittal plane, C. Horizontal plane

Uses of an Articulator

- To diagnose the state of occlusion in both the natural and artificial dentitions.
- To plan dental procedures based on the relationship between opposing natural and artificial teeth. e.g. evaluation of the possibility of balanced occlusion.
- To aid in the fabrication of restorations and prosthodontic replacements.
- To correct and modify completed restorations.
- To arrange artificial teeth.

Requirements of an Articulator

Minimal Requirements

- It should hold casts in the correct horizontal relationship.

- It should hold casts in the correct vertical relationship.
- The casts should be easily removable and re-attachable.

- It should provide a positive anterior vertical stop (Incisal pin).
- It should accept face-bow transfer record using an anterior reference point.
- It should open and close in a hinge movement.
- It should be made of non-corrosive and rigid materials that resist wear and tear.
- It should not be bulky or heavy.
- There should be adequate space present between the upper and lower members.
- The moving parts should move freely without any friction.
- The non-moving parts should be of a rigid construction.

Additional Requirements

- The condylar guides should allow protrusive and lateral jaw motion.
- The condylar guide should be adjustable in a horizontal direction.
- The articulator should be adjustable to accept and alter the Bennett movement.
- The incisal guide table should be customizable (allow modification).

Advantages of Articulators

- Properly-mounted casts allow the operator to visualize the patient's occlusion, especially from the lingual view.
- Patient cooperation is not a factor when using an articulator once the appropriate inter-occlusal records are obtained from the patient.
- The refinement of complete denture occlusion in the mouth is extremely difficult because of shifting denture bases and resiliency of the supporting tissues. This difficulty is eliminated when articulators are used.
- Reduced chair time, patient's appointment time.
- The patient's saliva, tongue and cheeks are not factors when using an articulator.

Limitations of an Articulator

- An articulator may be made of metal or plastic. Metal articulators show errors in tooling (manufacture) or errors resulting from metal fatigue.
- The articulator may not exactly simulate the intraborder and functional movements of the mandible.
- Errors in jaw relation procedures are reproduced as errors in the denture occlusion. Articulators do not have any provision to indicate or correct these errors.

Classification

Several classifications of articulators were proposed. The most popular methods of classifying articulators are:

- Based on the theories of occlusion.
- Based on the type of inter-occlusal record used.
- Based on the ability to simulate jaw movements.
- Based on the adjustability of the articulator.

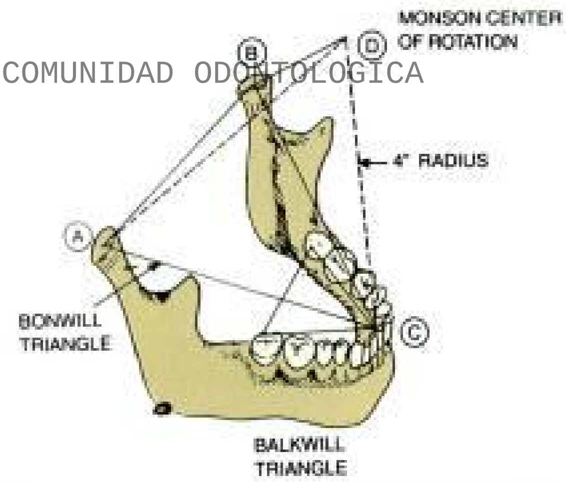
Articulators Based on Theories of Occlusion

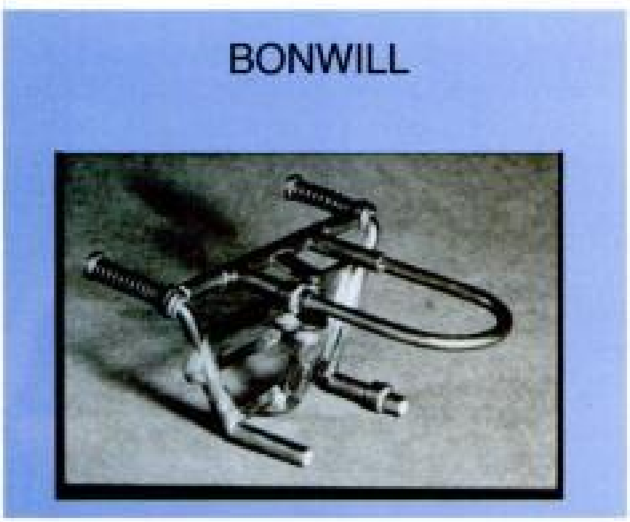
Bonwill theory articulators

- This articulator was designed by WGA Bonwill.
- According to the Bonwill's theory of occlusion the teeth move in relation to each other as guided by the condylar and the incisal guidances.
- Bonwill's theory is also known as the *Theory of equilateral triangle* according to which, the distance between the condyles is equal to the distance between the condyle and the midpoint of the mandibular incisors (incisal point).
- An equilateral triangle is formed between the two condyles and the incisal point. Theoretically, the dimension of the equilateral triangle is 4 inches (Fig. 10.2).
- Bonwill articulators allow lateral movement and permit the movement of the mechanism (joint) only in the horizontal plane.

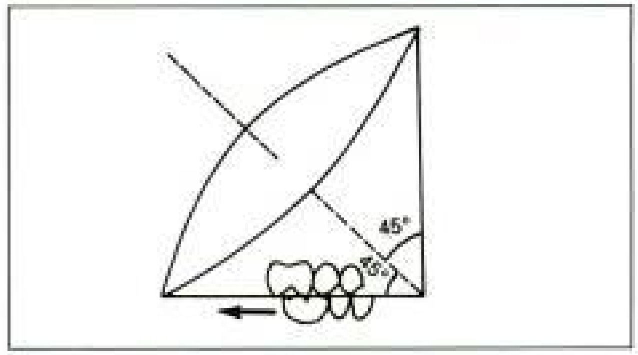
Conical theory articulators (proposed by RE Hall)

- The conical theory of occlusion proposed that the lower teeth move over the surfaces of the





Figs 10.2a and b: Bonwill theory articulators are designed such that the occlusal determinants (here incisal and condylar guidance) fall within an equilateral triangle measuring 4 inches at its sides



Figs 10.3a and b: The RE Hall articulator is designed such that teeth move as described by the conical theory

upper teeth as over the surface of a cone, generating an angle of 45-degrees with the central axis of the cone tipped 45° to the occlusal plane (Fig. 10.3).

- The Hall automatic articulator designed by RE Hall follows the conical theory of occlusion.

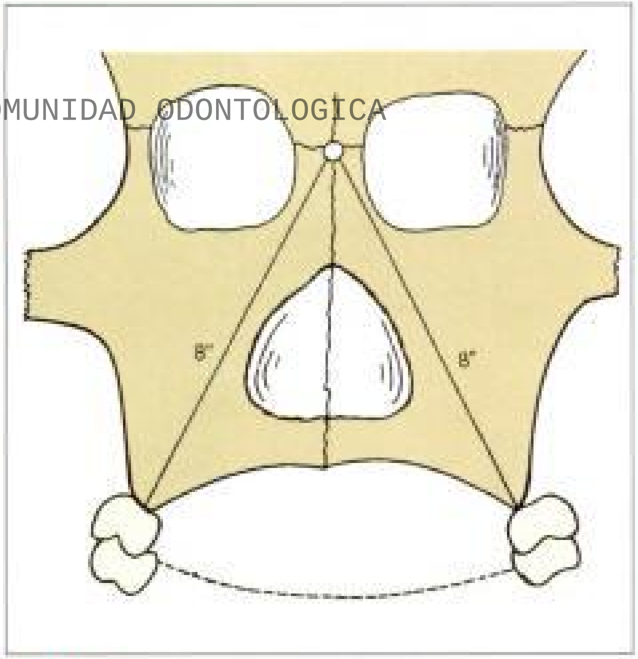
Spherical theory articulators

- The spherical theory of occlusion proposed that lower teeth move over the surface of upper teeth as over a surface of sphere with a diameter of 8 inches (Fig. 10.4a).
- The centre of the sphere was located in the region of glabella. The surface of the sphere passed through the glenoid fossa and along with the articulating eminences.
- The articulator devised by G.S. Monson operated on the spherical theory of occlusion (Fig. 10.4b).

Disadvantages of articulators based on theory of occlusion These articulators are based on theoretical concepts. There is no provision for variations from the theoretical relationships that occur in different persons.

Articulators Based on the Type of Record Used for Their Adjustment

Articulators are specifically designed to accept different jaw relation records. Based on the type of record accepted by the articulator, they are classified as:



Figs 10.4a: Spherical theory articulators are designed such that the teeth can be arranged to lie on the surface of a sphere of 4 inch radius with its centre at the glabella

Fig. 10.4b

Inter-occlusal record adjustment

Most articulators are adjusted by some kind of inter-occlusal records. These records are made of base plate wax, Plaster of Paris, zinc oxide eugenol paste or cold-cure acrylic resin.

Graphic record adjustment

- Graphic records consist of records of the extreme border positions of mandibular movements.
- These articulators are capable of accurately reproducing the border movements of the mandible.
- The face-bow and Jaw-writing apparatus (pantograph can be attached to transfer the records).
- Hinge-axis location for adjusting articulators: *A transographic record* can be used to record the accurate location of the hinge axis in an articulator.

Based on the Ability to Simulate Jaw Movements

Some articulators show three-dimensional movements but some show only single-dimensional movements. At the International Prosthodontic Workshop on complete denture occlusion at the University of Michigan in 1972, the articulators were classified based on the instrument's capability, intent, recording procedure and record acceptance. This is the most widely used classification.

Class I These are simple articulators capable of accepting a single static registration. Only vertical motion is possible. These articulators are used in cases where a tentative jaw relation is done, e.g. Slab articulator, Barndoor articulator.

Class II These articulators permit horizontal and vertical movements but they do not orient the movement to TMJ with a face-bow.

- *Type A:* Limited eccentric motion is possible based on the average values. Eg: Mean-Value articulator
- *Type B:* Limited eccentric motion is possible based on theories of arbitrary motion. Eg: Monson's articulator, Hall articulator.
- *Type C:* Limited eccentric motion is possible based on engraving records obtained from the patient. Eg: House's articulator.

Class III These articulators permit horizontal and vertical movements. They **do** accept face-bow transfer but this facility is limited. They cannot allow total customization of condylar pathways. These instruments simulate condylar pathways by using average or mechanical equivalents for the whole or part of the condylar motion.

- *Type A:* They accept a static protrusive registration, and they use equivalents for other types of motion, e.g: Hanau H, Hanau II Bergstrom articulator.
- *Type B:* They accept static lateral protrusive registration, and they use equivalents for other types of motion, e.g: Panadent, Trubite, Teledyne Hanau university series.

Class IV These articulators accept three-dimensional dynamic registrations. They are capable of accurately reproducing the condylar pathways for each patient. They allow point-orientation of the casts using a face-bow transfer.

- *Type A:* The condylar path is determined by the engraving registrations produced by the patients. This path cannot be modified. Eg: TMJ articulator.
- *Type B:* They are similar to type A but they allow angulations and customization of the condylar path. Eg: Stuart instrument gnathoscope.

Based on the Adjustability of the Articulator

Based on the adjustability, articulators can be classfied as:

- Non-adjustable
- Semi-adjustable
- Fully-adjustable

Non-adjustable articulators (Fig. 10.5)

- They can open and close in a fixed horizontal axis.
- They have a fixed condylar path along which the condylar ball can be moved to simulate lateral and protrusive jaw movement.
- The incisal guide pins ride on an inclined plate in a fixed inclination.

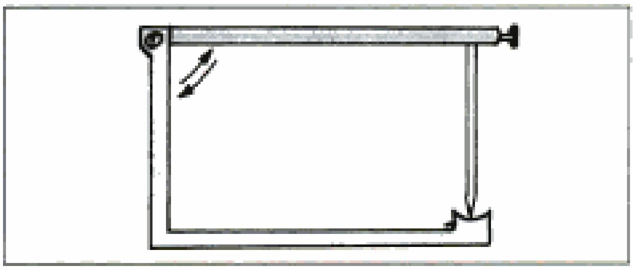


Fig. 10.5: Schematic diagram showing a non-adjustable articulator that is capable of showing only opening and closing movement

Semi-adjustable articulators

They have adjustable horizontal condylar paths, adjustable lateral condylar paths, adjustable incisal guide tables and adjustable intercondylar distances. The degree and ease of these adjustments differ. There are two types of semi-adjustable articulators:

- Arcon articulators
- Non-arcon articulators.

Arcon articulators (Fig. 10.6) The term *'arcon'* was derived by Bergstrom from the words *articulator* and *condyle*. E.g. Hanau University series and Whip-mix articulators.

The condylar element is attached to the lower member of the articulator and the condylar guidance is attached to the upper member. This articulator resembles the temporomandibular

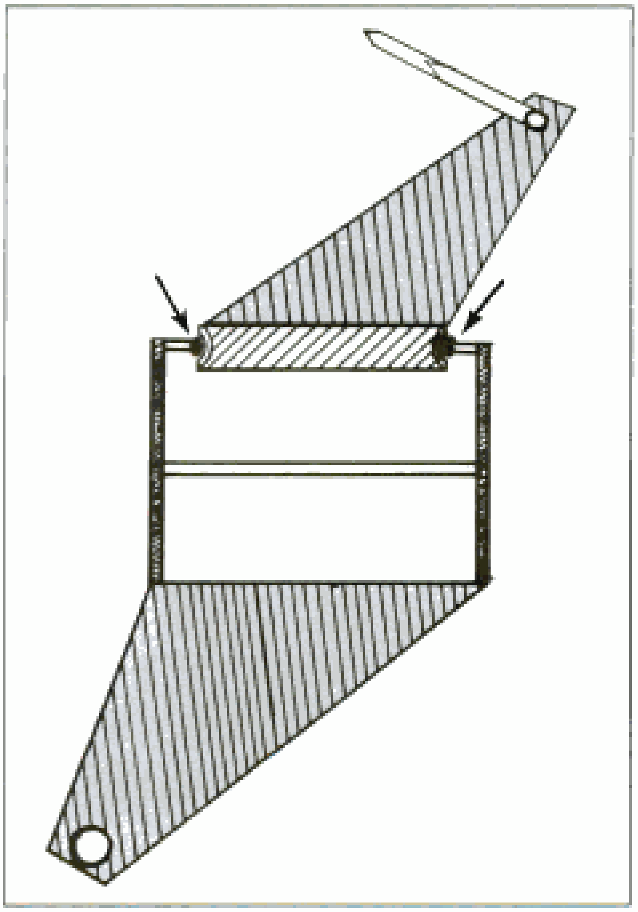


Fig. 10.6: Schematic diagram showing an " ARCON " articulator where the condylar elements are attached to the lower member

joint. *(Here, the condylar guidance is the mechanical analog of the glenoid fossa).*

Advantages of arcon articulators The face-bow transfer, occlusal plane and the relationship of the opposing casts are preserved when the articulator is opened and closed.

Non-arcon articulators

- These articulators have the condylar elements attached to the upper member.
- The condylar guidance is attached to the lower member.
- This articulator is the reverse of the temporomandibular joint.
- Some examples include Hanau H series, Dentatus and Gysi.

Fully Adjustable Articulators (Fig. 10.7)

They are capable of being adjusted to follow the mandibular movement in all directions. These articulators have numerous adjustable readings, which can be customized for each patient. They do not have a condylar guidance. Instead they have receptacles in which acrylic dough can be contoured to form a customized condylar and incisal guidance. They are not commonly used due to their complexity. E.g. Stuart instrument gnathoscope, Simulator by E.Granger.

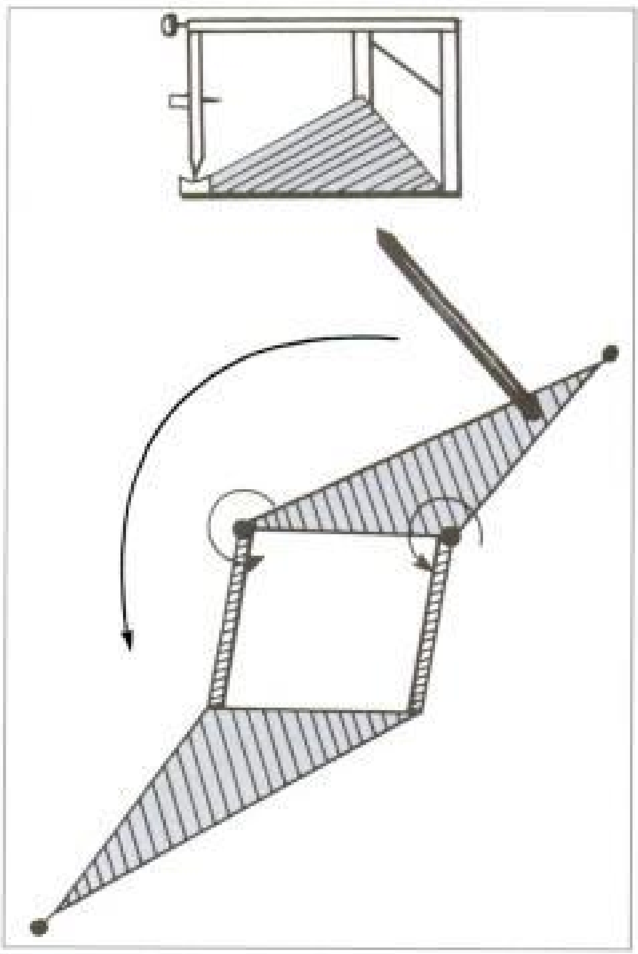
Fig. 10.7

Structure of an Articulator

Generally an articulator can be described as a trianguloid apparatus. It consists of an upper member and a lower member. The upper member represents the maxilla and the lower member represents the mandible.

The upper member is a triangular metal plate and the lower member is a 'L' shaped frame. The upper and lower members articulate around the condylar guidance. The condylar guidance represents the glenoid fossa of the temporomandibular joint.

A vertical rod (incisal pin) separates the upper and lower triangular components in the anterior end. The vertical rod rests on the incisal table of the lower member also known as the incisal guide table (Fig. 10.8).



Figs 10.8a and b: Schematic representation of a basic simple articulator

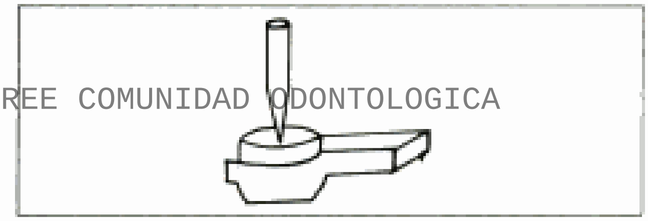


Fig. 10.8c: Incisal guide table of an articulator

In this section we shall study in detail about the structure of a mean value and Hanau Wide Vue semi-adjustable articulators.

Mean Value Articulator

It is a non-adjustable articulator. This articulator is designed using fixed dimensions, which are derived from the average distance between the incisal and condylar guidance of the population.

The condylar guidance (equivalent of glenoid fossa) is attached to the lower member and the condylar element (equivalent of the mandibular condyle) is attached to the upper member, hence, it is a non-arcon articulator. Now, we shall discuss in detail about the various components of this articulator.

Upper member It is a triangular frame with the base of the triangle placed posteriorly. The apex of the triangle contains a provision to accommodate the vertical rod (incisal pin). The vertical rod can be locked in position within the upper member with the help of a thumbscrew.

Two condylar elements are seen projecting on either side of the base of the triangle. They articulate with the condylar guidance of the lower member. The maxillary cast is attached to the upper member during articulation (Fig. 10.9).

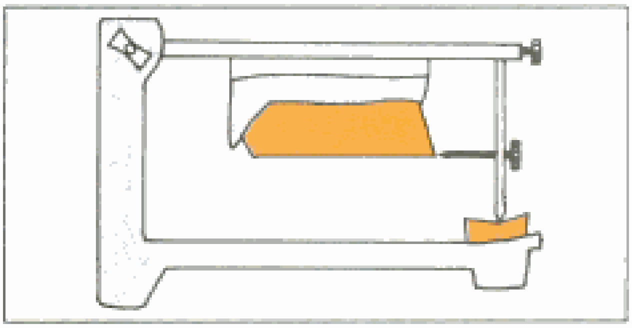


Fig. 10.9a: Diagram showing an articulated maxillary cast to the upper member of a mean value articulator

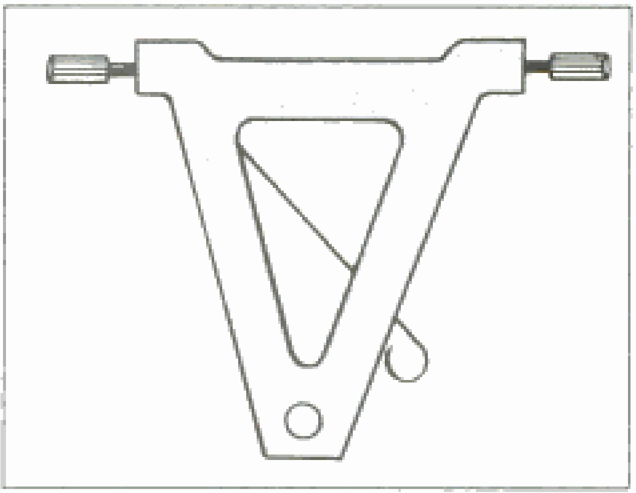


Fig. 10.9b: Triangular upper member with projecting condylar elements on the side. The circle at the apex of the triangle denotes the location of the vertical rod or incisal pin. (please do not confuse an incisal pin with an incisal guide pin)

Lower member It is a 'L' shaped frame with a horizontal and a vertical arm. The horizontal arm is triangular in shape and corresponds to the upper member. The apex of the triangle of the horizontal arm contains the incisal guide table. The vertical arm is rectangular containing the condylar guidance slot at the upper portion (Fig. 10.10).

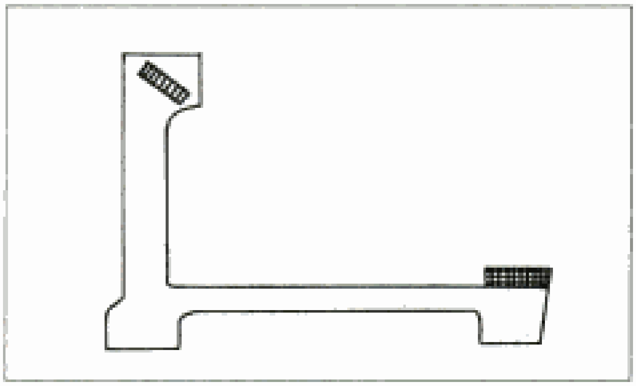


Fig. 10.10: Lower member of a mean value articulator showing the incisal guidance at the free end of the horizontal arm and the condylar guidance at the superior end of the vertical arm

Though the incisal and condylar guides are a part of the lower member they have been described separately. A fixed metal bar (horizontal bar) is present in the vertical arm of the lower member. The plane of occlusion should coincide with this horizontal bar during articulation.

Incisal guide table or anterior guidance of the articulator (*Read 'incisal guidance and condylar guidance of the patient' explained in factors controlling mandibular movements before proceeding*).

Incisal guide Table is defined as, *"That part of the articulator which maintains the incisal guide angle"* - GPT. The incisal guide table gives the incisal guidance of the articulator. The incisal guide table can be described as a very short cylinder whose upper surface is concave. The vertical rod should rest on the centre of the incisal guide table during articulation. The depth of the concavity is designed to have a slope equal to the average incisal guide angle (Fig. 10.11). The incisal guide angle is fixed and non-customizable.

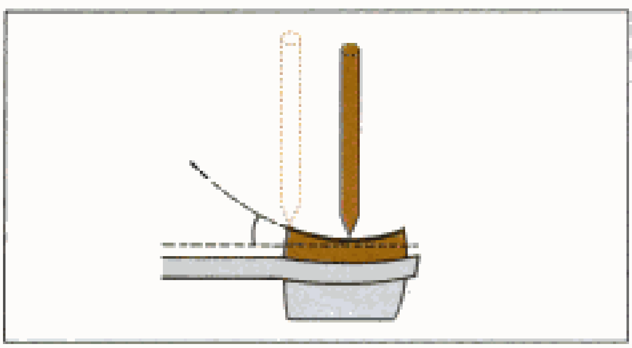


Fig. 10.11a: Incisal guidance of a mean value articulator

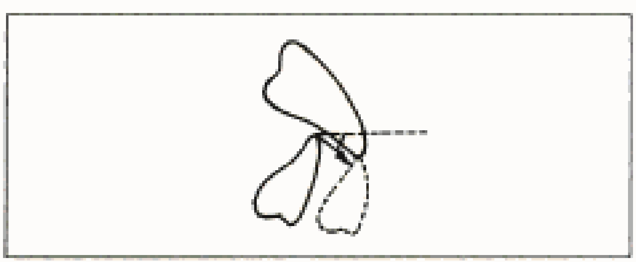


Fig. 10.11b: Incisal guidance of the arranged artificial teeth. It should coincide with the incisal guidance of an articulator to avoid interference during protrusive movement

Condylar guidance As the name suggests, it guides the movement of the condyle. In the mean value articulator, it is represented by a slot (condylar track) located in the upper part of the vertical arm of the lower member. The slot is inclined at an angle equal to the average inclination of the condylar guidance in the population.

The condylar element of the upper member passes through this track. A spring is mounted within this track (condylar guidance) to stabilize the condylar elements and hold them in their posterior most position (centric relation) when no movements are made. This condylar guidance does not accept face-bow transfer (Fig. 10.12).

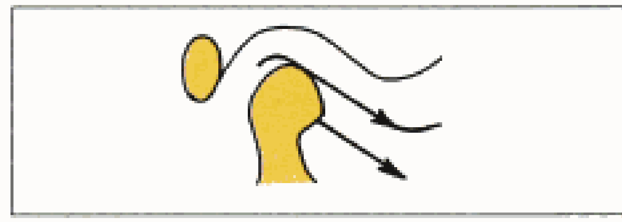


Fig. 10.12a: Condylar guidance of the temporomandibular joint

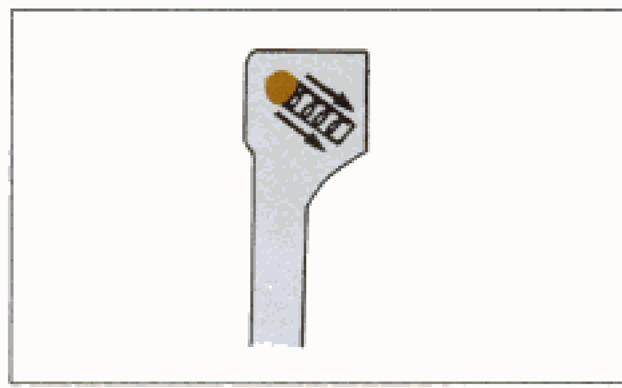


Fig. 10.12b: Condylar guidance of a mean value articulator. Its angulation should be equal to that of the temporomandibular joint. In a mean value articulation, it's not alterable and is based on the average condylar guidance value of most patients (hence the name)

Vertical rod or incisal pin It helps to keep a fixed distance between the upper and lower members at the anterior end. The vertical rod has a pointed tip, which should rest on the center of the incisal guide table during articulation.

At the midpoint of the vertical rod a hole is provided to fit the *incisal guide pin*. The tip of the incisal guide pin is the anterior reference point in this articulator. The incisal edge of the maxillary incisors at the midline of the occlusal rim should touch the tip of the incisal pin during articulation (Fig. 10.13). The upper flat surface of the vertical rod should always be locked flush with the superior surface of the upper member.

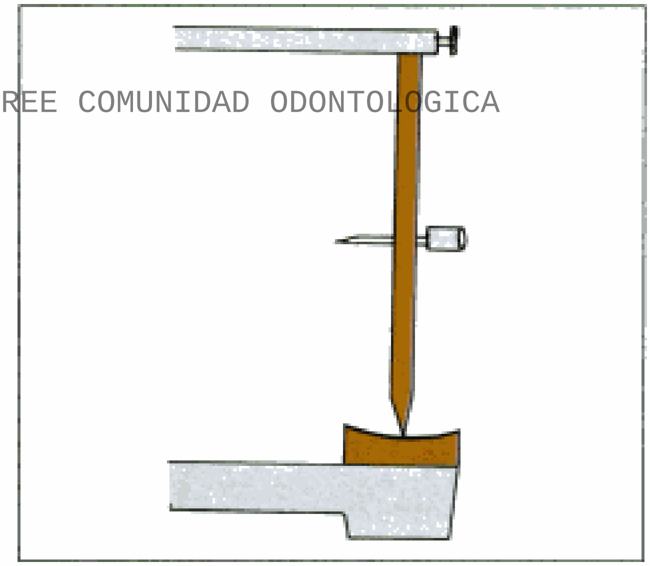


Fig. 10.13: Schematic diagram showing a incisal guide pin attached to the incisal pin of a mean value articulator

Hanau Wide Vue Articulator

It is a semi-adjustable arcon articulator. It is one of the most commonly used instruments. It accepts face-bow transfer and is capable of hinge and lateral movements. The design of the articulator is very complex, hence, only the important parts have been described to avoid confusion.

Upper member It is 'T' shaped when placed horizontally. The vertical arm of the 'T' runs antero-posteriorly and the horizontal arm runs transversely. The anterior end of the vertical arm has a provision to accept the incisal pin (incisal pin in a Hanau denotes the vertical rod described in a mean value articulator). The condylar guidance of the articulator is attached to the upper member (Transverse arm of T). On the center of the under surface of the upper member dowels are present to attach a mounting ring.

Near the dowels the orbital indicator is present. The orbital indicator is a curved metal shaft. It is the anterior reference point for the articulator. The orbital pointer of the face-bow should contact the orbital indicator during articulation. The position of the orbital indicator can be locked using a thumbscrew (Fig. 10.14).

Lower member It is 'L' shaped with a horizontal and a vertical arm. The horizontal arm is a

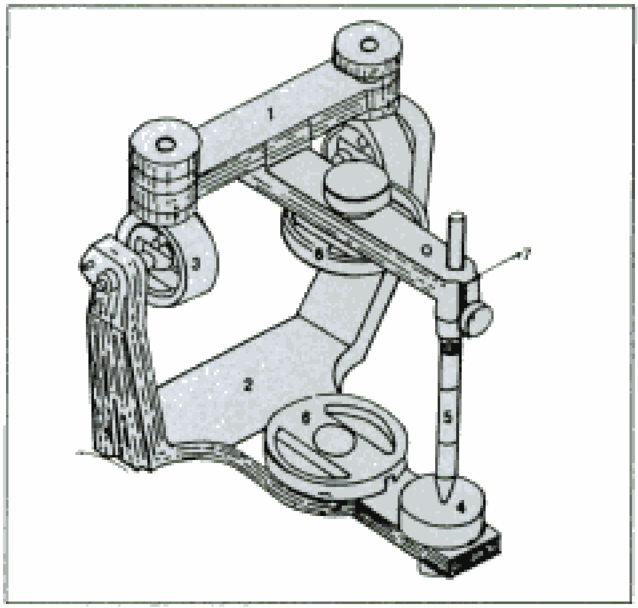


Fig. 10.14a: A semiadjustable Hanau's 'ARCON' articulator. Key: (1) Upper member, (2) Lower member, (3) Condylar guidance (4) Incisal guidance, (5) Incisal pin, (6) Mounting plates, (7) Condylar elements

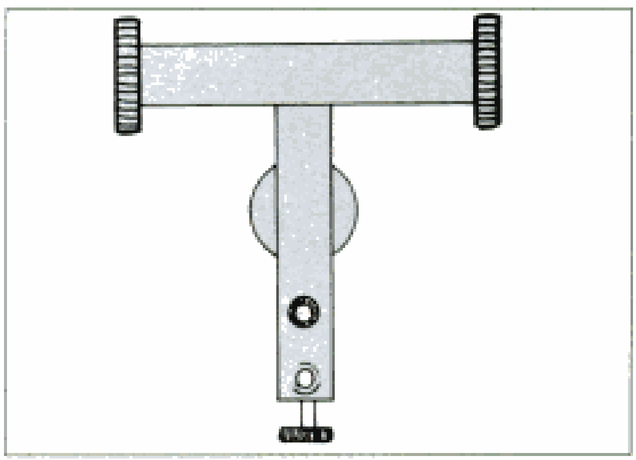


Fig. 10.14b: Schematic diagram representing the upper member of a Hanau Wide Vue articulator

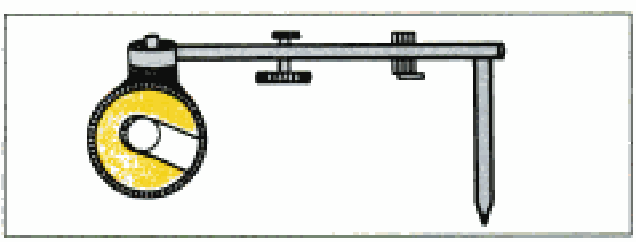


Fig. 10.14c: Lateral view of the upper member. The condylar guidance, mounting plate are visible. Anterior to the mounting plate, is the orbital indicator of the articulator

rectangular metal strap. The center of the lower member has a provision (dowel) for attaching a mounting ring and also a stand or pivot. The pivot holds and prevents vertical displacement of the upper occlusal rim during articulation (*during articulation dental plaster is loaded on the maxillary cast and the upper member of the articulator is pressed over it. This usually pushes the occlusal rim down*). The incisal guide table is located at the anterior end of the horizontal arm (Fig. 10.15).

The vertical arms slope outward and give a good lingual view. The upper portion of the

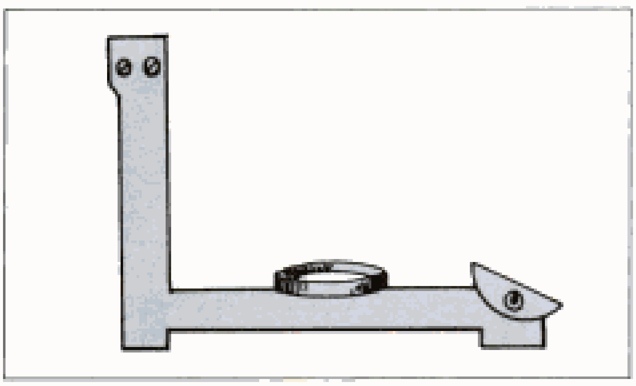


Fig. 10.15a: Schematic diagram representing the lower member of a Hanau Wide Vue articulator. The adjustable incisal guidance is present at the anterior end of the horizontal arm. The roll pin is found posterior to the attachment of the condylar element

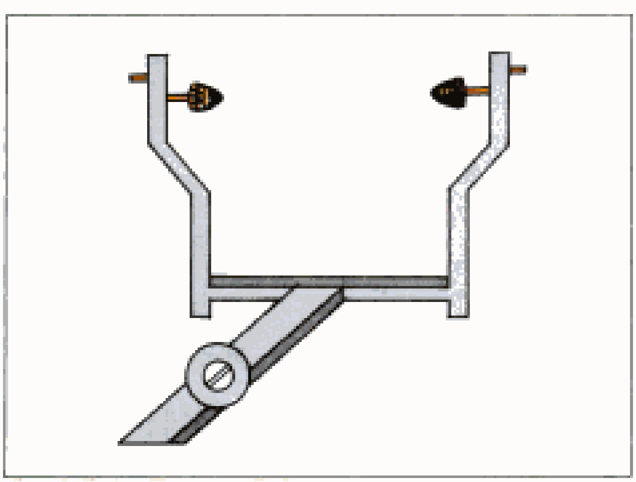


Fig. 10.15b: Anterior view of the lower member. (Note the condylar elements are found projecting on the inner aspect of the vertical arm and the roll pins are found projecting on the outer aspect)

vertical arm contains a *rollpin or auditory pin*. The rollpin is a small fixed metal pin which projects on the outer surface of the vertical arm. The earpiece of the face-bow will fit into these rollpins during articulation. It is the posterior reference point of the articulator.

The condylar shaft is seen attached to the inner surface of the vertical arm 12 to 13 mm anterior to the rollpin. The *condylar shaft* is a cylindrical piece of metal capable of free rotation. The condylar element is attached to the free end of the condylar shaft. The condylar element is a metal ball, which represents the condyle of the mandible. Since the condylar element is attached to the lower member, this articulator is described as an arcon articulator. The condylar element articulates with the condylar guidance (slot or track) to represent the temporomandibular joint (Fig. 10.16).

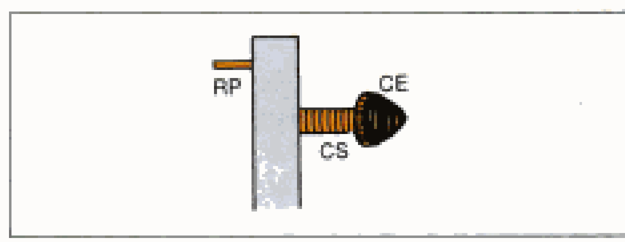


Fig. 10.16: Schematic diagram depicting the right vertical arm of the lower member. Note the condylar element and the roll pins

Condylar guidance It is attached to the upper member of the articulator. It represents the glenoid fossa of the temporomandibular joint. As previously mentioned, its name suggests that it guides the movement of the condyle. It is a very complex assembly of important components. It articulates with the condylar element of the lower member. It can be rotated in both coronal and vertical axis (Fig. 10.17).

The condylar guidance is a circular structure with a slot in the centre. The condylar element of the lower member articulates with this slot (also called condylar track) (Fig. 10.18). The condylar track can be opened or closed. Closed track condylar guidance has a complete circular structure. Open track condylar guidance is not a complete circle; the track opens out at one side

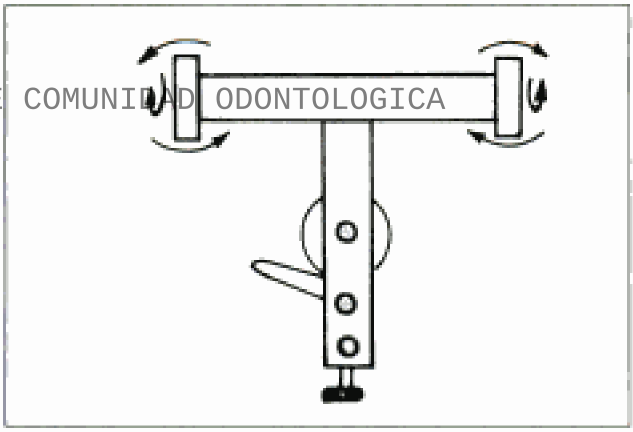


Fig. 10.17: The condylar guidance in the upper member is capable of rotation in both vertical and transverse axis

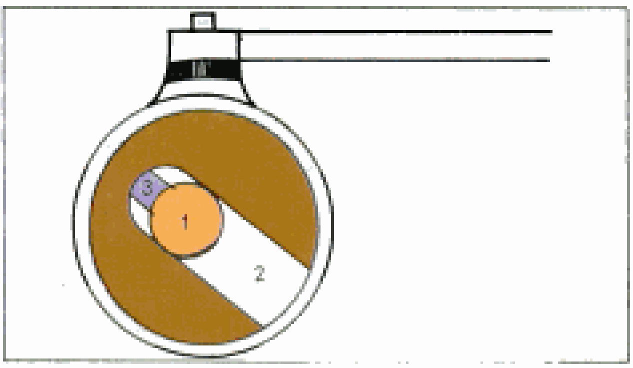


Fig. 10.18: Closed track condylar guidance. Key: (1) Condylar element (Lower member) (2) Condylar track (3) Centric stop (4) Condylar rim

giving it a 'U' shape. Open tracks facilitate easy removal and reattachment of the upper member of the articulator (Fig. 10.19).

The inclination of the condylar track can be customized for each patient. The actual path of the condyle can be measured using a pantograph in three dimensions. The condylar track can be rotated only in the coronal axis.

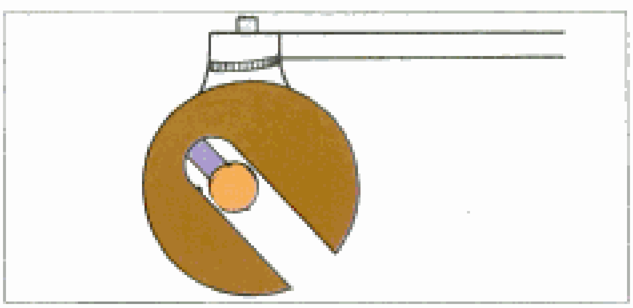


Fig. 10.19: Open track condylar guidance: Key: Same as 10.18 except that the condylar rim is open

The posterior end of the condylar track has a component known as the *centric stop*. The condylar element should contact the centric stop during articulation. The condylar guidance can be rotated around the vertical axis to set the Bennett angle. Bennett angle is determined by the following formula: Bennett angle (L)= (H/8) + 12. where H is the protrusive angle. With the help of a protrusive positional record, the horizontal angle is set on the condylar guidance by rotating it. The lateral angle is calculated with the above formula. The articulator is programmed by adjusting the graduated scale on its superior surface.

Incisal guide table The Hanau Wide Vue has a customizable incisal guide table. Just like the condylar guidance, the incisal guide table is also an assembly of many components. The important components of the incisal guide table are alone described here.

The platform of the articulator forms the base of the incisal table. The adjustable incisal guide table rests on top of the platform. The incisal guide table alone is a small rectangular strip of metal. The slope of the incisal guide can be changed in the antero-posterior direction. It is locked in position with a lock nut placed under the platform. During articulation, the incisal guide table should be flat and the incisal pin should be at its center (Fig. 10.20).

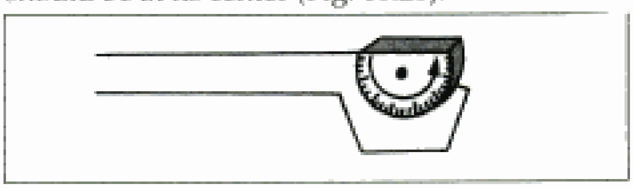


Fig. 10.20a: Schematic representation of the lateral view of the incisal guidance. The incisal guidance is kept horizontal

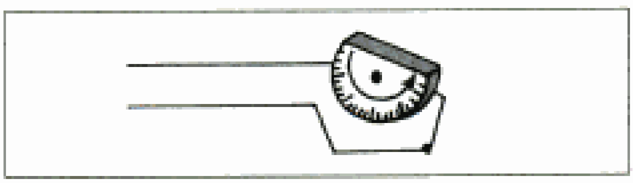


Fig. 10.20b: Schematic representation of the lateral view of the incisal guide table. The incisal guide table can be tilted as required in the transverse axis

A pair of lateral wings is present around the incisal guide table. The lateral wings can be sloped towards the centre of the incisal guide table according to the lateral guidance required with the help of elevating screws (Fig. 10.21).

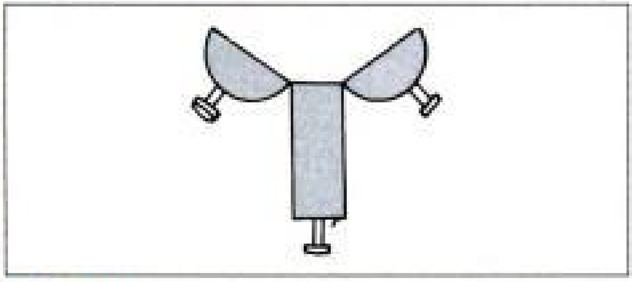


Fig. 10.21: Schematic representation of the cross-section of the incisal guide table. The central rectangular portion and two lateral wings are visible. The whole assembly can be rotated in the transverse axis. The inclination of the lateral wing can be altered to elicit the excursive movements

Procedure for setting the incisal guidance

- Incisal guidance is set only after anterior try-in. The anterior teeth are arranged on the occlusal rims using standard principle. If the overjet, overbite and the aesthetics are not acceptable, the setting is modified till an acceptable result is obtained (Fig. 10.22).

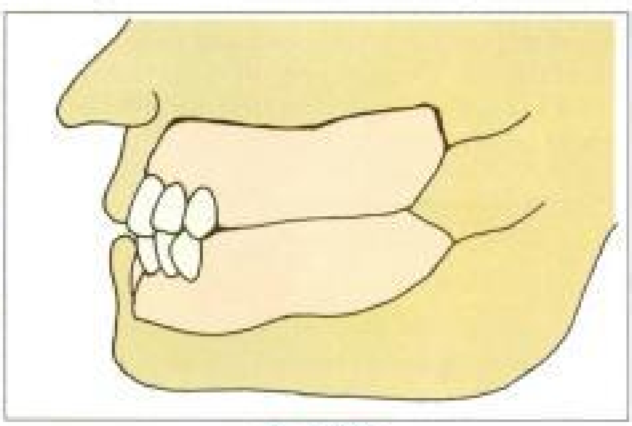


Fig. 10.22a

- After try-in verification, the patient is asked to move his mandible forward till the incisors come to an edge-to-edge relationship. The position of the anterior teeth should be altered to achieve balanced occlusion (Ref. balanced occlusion) (Fig. 10.23).
- The occlusal rims are transferred to the articulator and the same movement is repeated. When the teeth are in edge-to-edge relationship, the incisal pin will not touch the incisal guide table (Fig. 10.24).
- The incisal table should be rotated till it contacts the incisal pin (Fig. 10.25).

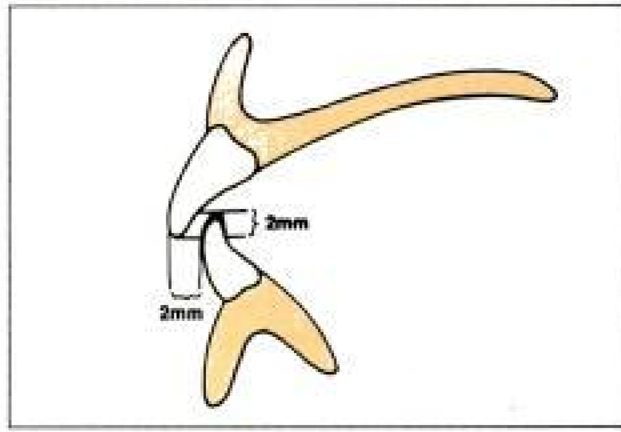
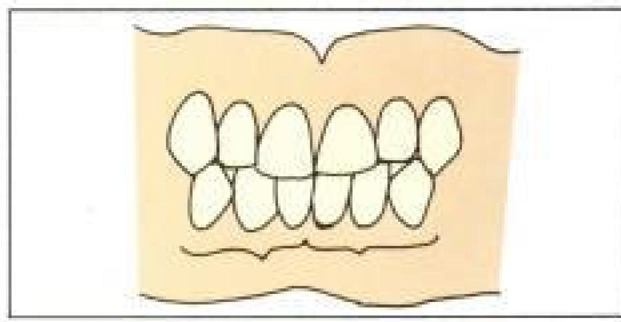
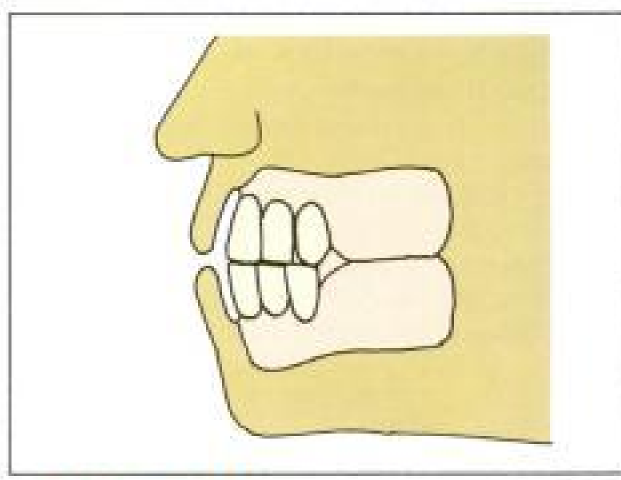


Fig. 10.22b

Figs 10.22a and b: The anterior teeth arrangement should be tried – in and the overjet and overbite should be adjusted prior to setting the incisal guidance in an articulator





Figs 10.23a and b: Diagram showing edge-to-edge relationship of the artificial teeth during trial

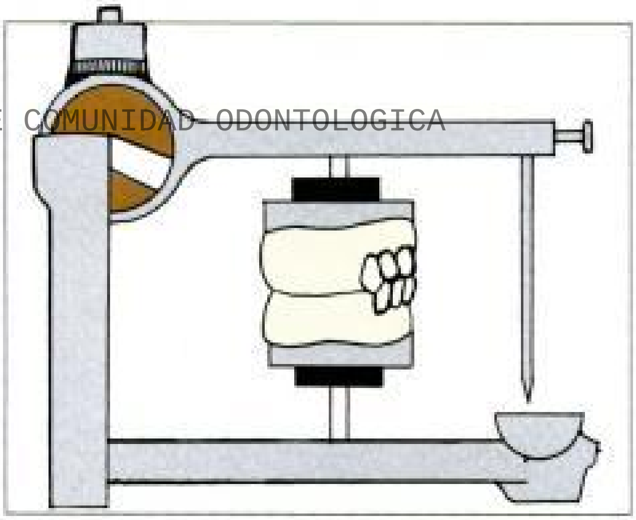


Fig. 10.24: After trial, the denture bases should be placed on their respective casts in the articulator. Note: when the teeth are moved to an edge-to-edge relationship, the incisal pin will not contact the incisal guide table

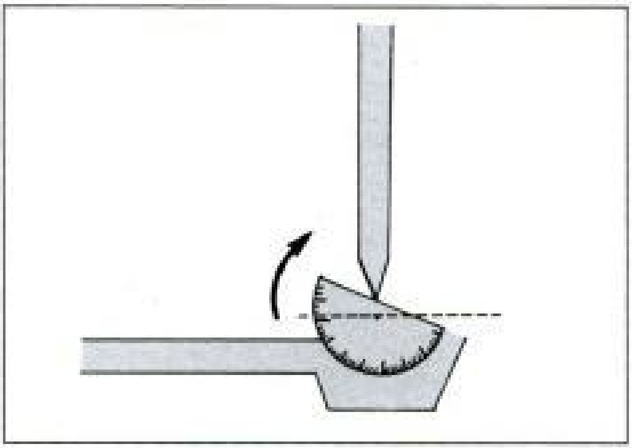


Fig. 10.25: The incisal guide table should be rotated in its transverse axis till it touches the incisal pin. Now the protrusive incisal guidance is set

- After recording the protrusive incisal guidance, the patient is asked to move his mandible to the right (to reach an edge-to-edge canine relationship) till there is disocclusion elsewhere and the position is noted. The mandible should not be moved beyond the point of disocclusion (Fig. 10.26).
- The occlusal rims are transferred to the articulator and the same movement is carried out. During lateral disocclusion, the incisal pin will raise from the table . The upper member is held firm in this position and the lateral

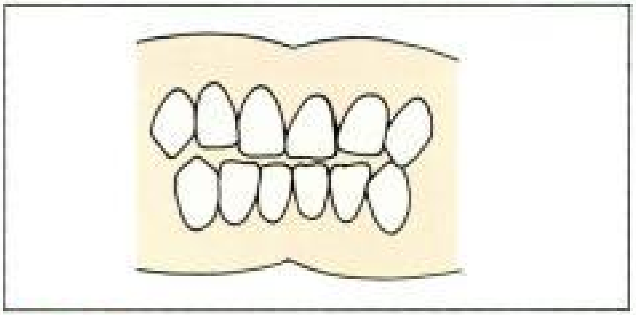


Fig. 10.26: After setting the protrusive incisal guidance the teeth are moved till the contralateral canines come to an edge to edge relation (laterotrusion)

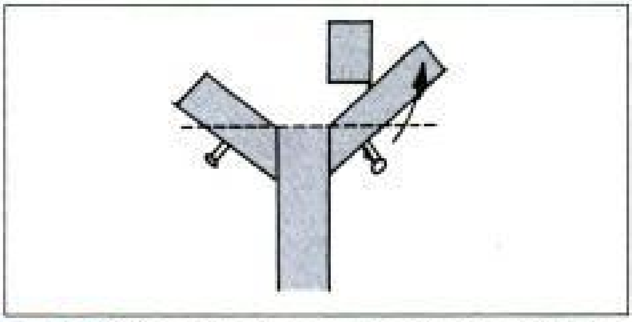


Fig. 10.27: When the teeth are at a laterotrusive relationship, the incisal pin will not touch the incisal guide table. The lateral wings of the incisal guide table should be inclind till they touch the incisal pin. Now the lateral incisal guidance is set

wing of the incisal guidance is elevated till one edge of the incisal pin rests on it (Fig. 10.27).
- The procedure is repeated for the contralateral side.

Incisal pin It is equivalent to the vertical rod described in the mean value articulator. It is a double-sided pin. One end is sharp but chisel-like with a flat edge. The other end tapers to a pointed-tip. Usually the flat end is used. The pointed-end is used in cases where more customization of the incisal guidance is required like in fully adjustable articulators. The flat end should rest on the center of the incisal guide table.

The incisal pin has series of markings closely placed in one end and two widely-spaced markings in the other end. The upper member of the articulator should be at the level of the darkest marking of the close markings. The spaced-out markings act as the anterior reference point in the absence of face-bow transfer (Fig. 10.28).

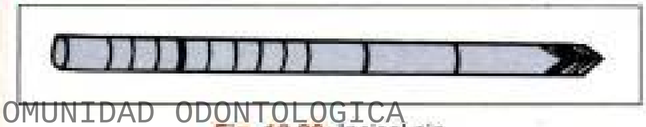


Fig. 10.28: Incisal pin

MOUNTING PROCEDURE

- Zeroing the articulator
- Mounting the maxillary cast
- Mounting the mandibular cast
- General consideration

The procedure of attaching the maxillary and mandibular casts to the articulator in their recorded jaw relation is called articulation.

The maxillary cast is first articulated after orientation jaw relation with the help of a face-bow. The mandibular cast is articulated after recording the vertical and centric jaw relations.

Zeroing or Resetting the Articulator

Before articulation, the articulator should be checked for the following factors:

- The movable surfaces of the articulator should move freely without any hindrance.
- The incisal pin of the articulator should be tightly fitted at the level of the darkest marking in the pin.
- The condylar track in the condylar guidance should be inclined to 30°. If an accurate value is measured with a pantograph, then that value is used to determine the condylar inclination. The Bennett angle is normally calculated and set along the vertical axis of the condylar guidance-but in this articulator, the Bennett angle is also set to 30° (Fig. 10.29).
- The incisal pin should be positioned to touch the zero point in the incisal guide table. The lateral wings are also set to the zero marking (Fig. 10.30).

Mounting the Maxillary Cast

The maxillary cast is attached to the articulator using the orientation jaw relation records. The procedure of transferring the orientation relation to the articulator is called *face-bow transfer*. After recording the orientation jaw relation, the following steps are carried out.

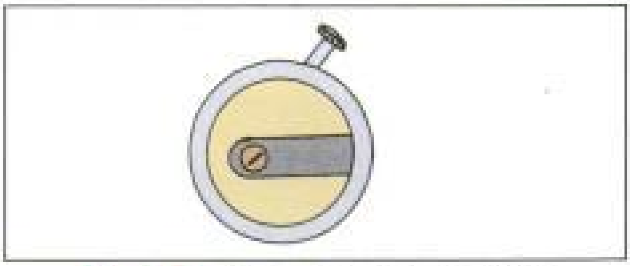


Fig. 10.29a: Horizontal condylar track at 0°

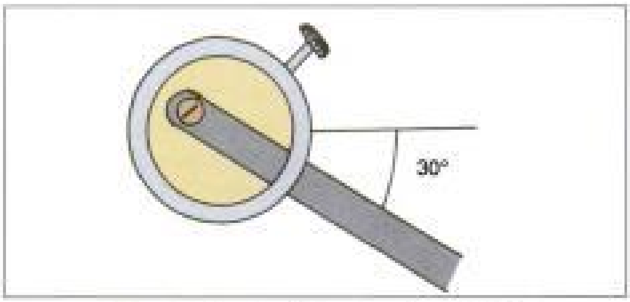


Fig. 10.29b: Condylar track set to 30°

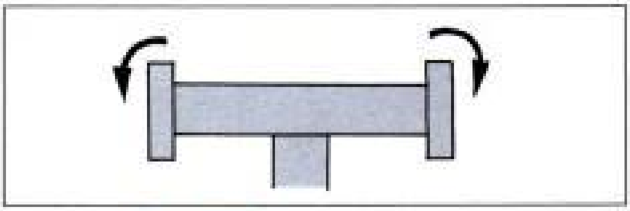


Fig. 10.29c: Bennett angle at 0°

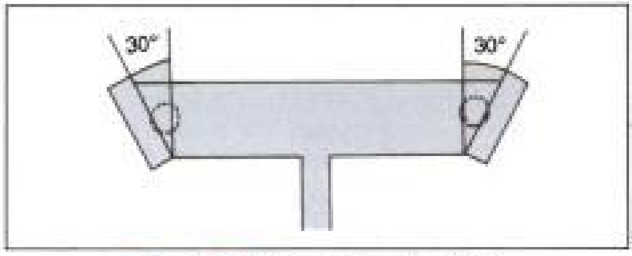


Fig. 10.29d: Bennett angle at 30°

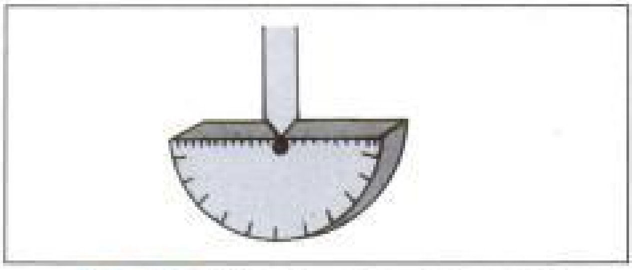


Fig. 10.30a: The horizontal plank is set at 0°

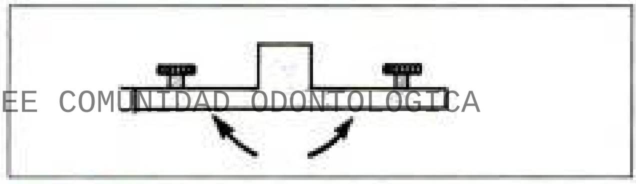


Fig. 10.30b: The lateral wings of the incisal guide table are set horizontal

- The face-bow with its bite fork attached to the maxillary occlusal rim is positioned in the articulator (Fig. 10.31).

Fig. 10.31: Face-bow transfer to an articulator

- First, the earpiece of the face-bow is attached to the rollpin of the articulator. This transfers the posterior reference point of the face-bow to the articulator (Fig. 10.32).

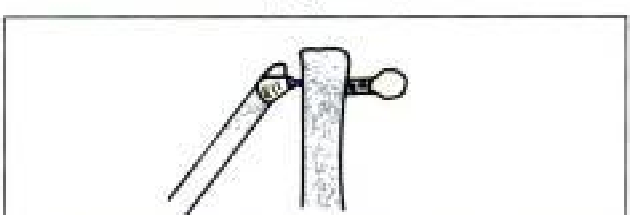


Fig. 10.32: The earpiece of the face-bow should be attached to the roll pin of the articulator

- After attaching the posterior reference points, the anterior reference points should be positioned by making the orbital indicator (attached to the upper member of the articulator) contact the orbital pointer of the face-bow (Fig. 10.33).

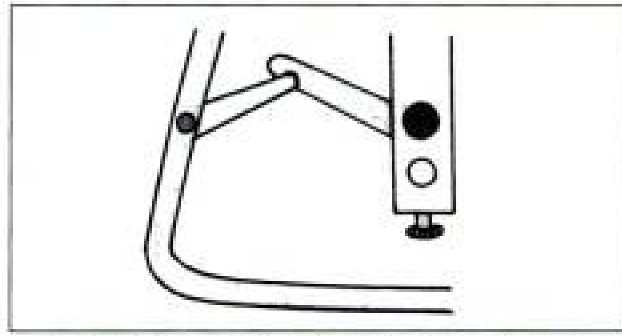


Fig. 10.33: The orbital pointer of the face-bow should touch the orbital indicator of the articulator

- The face-bow can be stabilized in this position with the help of a face-bow support, which will hold it in position. A pivot stand (cast support) attached to the lower member of the articulator also helps to prevent vertical displacement of the occlusal rim during articulation (Fig. 10.34).

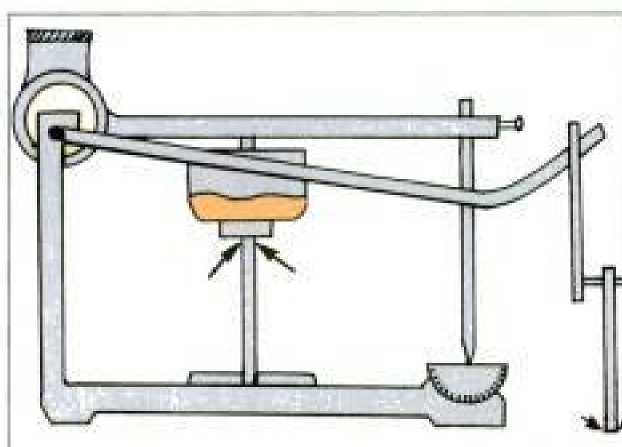


Fig. 10.34: Face-bow transfer is stabilised using an articulator pivot

- Once the face-bow support is attached, the upper member of the articulator can be opened. The upper member is opened completely so that it does not interfere with the placement of the cast (Fig. 10.35).
- The maxillary cast should be placed in slurry water for at least five minutes for better adhesion of the cast to the mounting plaster.

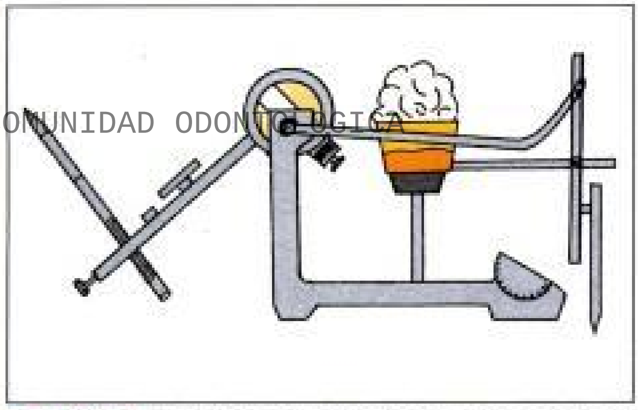


Fig. 10.35: Mounting the maxillary cast on the upper member. Dental plaster is loaded over the maxillary cast and the upper member should be closed

- The maxillary cast is placed onto the record base of the occlusal rim.
- A relatively thick mix of dental plaster is mixed and placed over the maxillary cast. If the cast is indexed with a remounting plate (Ref Chapter 8) then separating medium should be applied over the maxillary cast.
- The upper member of the articulator is closed and the mounting plaster is contoured to obtain a good finish (Fig. 10.36).

Mounting the Mandibular Cast

- The mandibular cast is mounted after recording the tentative vertical and centric jaw relations.
- The articulator with the mounted maxillary cast is inverted to aid in mounting the mandibular cast.
- The maxillary occlusal rim is placed on the maxillary cast. The mandibular occlusal rim is positioned over the maxillary occlusal rim using the centric relation records (Fig. 10.37).

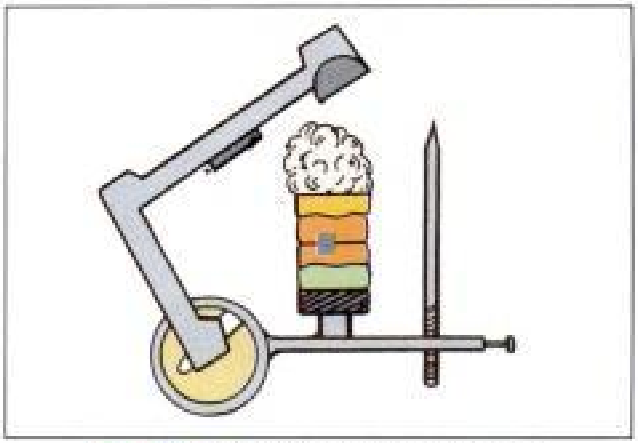


Fig. 10.37: Mounting the mandibular cast

- The mandibular cast is placed on the lower occlusal rim. (It should be soaked in slurry water before mounting).
- The mandibular cast is attached to the lower member of the articulator using dental plaster. The procedure is similar to that described for mounting the maxillary cast (Figs 10.38 and 10.39).

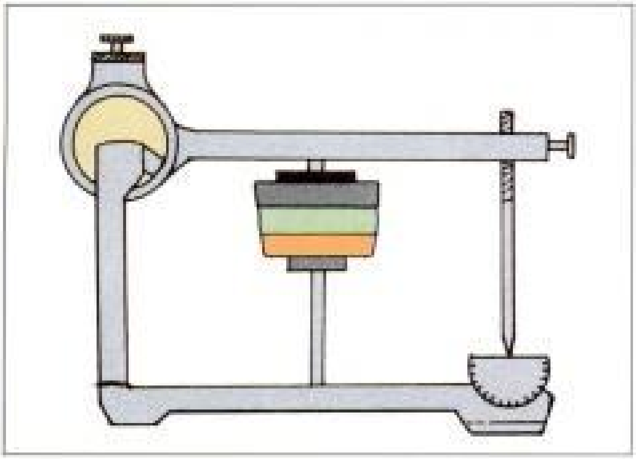


Fig. 10.36: The maxillary mount is contoured to have good line angles using a wax knife or plaster knife

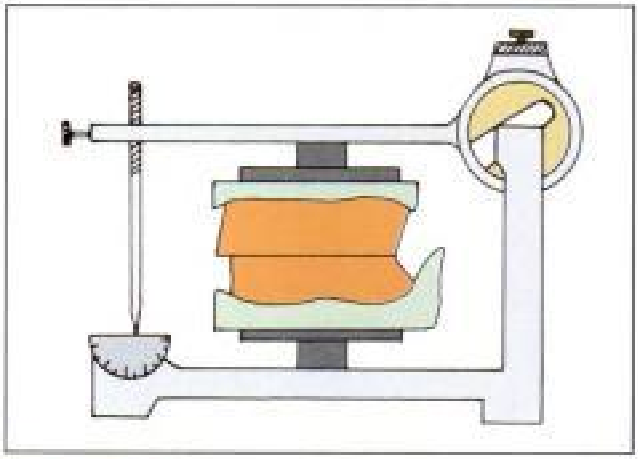


Fig. 10.38: The mandibular articulation is contoured as done for the maxillary cast

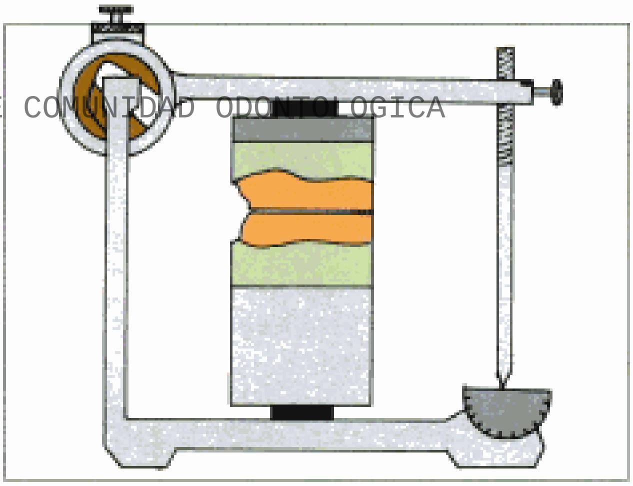


Fig. 10.39: Completed articulation

General Considerations

- After articulation, the anterior teeth are arranged and anterior aesthetic trial is completed. The incisal guide table is programmed on the articulator with the aid of the arranged teeth according to the phonetics and aesthetics of the patient.
- The articulator should be maintained to avoid errors in tooling that would produce discrepancies in occlusion.
- Excess plaster on the articulator should be cleaned.
- The moving parts should be lubricated periodically. Excess oil should not be present in the articulator.
- After articulation, the articulator should be wiped dry to avoid rusting.
- The articulator should **not** be stored in a closed chamber at least for an hour after articulation to prevent corrosion.

TEETH SELECTION

The next step in the fabrication of a complete denture after articulation is teeth arrangement. Before arrangement, the teeth should be selected. Artificial teeth are available in various forms and shades. Teeth selection is very important as the selection of the appropriate size, shape/occlusal form and colour/shade of the artificial teeth determines the aesthetics and the function of the denture. Aesthetics is a pleasurable feeling created within an individual against the perception of an object.

Objectives in Teeth Selection

- The teeth should be in harmony with the surrounding tissues.
- They should maintain the vertical dimension.
- They should be efficient for mastication.
- Posterior teeth should be selected based on function whereas the anterior teeth are selected predominantly based on aesthetics.

General Considerations in Teeth Selection

The following principles should be considered prior to teeth selection:

- The patient should be seated upright with his facial muscles relaxed.
- The operator should sit in front of the patient and adequate lighting should be used. Light source can be daylight, neon light or fluorescent light.

The selection of artificial teeth for a complete denture can be divided into two sections:

- Anterior teeth selection
- Posterior teeth selection

ANTERIORTEETH SELECTION

Anterior teeth play an important role in the aesthetics of a patient. They are not subjected to heavy occlusal load like the posteriors. Hence, aesthetics is given more importance during anterior teeth selection. The following factors are also considered during the selection of anterior teeth:

- Size of the teeth
- Form of the teeth
- Colour/shade of the teeth

Size of the Anterior Teeth

The tooth size should be appropriate to the size of the face and sex of the patient. The following methods are used as a guide to select the size of the teeth:

- Methods using pre-extraction records.
- Methods using anthropological measurements of the patient.
- Methods using anatomical landmarks.
- Methods using theoretical concepts.
- Other factors.

Methods Using Pre-extraction Records

The pre-extraction records like diagnostic casts, photographs, radiographs, teeth of close relatives and preserved extracted teeth can be used to determine the size of the artificial teeth.

Diagnostic casts They are prepared before the extraction of the teeth. The operator can obtain an idea about the size and shape of the teeth from these casts. The actual size and shape required can be determined but the shade of the teeth cannot be determined using this method.

Pre-extraction photographs Photographs showing the lateral, anterior and anterolateral views of the patient should be taken before extraction. These photographs must show at least the incisal edges of the anterior teeth. This method is useful to determine the exact width and outline of the teeth.

Pre-extraction radiographs This is usually obtained from the patient's previous dentist. Radiographic errors are a major limitation to this method. The occluso-gingival height and the outline of the teeth can be recorded. But the contour and size cannot be accurately determined, because the radiograph is a two-dimensional image.

Teeth of close relatives This method is usually followed only if the other records are not available. The size and contour of the patient's son or daughter's tooth is taken as reference.

Preserved extracted teeth This is the best method to determine the size of the anterior tooth. The exact details about the size and contour can be recorded from this method.

Methods using Anthropological Measurements of the Patient

Anthropological measurements are usually post-extraction records made directly from the edentulous patient. These methods measure certain anatomical dimensions and derive the size of the teeth using certain formulae.

Anthropometric cephalic index The transverse circumference of the head is measured using a measuring tape at the level of the forehead. The width of the upper central incisor can be derived from this measurement. Sears called this formula as the anthropometric cephalic index (Fig. 10.40).

$$\text{Width of the upper central incisor} = \frac{\text{Circumference of the head}}{13}$$

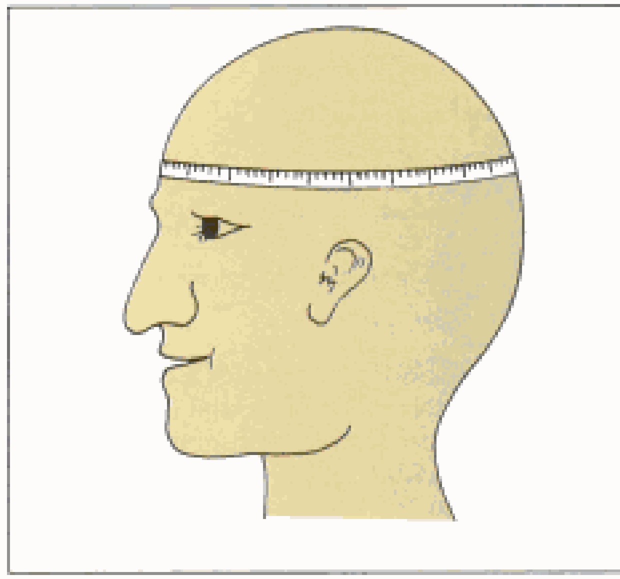


Fig. 10.40: Measuring the circumference of the head at the level of the forehead

The bizygomatic width can be used to determine the width of the central incisor and also the combined width of the anteriors. The bizygomatic width is the distance measured between the malar prominences on either side. This measurement is also used in Berry's Biometric index and H. Pound's formulae.

$$\text{Total width of the upper anteriors} = \frac{\text{Bizygomatic width}}{3.36}$$

$$\text{Total width of the lower anteriors} = \frac{4^{th}\ \text{the width of the upper anteriors}}{5}$$

Berry's Biometric index Berry's bimetric index is used to derive the width of the central incisor using the bizygomatic width and/or the length of the face. The formula using the length of the face cannot be used for edentulous patients. The length of the face is the distance measured between the hairline and the tip of the chin (Fig. 10.41).

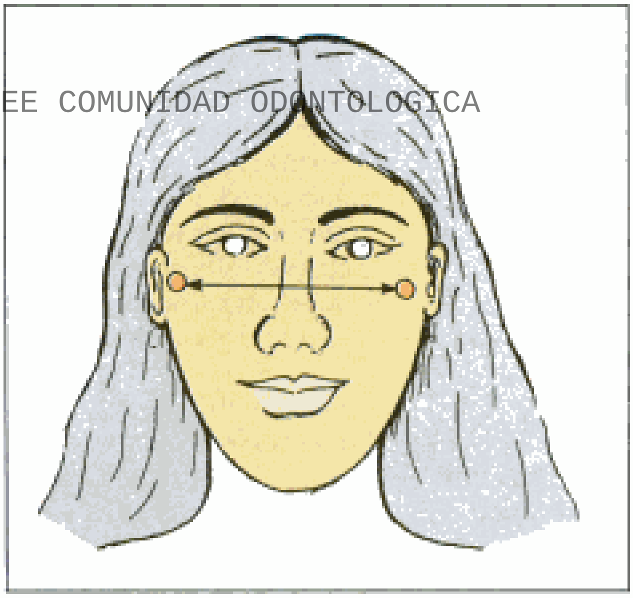


Fig. 10.41: Bizygomatic width

$$\text{The width of the maxillary central incisor} = \frac{\text{Bi-zygomatic width}}{16}$$

$$\text{The width of the maxillary central incisor} = \frac{\text{Length of the face}}{20}$$

Based on the size of the face This is a tentative measurement in which the size of the teeth is determined by the size of the face. For example, large teeth are selected for patients with a large face.

H. Pound's formula Pound derived two formulae to determine the width and length of the central incisor using the bi-zygomatic width and the length of the face respectively.

$$\text{The width of the maxillary central incisor} = \frac{\text{Bizygomatic width}}{16}$$

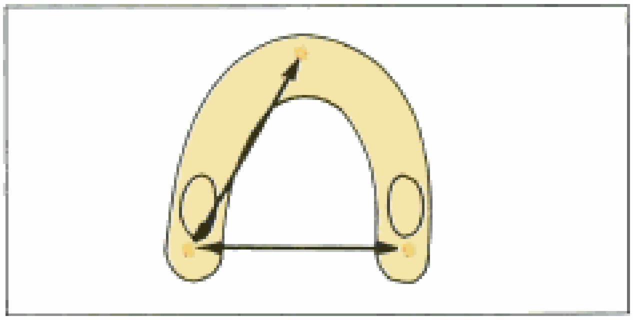
$$\text{The length of the maxillary central incisor} = \frac{\text{Length of the face}}{16}$$

Based on the width of the nose The width of the nose is measured with a vernier calliper. This measurement is transferred to the occlusal rim. The width of the nose is equal to the combined width of the anterior teeth.

Methods using Anatomical Landmarks

Various anatomical landmarks like the size of the maxillary arch and location of the canine eminences, buccal frenal attachments, corners of the mouth and ala of the nose can be used to determine the size of the artificial teeth.

Size of the maxillary arch The distance between the incisive papilla and the hamular notch on one side is added with the distance between two hamular notches. This gives the combined width of all the anterior and posterior teeth of the maxillary arch (Figs 10.42a and b).



Figs 10.42a and b: Sum of the width of all anterior and posterior teeth

Location of canine eminences A canine eminence is formed in the region between the canine and the first premolar after extraction of teeth.

The distance between the two canine eminences is measured along the residual ridge. This measured value gives the combined width of the anterior teeth (Fig. 10.43).

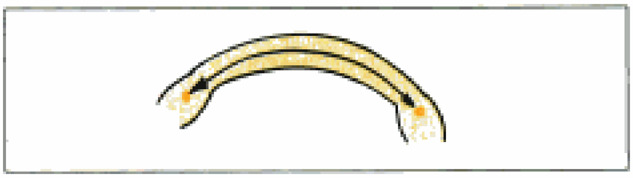


Fig. 10.43: Combined width of all anterior teeth

Location of the buccal frenal attachments The attachments of the buccal frenum are marked on the residual ridge. The distance between the two markings recorded along the residual ridge gives the combined width of the maxillary anteriors (Fig. 10.44).

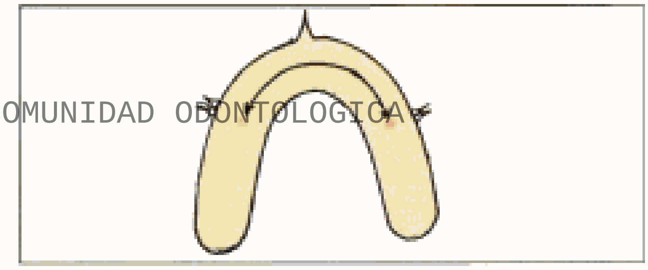


Fig. 10.44: Combined width of maxillary anteriors

Location of the corners of the mouth The corner of the mouth marks the distal end of the canine. The corners of the mouth are recorded on the occlusal rim and the distance is measured between these markings. The anterior teeth are set within these markings (Fig. 10.45).

Fig. 10.45

Location of the ala of the nose The patient is asked to sit upright and look straight. A line passing through the midpoint between the eyebrows and the lateral end of the ala of the nose extended onto the occlusal rim gives the combined width of the anterior teeth (Fig. 10.46).

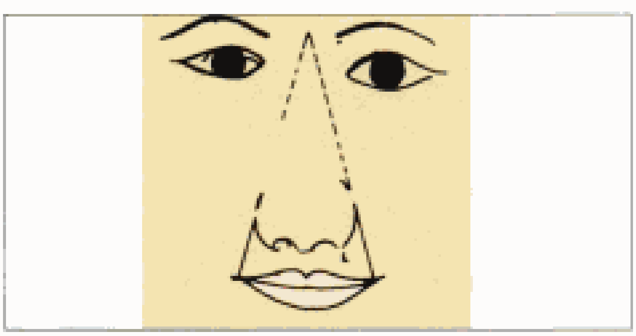


Fig. 10.46

Methods Using Theoretical Concepts

The following theoretical concepts proposed by various authors can be used to determine the size of the anterior teeth.

Winkler's concept According to Winkler, the teeth should be selected based on three different views, namely, physiological, psychological and biomechanical.

Physiological-biological The facial musculature contributes to the aesthetics of a patient. Increasing the thickness of the denture base in the labial and buccal sulci can produce a puffy appearance. Facial wrinkles fade when the vertical dimension is increased. But this should not be carried out to avoid other complications listed in the previous chapter. The dentist should evaluate the perioral tissues and arrange the teeth accordingly. Refer clinical examination in Chapter 2.

Psychological; A patient with a positive self-evaluation shows a broad smile and the one with a negative self-evaluation shows a tight-lipped small smile. The Camper's line is the psychological plane of orientation. It is raised in happy people and is tilted downward in depressed people (Fig. 10.47).

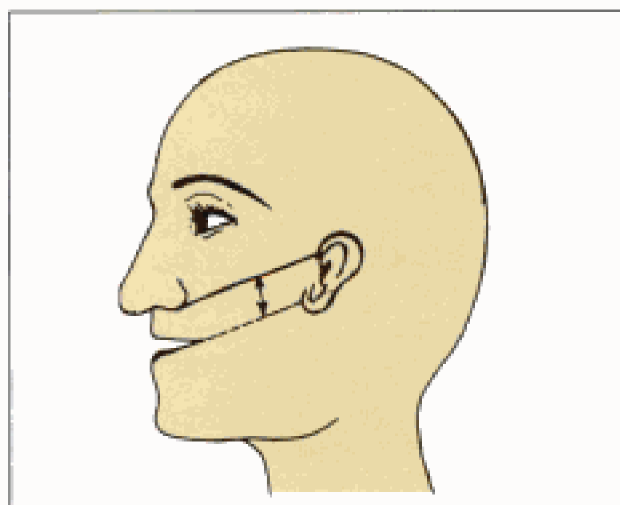


Fig. 10.47a: Raised Camper's line in a patient with a good mental temperament

Biomechanical The teeth should be placed such that they fulfil the biomechanics of the denture. It is not necessary to set the teeth on, outside, or inside the ridge. Instead they should be set in the neutral zone (the zone of balance between the buccal and lingual musculature) (Fig. 10.48).

Typal form theory: Leon Williams (1917) This theory helps to determine the size and form of the anterior teeth. According to him, the shape of the teeth should be inverse of the shape of the

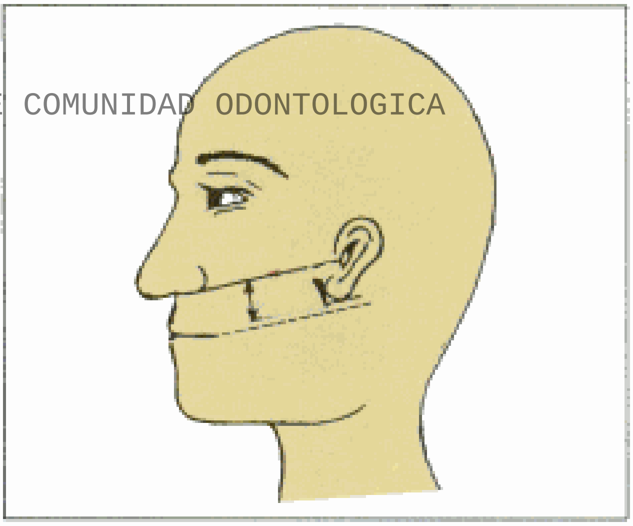


Fig. 10.47b: Lowered Camper's line in a patient with poor mental temperament

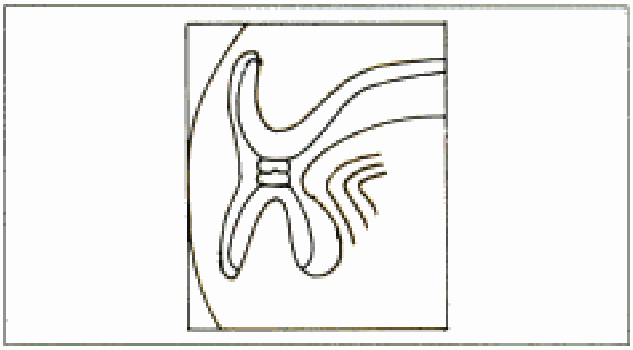
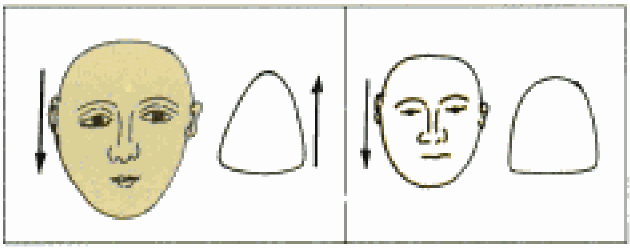


Fig. 10.48: Neutral zone

face. That is, if the face tapers downwards, the teeth should taper upwards (Fig. 10.49).

Steins, in 1936, opposed this concept and said that the shape of the teeth may vary for each individual, because, it was not possible for two fingerprints to be alike. According to him, the outline of the teeth are not important, because, it is subjected to change throughout life. He proposed that the size, colour, form and contour



Figs 10.49a and b: Leon Williams concept

are the most important factors to be considered during teeth selection.

Temperamental theory: Dr. Sparzheim This theory is based on the concept of *Hippocrates*. It is one of the oldest theories proposed around 2400 years ago. Hippocrates stated that the body comprised of four *juices of humour* namely blood, phlegm, yellow and black biles. Imbalance of these juices is the basis for the various ailments and differences in man.

Man can be classified based on the dominance of humour as follows:

- *Sanguinous type:* Blood dominance.
- *Phlegmatic type:* Phlegm dominance (phlegm is a watery fluid elaborated from brain).
- *Choleric type:* Yellow bile dominance (from liver).
- *Melancholic type:* Black bile dominance (from spleen).

Association of certain mental, functional and physical characteristics created the temperamental theory. People of each group exhibit a certain type of teeth.

Concept of Harmony: J.W. White in 1872 According to him, the size and colour of the teeth should be in harmony with the size of the head and colour of the eye, respectively.

Other factors Other factors that influence the size of teeth are:

- Size of the face.
- Inter-arch spacing.
- Distance between the distal ends of the maxillary cuspids.
- Length of the lips.
- Size and relation of the arches.

Form of the Anterior Teeth

The form or outline of the anterior teeth can be determined using the following factors:

- Shape of the patient's face or facial form.
- Patient's profile.
- Dentogenic concept and dynesthetics.

Shape of the Patient's Face or Facial Form

This is based on Typal form theory by Leon Williams. According to him, the facial form can

be described as one among the following four types:
- Ovoid
- Tapering
- Square
- Combination of the above.

The teeth selected should be in harmony with the facial form. Ovoid teeth are preferred for patients with an oval face, etc (Fig. 10.50).

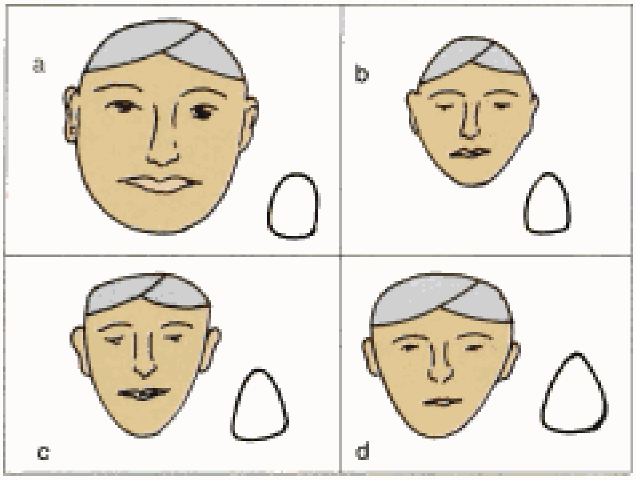


Fig. 10.50: Facial form and tooth shape (a) square, (b) oval, (c) tapering, (d) combination

Patient's Profile

The patient may have a convex, straight or a concave profile. The labial form of the anterior teeth should be similar to the facial profile of the patient. For example, the labial form should be straight for patients with a straight profile, convex for a patient with a convex profile (Fig. 10.51).

Dentogenic Concept and Dynesthetics: (Sex, Personality, Age or SPA factor)

It was first described by Frush and Fisher. According to them, the sex, personality and age of the patient determine the form of the anterior teeth.

Sex The form or shape of the teeth differs in males and females. The differences in the shape of the anterior teeth in males and females are:
- In females, the incisal angles are more rounded and the teeth have a lesser angulation. In males, the incisal angles are rounded to a lesser degree and the teeth are more angular (Fig. 10.52).
- The incisal edge of the central incisors is parallel to the lips and the laterals are above the occlusal plane in males. But the incisal edges of the central and lateral incisors follow the curve of the lower lip in females (Fig. 10.53).

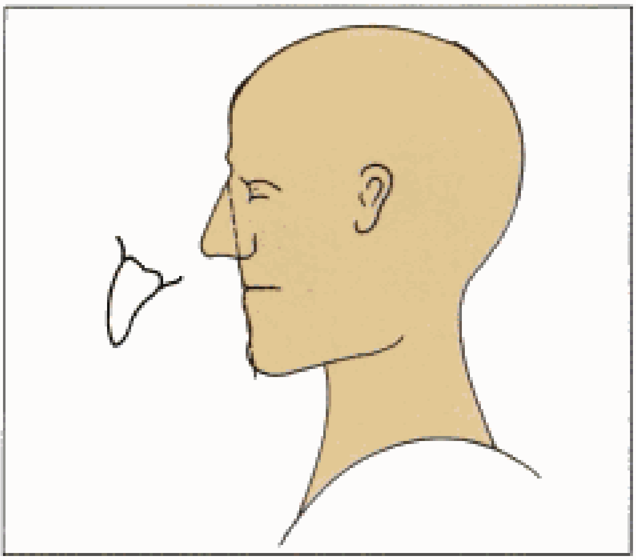
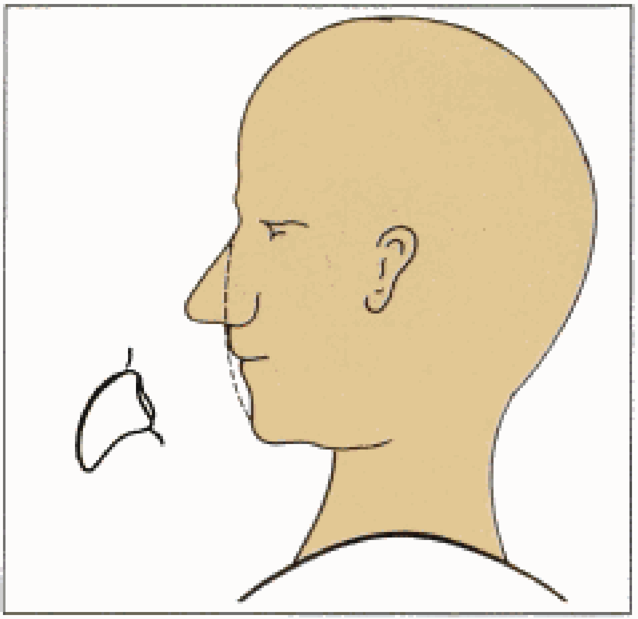


Fig. 10.51a



Figs 10.51a and b: Facial profile and labial convexity

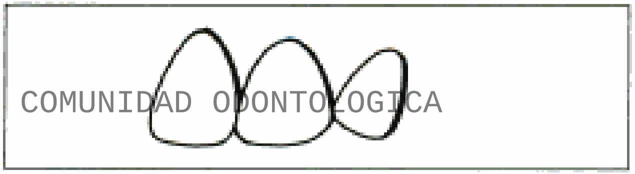


Fig. 10.52a: Arrangement of maxillary laterals in males

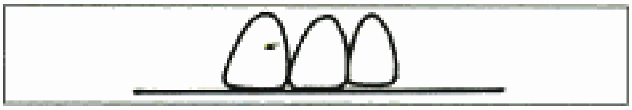


Fig. 10.52b: Arrangement of maxillary laterals in females

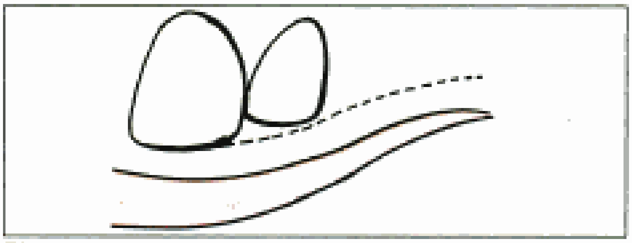


Fig. 10.53a: Arrangement of maxillary anteriors in relation to the lower lip line in males

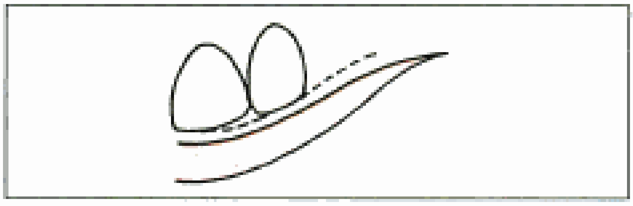


Fig. 10.53b: Arrangement of maxillary anteriors in relation to the lower lip-line in females

- The distal surface of the centrals are rotated posteriorly for females.
- The mesial surface of the lateral incisors are rotated anteriorly in relation to the centrals in females (Fig. 10.54).

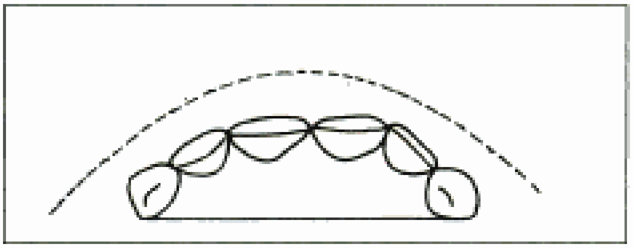


Fig. 10.54: Incisal view of maxillary anterior teeth in females

- In males the mesial end of the laterals are hidden by the centrals. This makes the canine very prominent in males (Fig. 10.55).
- Only the mesial thirds of the canines are visible in females because they are rotated anteriorly,

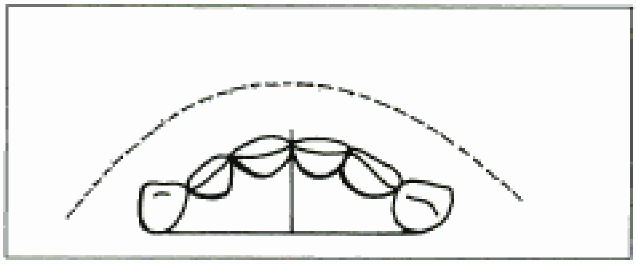
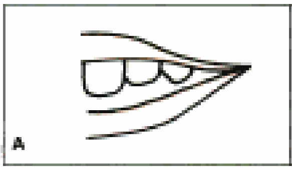


Fig. 10.55: Incisal view of maxillary anterior teeth in males

whereas even the middle two-thirds of the canines are visible in males (Fig. 10.56).

- The cervical regions are prominent in males than in females.
- Females on smiling expose more anterior teeth hence, the premolars should be arranged based on aesthetics for females.



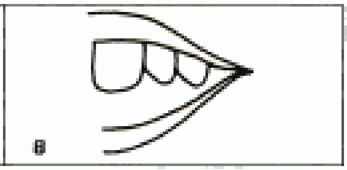


Fig. 10.56: Exposure of canines in females (a) and males (b) while smiling

Age The age of the patient is important in teeth selection because of the physiological and functional changes that occur in the oral tissues. The patient can be either young, middle-aged or old-aged. The following changes are observed with an advance in age of the patient:

- Due to decrease in muscle tone, sagging of the cheeks and the lower lips occur. To prevent cheek biting (due to sagging), the horizontal overlap of the posterior teeth can be increased.
- Inter-occlusal distance reduces with age. Hence, mandibular teeth are more visible than the maxillary teeth.
- Old people usually have abraded teeth with worn out contacts. Hence, placement of contoured teeth may look artificial.
- Old patients have gingival recession. It can be reproduced in the dentures to provide a natural appearance.
- Old people show a blunt smile line and pathologic migration of teeth.
- The colour of the teeth also changes with age. In old people, the enamel is abraded and the

dentine which carries a yellow tinge, is more visible (Refer colour selection).

Personality The dentist should select and arrange the teeth so that it improves the patient's personality. The patient can be either vigorous or delicate.

- More squarish, large teeth are selected for vigorous people.
- The anteriors should be in a flat plane for executives.
- For executives, the teeth should be relatively smaller and more symmetrically arranged (Fig. 10.57).

Fig. 10.57: Small teeth for executives

Colour for Anterior Teeth

Before selecting the colour for anterior teeth, some basic concepts about colour should be understood. A single colour can be described under four parameters.

- Hue.
- Saturation or chroma.
- Brilliance or value.
- Translucency.

Hue

It denotes a specific colour produced by a specific wavelength of light. It should be in harmony with the patient's skin colour or else it will produce an artificial look for the denture.

Saturation or Chroma

It is the amount of colour per unit area of an object. In other words, it denotes the intensity of the colour. Objects with highly saturated colours lack depth.

Brilliance or Value

It denotes the lightness or darkness of an object. It is actually the dilution of the colour with either black or white to produce darker or lighter shades respectively. In people with light skin colour, teeth with lighter shades should be chosen and vice versa.

Translucency

It is the property of the object to partially allow passage of light through it. Enamel has high brilliance and translucency; hence, artificial teeth should also show the same properties for a natural appearance.

The hue and brilliance of a tooth is influenced or determined by the following factors:

- Age.
- Habits.
- Complexion.
- Colour of the eyes.
- Colour of the patient's hair.

Age

- Young people have lighter teeth where the colour of the pulp is shown through the translucent enamel.
- Old people show dark and opaque teeth due to the deposition of secondary dentin and consequent reduction in size of the pulp chamber.
- Teeth are more shiny in old people as they get polished due to regular wear of the teeth.
- Teeth of older people obtain a brownish tinge because exposed dentin tends to stain.
- Preserved extracted teeth are not used to select the colour of the teeth because they become discoloured (as they are non-vital).

Habits

Smokers, alcoholics and pan chewers have discoloured teeth due to stains. In such people, porcelain teeth are preferred because they are not porous and do not allow percolation.

Complexion

- The colour of the teeth chosen should be in harmony with the complexion of the patient.
- The colour of the face is more important because the teeth fall into the framework of the face.

Colour of the Eyes

- Only the colour of the iris is considered.

- This measure is more unreliable because the eyes are too small and far away from the teeth to significantly influence the choice of colour.

Colour of the Patient's Hair

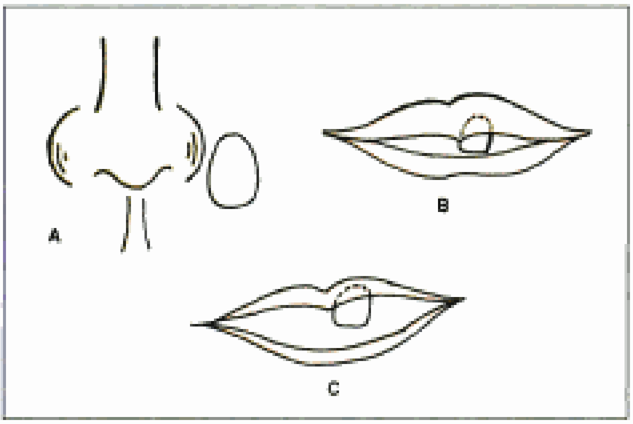
It is very unreliable because of factors like cosmetics, etc. Also, hair colour changes with age.

Steps in the selection of colour for anterior teeth

For the replacement of a single tooth, the adjacent teeth can be taken as a guide. For an edentulous patient, factors like skin colour, hair colour and eye colour are considered.

The following reference points on the face can be used to select the colour of the tooth (Fig. 10.58).

- *Side of the nose:* This point helps to determine the basic hue, brilliance and saturation (Fig. 10.58a).
- *Under the lips with only the incisal edge exposed:* This reference point gives an idea of how the teeth will look when the patient is relaxed (Fig. 10.58b).
- *Under the lips with the mouth wide open and only the cervical third covered:* The third reference point gives an idea of how the teeth will look when the patient is smiling (Fig. 10.58c).



Figs 10.58a to c: Selecting the colour of anterior teeth at various reference points

Squint test It is used to check and compare the colour of the teeth with the colour of the face. The dentist should partially close his eyes to reduce light and compare artificial teeth of different shades with the colour of the face. The colour of the teeth that fades first from view is least conspicuous (contrasting) to the colour of the face (Fig. 10.59).

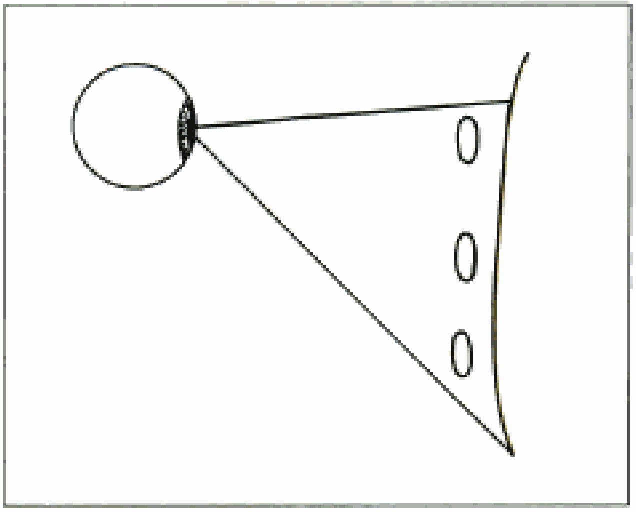


Fig. 10.59: Squint test for shade selection

POSTERIORTEETH SELECTION

It is classified under two divisions, namely:

- Size of the teeth
- Form of the teeth.

Size of the Posterior Teeth

The following factors are considered while selecting the size of the teeth:

- Buccolingual width.
- Mesiodistal length.
- Occlusogingival height.

Buccolingual Width

The buccolingual width of the artificial teeth should be decreased so that the buccal and lingual surfaces slope out from the occlusal surface to provide a proper path of escapement of food during mastication.

It should be such that the forces from the tongue neutralize the forces of the cheek. If the buccolingual width increases, the forces acting on the denture will also increase, leading to increase in the rate of ridge resorption. Broader teeth encroach into the tongue space leading to instability of the denture. Also, the teeth should not encroach into the buccal corridor space to avoid cheek biting (Fig. 10.60).

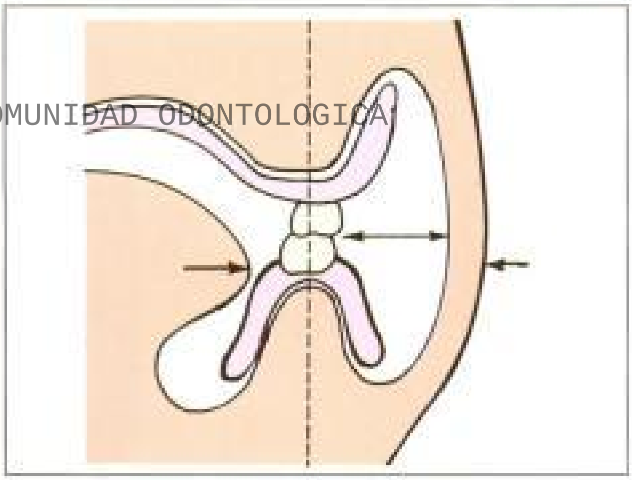
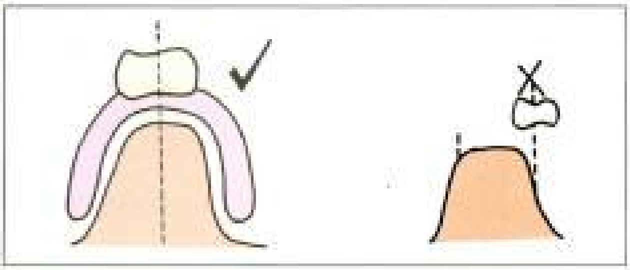


Fig. 10.60a: Placement of posterior teeth in the neutral zone



Figs 10.60b and c: (b) Co-relation of the tooth to the ridge. The long axis of the tooth co-incides with the long axis of the edentulous ridge (c) Improper relation of the tooth to the ridge

Mesiodistal Length

The mesiodistal length of each tooth should be selected such that the combined length of all the posterior teeth on that side of the arch does not exceed the distance between the canine and the retromolar pad (Fig. 10.61).

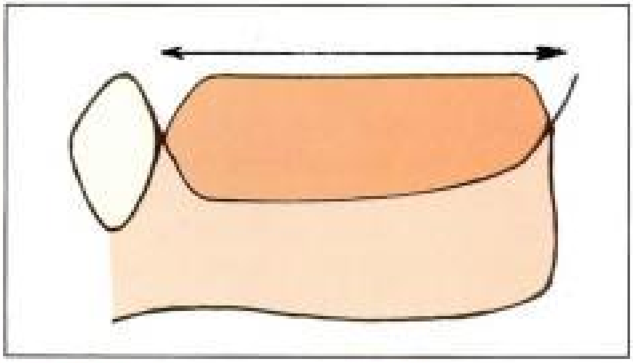


Fig. 10.61: Mesiodistal length of the edentulous ridge

Posterior teeth should not be placed over steep anteroposterior ridge slope as this would lead to forward displacement of the denture. Similarly the teeth should not be placed over displaceable tissues like the retromolar pad as it will cause tipping of the denture during function.

In cases with inadequate mesiodistal length, the premolar can be omitted.

Occluso-gingival Height

It is determined by the available inter-arch distance. The occlusal plane should be located at the midpoint of the interocclusal distance (Fig. 10.62). Large teeth selected for cases with inadequate interocclusal distance appear artificial and require modification before arrangement. Measures like altering the thickness of the denture base can also be done to accommodate large teeth.

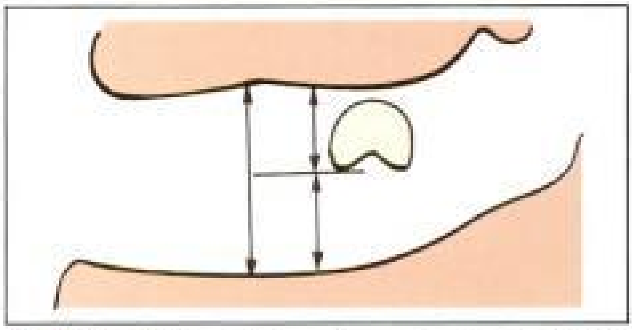


Fig. 10.62a: (a) Good inter-arch space to place teeth with high occluso-gingival height

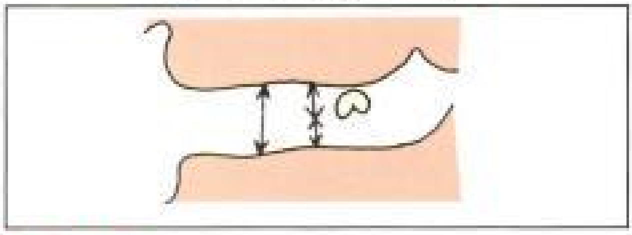


Fig. 10.62b: Decreased inter-arch distance that will compromise on the occluso-gingival height of the prosthetic teeth

Form of the Posterior Teeth

Posterior teeth are available in different forms. Before we go into the details about each tooth form, we shall discuss the factors that control the selection of the form of a tooth.

Factors that control the selection of the form of a tooth:

- *Condylar inclination:* Teeth with a high cuspal height are required for patients with steep condylar guidance (Fig. 10.63). This is because the jaw separation will increase for patients with acute condylar guidance during protrusion.

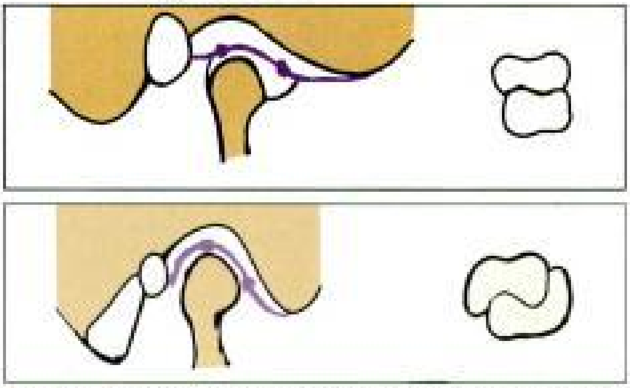


Fig. 10.63: (a) Shallow condylar guidance will require teeth with shallow (lower) cuspal angle (b) Steep condylar guidance will require teeth with higher cuspal angulation to produce occlusal balance

- *Height of the residual ridge:* Shallow cusped teeth go better with shallow ridges (Fig. 10.64).
- *Patient's age:* Teeth with shallow cusps are preferred in older people.
- *Ridge relationship:* 0° or monoplane teeth are preferred for cases with posterior cross bite or severe class II relationship (Fig. 10.65).
- Hanau's quint (discussed later).

Morphologically teeth can be classified as:

- Cusp teeth
  - — Anatomic teeth
  - — Semi-anatomic or modified cusp or low cusp teeth
- Cuspless teeth
- Special forms

Cusp Teeth

They have cusps and fossae-like natural teeth. They are of two types, namely anatomic and semi-anatomic. Cusp teeth can be used in the following occlusal schemes:

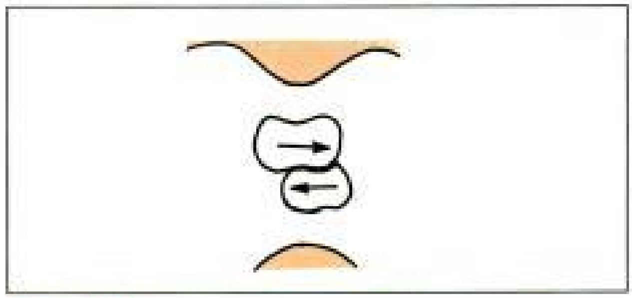


Fig. 10.64a: Shallow cusped teeth should be used over shallow ridges

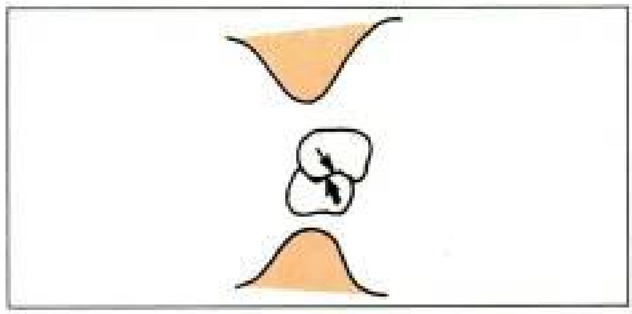


Fig. 10.64b: Deep/steep cusp teeth should be used over steeper and taller ridges

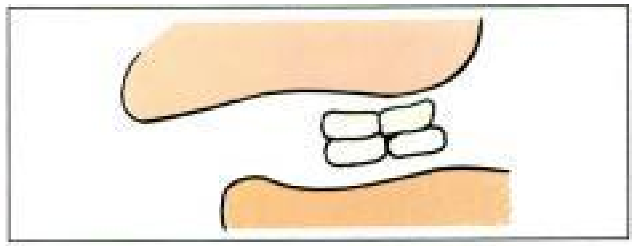


Fig. 10.65: Monoplane teeth are preferred to attain good occlusal harmony in severe class II ridge relationships

- Bilateral balanced occlusion in centric and eccentric relations.
- Balance in centric only.
- *Non-intercusping cusp* (modified occlusion).

Anatomic teeth These teeth resemble normal newly-erupted teeth. They provide the best aesthetics and are the most commonly used type of artificial teeth. The cusps resemble normal dentition with an angle of 33°. Anatomic teeth with 30° cuspal angulation are also available and are commonly known as *Pilkington-Turner teeth* (Fig. 10.66).

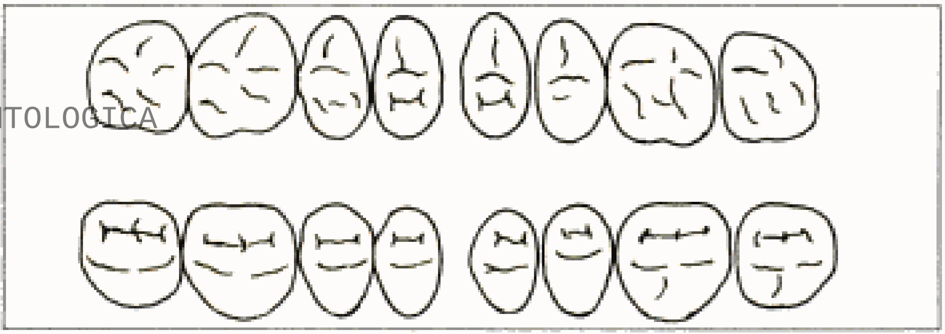


Fig. 10.66: Pilkinton turner teeth with 30° cusps

Advantages of anatomic teeth

- Closely resembles natural teeth – highly aesthetic.
- Proper contours for crushing and triturating.
- Presence of adequate sluiceways.
- Greater chewing efficiency, excessive chewing pressure is minimized.
- More vertical chewing stroke.
- Cuspal inclines provide a depth to obtain eccentric balance.
- Provides a greater resistance to rotation of dentures.
- Provides a comfortable position to return to when cusps are making contact in fossae.

Disadvantages of anatomic teeth

- More difficult and time consuming to obtain balanced occlusion.
- Settling (stabilization of occlusion) results in more damaging interferences.
- Possibilities of more lateral stress in function.
- Settling also causes the vertical dimension at occlusion to decrease and the mandible to move forward.
- Settling will lead to residual ridge resorption.

Semi-anatomic Teeth

They are also known as *modified-cusp* or *low-cusp teeth*. They may have 20° or 10° cuspal angulation. 10° semi-anatomic teeth are commonly known as *functional* or *anatoline* teeth (Fig. 10.67). They are used in cases with mild discrepancies in jaw relation. They are more flexible to arrange than anatomic teeth but they are not as flexible as non-anatomic teeth.

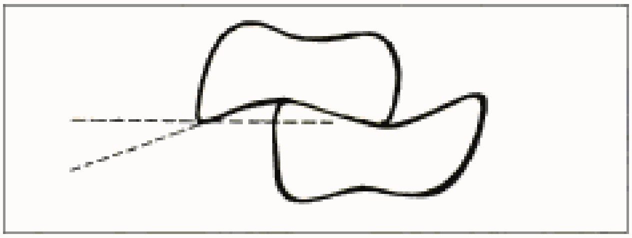


Fig. 10.67: Semianatomic teeth

Advantages of semi-anatomic teeth

- Easier to arrange and obtain balanced occlusion.
- Can provide freedom if settling occurs.
- Reduction of lateral stresses.
- Provides all the advantages of cusp teeth.

Disadvantages of semi-anatomic teeth

- Less aesthetic (buccal cusps are shorter)
- Less chewing efficiency (controversial: some claim greater)

Cuspless Teeth

They are also known as *0°, flat, or monoplane* teeth. They have no cuspal angulation hence are very flexible to set. It is easy to set non-anatomic teeth in balanced occlusion. Cuspless teeth can be used for the following occlusal schemes:

- Bilateral balance with a compensating curve.
- Three-point balance with a balancing ramp.
- Flat plane-balance in centric only.
- Reverse-pitch (Anti-Monson) curve.

Advantages of cuspless occlusal schemes

- More stable lower denture during mastication.
- More vertical chewing stroke.

- More shear in the chewing stroke.
- More tongue room.

Disadvantages of cuspless occlusal schemes
- Less stability to the upper denture.
- No balance in excursive glides (unless pleasure curve added). Refer arrangement of teeth.

Advantages of 0° teeth
- Easy to set up.
- Least lateral stress.
- Least anterior-posterior interferences after settling.
- Best for patients with poor muscular control.
- Best for patients with poor ridge relationships.
- Reduced buccolingual width, and sharp grooves and sluiceways compensate for cusps in obtaining equal chewing efficiency.

Disadvantages of 0° teeth
- Very difficult to obtain balanced occlusion in excursive movements.
- Less chewing efficiency especially for fibrous or tough food.
- Poor aesthetics.
- When set on a flat plane, a space develops posteriorly when excursions occur ("Christensen's phenomenon"), causing excessive pressure and resorption in the anterior region.

Special Tooth Forms

They include French's posteriors, cutter bars, masticators, VO posteriors, Sosin-bladed teeth and many others. Cutter bars and masticators are no longer available. These teeth are discussed in detail in the first chapter under the parts of a complete denture.

Advantages
- Some can provide moderate to excellent function
- To date, most efficient design is Sosin bladed teeth.

Disadvantages
- Often aesthetics is poor.
- Best forms require meticulous execution and skill.
- More expensive
- Many commercially available forms are poorly designed and have only "gimmick" value.

Selection of Teeth Based on the Type of Material Used

Acrylic, porcelain or new hard acrylics are the most commonly used. Composite teeth are also available. Acrylic and porcelain teeth have been discussed in parts of a complete denture. Hard acrylic teeth show more resistant to wear and stains. Acrylic and porcelain teeth are discussed in detail in parts of a complete denture in Chapter 1.

Teeth arrangement is the next step in the fabrication of a complete denture. Before we go into the principles of arrangement of teeth, we shall discuss the concepts of occlusion.

OCCLUSION

Occlusion is defined as, "*Any contact between the incising or masticating surfaces of the maxillary and mandibular teeth*" –GPT.

Another term, which deals with the relationship of the maxillary and mandibular teeth is *Dental articulation*.

Dental articulation is defined as, "*The static and dynamic contact relationship between the occlusal surfaces of the teeth during function*" – GPT (Fig. 10.68).

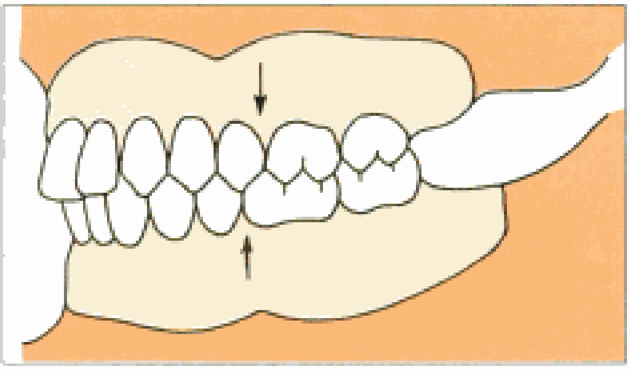


Fig. 10.68

It is generally considered that occlusion deals with the static relationship of opposing teeth and articulation deals with the dynamic (during movement) relationship of the opposing teeth. In this chapter, we have grouped for convenience occlusion and articulation as a single phenomenon.

Occlusion is an important factor, which governs the retention and stability of the complete denture *in vivo*. It is important for one to know the principles of occlusion before arranging artificial teeth.

DIFFERENCES BETWEEN NATURAL AND ARTIFICIAL OCCLUSION

Occlusion of natural and artificial teeth vary to a great extent. It is important for one to know about these differences in order to understand the need of balanced occlusion in a complete denture which is discussed later.

Natural teeth	*Artificial teeth*
• Natural teeth function independently and each individual tooth disperses the occlusal load.	• Artificial teeth function as a group and the occlusal loads are not individually managed.
• Malocclusion can be non-problematic for a long time	• Malocclusions pose immediate drastic problems
• Non-vertical forces are well tolerated	• Non-vertical forces damage the supporting tissues
• Incising does not affect the posterior teeth.	• Incising will lift the posterior part of the denture.
• The second molar is the favoured area for heavy mastication for better leverage and power.	• Heavy mastication over the second molar can tilt or shift the denture base.
• Bilateral balance is not necessary and usually considered a hindrance	• Bilateral balance is mandatory to produce stability of the denture.
• Proprioceptive impulses give feedback to avoid occlusal prematurities. This helps the patient to have a habitual occlusion away from centric relation	• There is no feedback and the denture rests in centric relation. Any prematurities in this position can shift the base

GENERAL CONCEPTS OF COMPLETE DENTURE OCCLUSION

Unlike natural teeth, the artificial teeth act as a single unit. Hence, there should be a minimum of three contact points (usually one anterior and two posterior) between the upper and lower teeth at any position of the mandible for even force distribution and stabilization of the denture.

Complete denture occlusion varies with the type of teeth selected. In posterior teeth selection we discussed anatomic and non-anatomic teeth. Anatomic teeth should be arranged using balanced occlusion and non-anatomic teeth are usually arranged using monoplane occlusion.

All occlusal forms should at least have a tripod contact in centric relation. Balanced occlusion should have tripod contact even in eccentric relation. Before we go in detail about each type of occlusion, let us look at the different concepts of occlusion.

Spherical Concept of Occlusion: (Monson)

According to this concept, the anteroposterior and mesiodistal inclines of the artificial teeth should be arranged in harmony with a spherical surface. (Refer spherical theory in articulators).

Organic Concept of Occlusion

Here, the shapes of the teeth are altered to have cusps suitable for the patient. The movement of the condyle determines the direction of the ridges and grooves of the teeth and the mandibular movements determine other factors like cusp height, fossa, depth of the fissure, and concavity of the lingual surfaces.

In organic or organized occlusion, the aim is to relate the occlusal surfaces of the teeth so that the teeth are in harmony with the muscles and joints during function. The muscles and joints determine the mandibular position of occlusion without any tooth guidance. In function, the teeth are supposed to have a passive role and do not influence or determine the path of mandibular movement. (In normal occlusion, tooth factors determine mandibular movements e.g. incisal guidance).

Neutrocentric Concept of Occlusion

According to this concept, the plane of occlusion should be flat and parallel to the residual alveolar ridge (Fig. 10.69). This concept is similar to the monoplane occlusion used to set non-anatomic teeth. The term *neutrocentric* denotes an occlusion that eliminates the anteroposterior and buccolingual inclines in order to direct the forces to the posterior teeth.

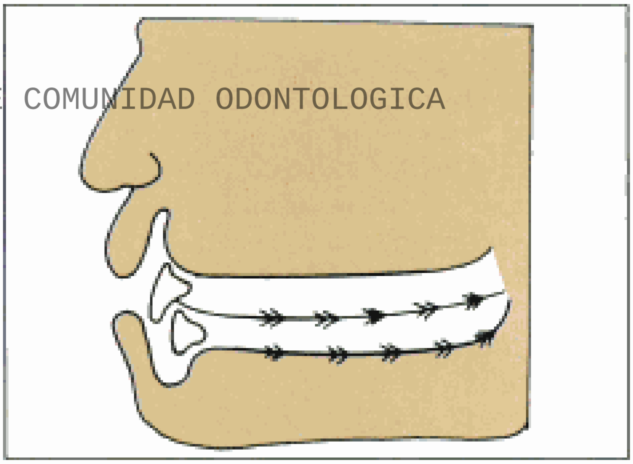


Fig. 10.69a: A neutrocentric plane of occlusion should be parallel to the residual alveolar ridge

SEARS AXIOMS OF COMPLETE DENTURE OCCLUSION

Sears published the following factors to be considered that helps to plan a complete denture occlusion.

- Smaller the area of the occlusal surface, the lesser is the amount of occlusal load transmitted to the supporting structures.
- Vertical force on a tilted occlusal surface will produce a non-vertical force on the denture.
- Vertical force-acting on a tilted tissue support will produce a non-vertical force on the denture base.
- Vertical force on the denture base lying over the resilient tissues will produce lever forces on the denture.
- Vertical forces acting outside the ridge crest will produce tipping of the denture.

IDEAL REQUIREMENTS OF COMPLETE DENTURE OCCLUSION

Complete denture occlusion should fulfil the following characteristics:

- Stability of the denture and its occlusion when the mandible is in both centric and eccentric relations.
- Balanced occlusal contacts (tripod contact) during all eccentric movements.
- Unlocking (removing interferences) the cusps mesiodistally so that the denture can settle when there is ridge resorption.
- The cuspal height should be reduced to control the horizontal forces.
- Functional *lever balance* should be obtained by vertical tooth to ridge crest relationship. *(Lever balance is the balance against leverage foces acting on the denture. Presence of positive contact on the opposing side provides lever balance. It differs from bilateral balance in that it does not necessarily require three-point contact).*
- Cutting, penetrating and shearing efficiency of the occlusal surface equivalent to that of natural dentition.
- Incisal clearance during posterior functions like chewing.
- Minimal area of contact to reduce pressure while crushing food (*Lingualized occlusion*).
- Sharp ridges, cusps and sluiceways to increase masticating efficiency.

OCCLUSAL SCHEME REQUISITESTO FULFILTHE REQUIREMENTS

Each occlusal scheme has three characteristics, namely, the incisal, working and balancing units. The incisal unit includes all the four incisors. The working unit includes the canine and the posterior teeth of the side towards which the mandible moves. The balancing unit includes the canine and the posteriors opposite to the working side.

The ideal requirement of a complete denture occlusion can be fulfilled by creating or providing the following characteristics for each unit.

Incisal Units

- Sharp units for improved incising efficiency.
- The units should not contact during mastication. The units should contact only during protrusion.
- Shallow incisal guidance.
- Increased horizontal overlap to avoid interference during settling (the mandibular denture may slide anteriorly as it settles).

Working Units

- Cusps for good cutting and grinding efficiency.
- Smaller buccolingual width to decrease the occlusal load transferred to the tissues.

- Group function at the end of the chewing cycle in eccentric positions. *(During lateral movement if there is simultaneous contact of the posterior teeth of the working side its called group function. In the same situation if the canine alone contacts then its called canine guided occlusion. Canine guided occlusion and group function are usually described in relation to the natural teeth).*

- The occlusal load should be directed to the anteroposterior centre of the denture (Fig. 10.69).
- The plane of occlusion should be parallel to the mean foundation plane of the ridge.

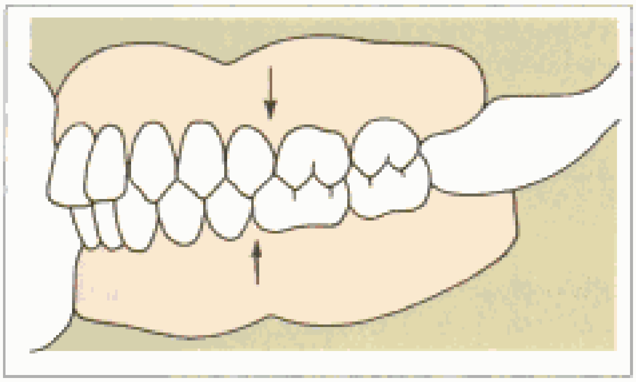


Fig. 10.69b: Forces on a denture should be concentrated over the first molar region

Balancing Units

- The second molars should be in contact during protrusive action (Protrusive balance).
- They should have contact alongwith the working side at the end of the chewing cycle.
- Smooth gliding contacts should be available for uninterfered lateral and protrusive movements.

TYPES OF COMPLETE DENTURE OCCLUSION

Complete denture occlusion can be of three types namely:

- Balanced occlusion
- Monoplane occlusion
- Lingualized occlusion

Each type has its own indications and contraindications, advantages and disadvantages. The most important type of occlusion employed in complete dentures is the balanced occlusion.

Balanced Occlusion

It is defined as, *"The simultaneous contacting of the maxillary and mandibular teeth on the right and left and in the posterior and anterior occlusal areas in centric and eccentric positions, developed to lessen or limit tipping or rotating of the denture bases in relation to the supporting structures"* –GPT.

Balanced occlusion can be described as the position of the teeth such that they have simultaneous contact in centric relation and provide a smooth sliding motion to any eccentric position. A three-point contact (usually one anterior and two posterior) at centric relation is not sufficient for balanced occlusion. Instead there should be simultaneous contact of all the teeth. Remember, balanced occlusion is **absent** in natural dentition.

Characteristic Requirements of Balanced occlusion

A balanced occlusion should have the following characteristics:

- All the teeth of the working side (central incisor to second molar) should glide evenly against the opposing teeth
- No single tooth should produce any interference or disocclusion of the other teeth.
- There should be contacts in the balancing side, but they should not interfere with the smooth gliding movements of the working side.
- There should be simultaneous contact during protrusion.

Importance of Balanced Occlusion

Balanced occlusion is one of the most important factors that affect denture stability. Absence of occlusal balance will result in leverage of the denture during mandibular movement.

Sheppard stated that, *"Enter bolus, Exit balance"* according to this statement, the balancing contact is absent when food enters the oral cavity. This makes us think that balanced occlusion has no function during mastication and so, it is not essential in a complete denture. But this is not true. Brewer reported the importance of balanced occlusion. He reported that on an average, a normal individual makes masticatory tooth contact only for 10 minutes in one full day compared to 4 hours of total tooth contact during other functions. So, for these 4 hours of tooth contact, balanced occlusion is important to maintain the stability of the denture. Hence, balanced occlusion is more critical during parafunctional movements.

General Considerations for Balanced Occlusion

The following points should be considered while developing balanced occlusion:

- Ideal balanced occlusion can be achieved in cases with wide and large ridges and in complete dentures, with teeth arranged close to the ridge.
- Complete dentures that have teeth arranged away from the ridge and those that rest on narrow and short ridges will have poor balanced occlusion.
- Teeth that have a narrow buccolingual width and those that rest on wide ridges provide ideal balanced occlusion.
- Ideal balance can be achieved by arranging the teeth slightly on the lingual side of the crest of the ridge. Arranging the teeth buccally will lead to poor balanced occlusion (Fig. 10.70). If the teeth are set outside the ridge the denture may elevate on one side during tooth contact. Stability of the denture against these lever forces is called as *lever balance*. Lever balance is different from balanced occlusion. It can be safely quoted that lever balance is also necessary for balanced occlusion (Refer ideal requirements of balanced occlusion).
- The complete denture should be designed in such a way that the forces of occlusion are centred anteroposteriorly in the denture.

Types of Balanced Occlusion

Occlusal balance or balanced occlusion can be classified as follows:

- Unilateral balanced occlusion
- Bilateral balanced occlusion
- Protrusive balanced occlusion
- Lateral balanced occlusion

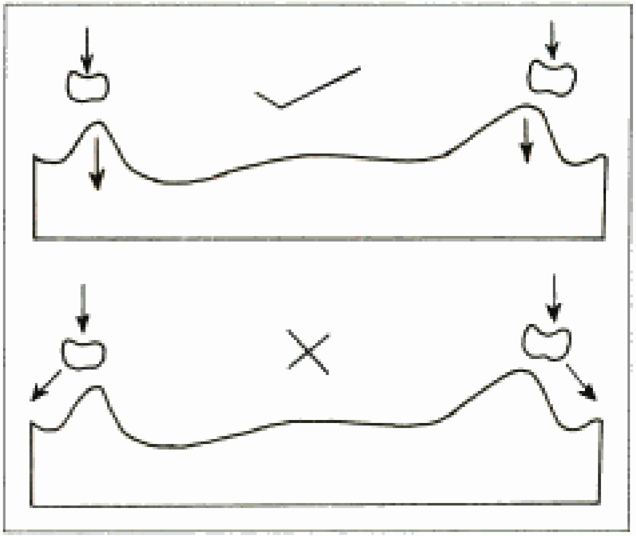


Fig. 10.70: The teeth should be placed over the ridge to provide lever balance to the denture

Unilateral balanced occlusion This is a type of occlusion seen on occlusal surfaces of teeth on one side when they occlude simultaneously with a smooth, uninterrupted glide. This is not followed during complete denture construction. It is more pertained to fixed partial dentures.

Bilateral balanced occlusion This is a type of occlusion that is seen when simultaneous contact occurs on both sides in centric and eccentric positions. Bilateral balanced occlusion helps to distribute the occlusal load evenly across the arch and therefore helps to improve stability of the denture during centric, eccentric or parafunctional movements (Fig. 10.71).

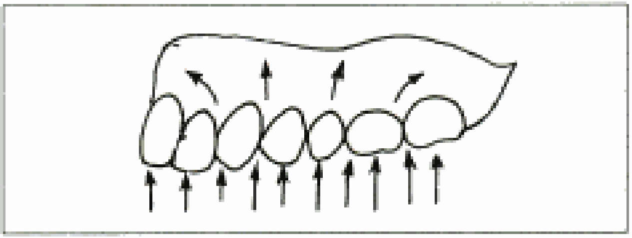


Fig. 10.71

For minimal occlusal balance, there should be at least three points of contact on the occlusal plane. More the number of contacts, better the balance. Bilateral balanced occlusion can be protrusive or lateral balance.

Protrusive balanced occlusion This type of balanced occlusion is present when mandible moves in a forward direction and the occlusal contacts are smooth and simultaneous anteriorly and posteriorly. There should be at least three points of contact in the occlusal plane (Fig. 10.72). Two of these should be located posteriorly and one should be located in the anterior region. This is absent in natural dentition.

If this relationship is followed during teeth arrangement, then the denture will lose its stability due to lever action (Fig. 10.73a). To prevent this the teeth should be arranged such that there is simultaneous tooth contact in the balancing and working sides (Figs 10.73b and c) (working side is the side to which the mandible moves; here right. Balancing side is opposite to the working side; here left).

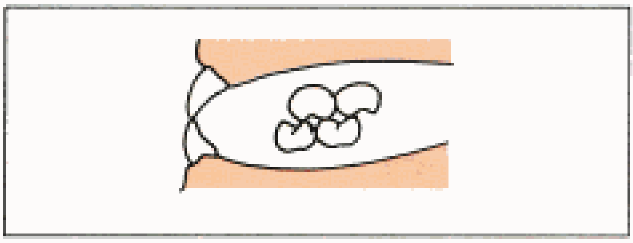


Fig. 10.72: Posterior contact during protrusion to maintain balance

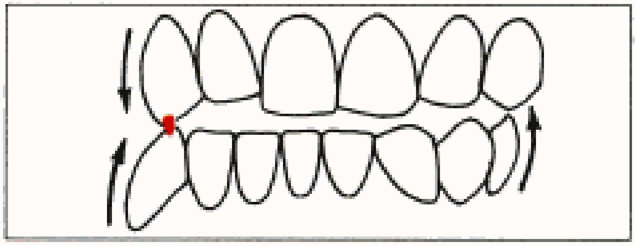


Fig. 10.73a: Canine guided disocclusion. This relationship is seen in natural dentition

The factors that govern protrusive balance:
- The inclination of the condylar path: This inclination recorded on the patient represents the path travelled by the condyle in protrusion which is modified by the combined action of all the tissues in the temporomandibular joint and the ridges covered by the recording bases.
- Angle of the incisal guidance chosen for the patient.
- Angle of the plane of occlusion.
- The compensating curves chosen for orientation with the condylar path and the incisal guidance.
- Cuspal height and inclination of the posterior teeth.

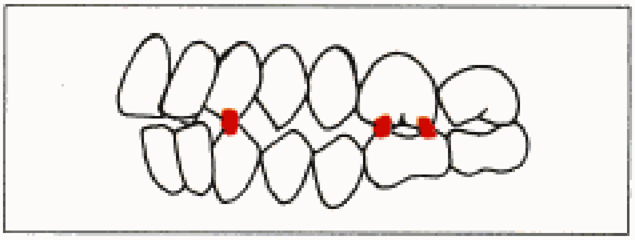


Fig. 10.73b: Anterior and posterior tooth contact during laterotrusion seen on the working side

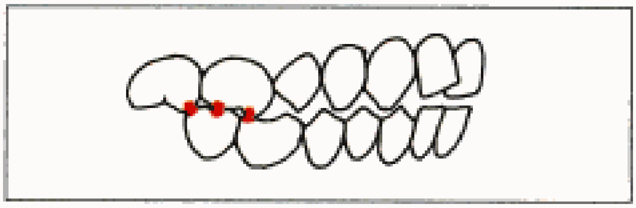


Fig. 10.73c: Balancing side contact during laterotrusion

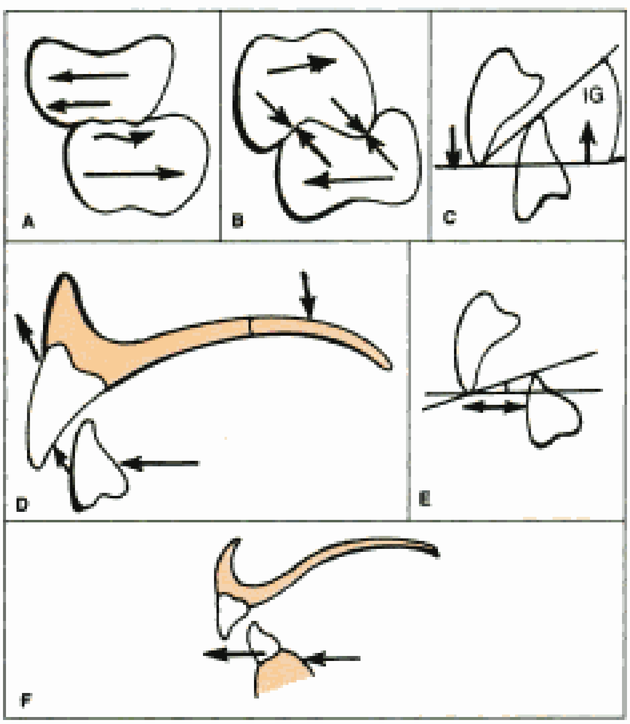
Lateral balanced occlusion In lateral balance, there will be a minimal simultaneous three point contact (one anterior, two posterior) present during lateral moment of the mandible.

Lateral balanced occlusion is absent in normal dentition. When a dentulous person with canine guided occlusion moves his mandible to the right, there will be canine guided disocclusion of all his teeth. That is, the canine will be the only tooth that contacts the opposing tooth. Even the canine of the opposite side will not have contact .

The factors that govern lateral balance:
- Angle of inclination of the condylar path on the balancing side.
- Angle of inclination of the incisal guidance and cuspid lift.
- Angle of inclination of the plane of occlusion on the balancing side and working side.
- Compensating curve on the balancing side and working side.

- The buccal cusp heights or inclination of the teeth on the balancing side.
- The lingual cusp heights or inclination on the working side.
- The Bennett side shift on the working side.

Steep cusps produce more displacement of the denture base than shallower or cuspless forms. The forces of occlusion acting on a complete denture should be balanced from right to left and anterior to posterior direction (Fig. 10.74a and b).



Figs 10.74a to f: (a) Shallow cusp teeth allow the opposing members to slide through during mastication. (b) Teeth with higher cuspal angle tend to lock the opposing teeth during movement (c,d) Dentures with steep incisal guidance tend to get displaced during protrusion (e, f) Dentures with shallow incisal guidance produce lesser interference during protrusion. However, the amount of anterior interference depends on other factors like condylar guidance, etc.

An increase in any of the above factors will affect balanced occlusion leading to compromised stability of the denture.

If the vertical overlap of the anterior teeth is increased for aesthetic and phonetic reasons, then the horizontal overlap should be adjusted to reduce the incisal guidance angle.

This adjustment provides space for free movement of the anterior teeth. Without this adjustment, there will be increased anterior interference leading to initial instability of the denture base during protrusion. In the long run, this may lead to resorption of the residual alveolar ridge in the anterior region (Fig. 10.74).

Concepts Proposed to Attain Balanced Occlusion

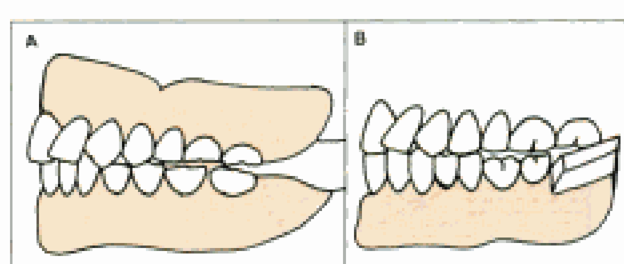
Many authors proposed different concepts for obtaining balanced occlusion. Most of them are not in use now and carry only a historical significance. Any way, we must know these concepts to understand how the present concepts have been derived from them.

Gysi's concept He proposed the first concept towards balanced occlusion in 1914. He suggested arranging 33° anatomic teeth could be used under various movements of the articulator to enhance the stability of the denture.

French's concept (1954) He proposed lowering the lower occlusal plane to increase the stability of the dentures along with balanced occlusion. He arranged upper first premolars with 5° inclination, upper second premolars with 10° inclination and upper molars with 15° inclination. He used modified French teeth to obtain balanced occlusion.

Sears's concept He proposed balanced occlusion for non-anatomical teeth using posterior balancing ramps or an occlusal plane which curves anteroposteriorly and laterally (Fig. 10.75).

Pleasure's concept Pleasure introduced a *pleasure curve or the posterior reverse lateral curve* (see



Figs 10.75a and b: Balancing ramps made of arylic are help to provide posterior balance during protrusion

compensating curves) to align and arrange the posterior teeth in order to increase the stability of the denture.

Frush's concept He advised arranging teeth in a one-dimensional contact relationship, which should be reshaped during try-in to obtain balanced occlusion.

Hanau's Quint (Fig. 10.76) Rudolph. L. Hanau proposed nine factors that govern the articulation of artificial teeth. They are:

- Horizontal condylar inclination
- Compensating curve
- Protrusive incisal guidance
- Plane of orientation
- Buccolingual inclination of tooth axis
- Sagittal condylar pathway
- Sagittal incisal guidance
- Tooth alignment
- Relative cusp height

These nine factors are called the *laws of balanced articulation*. Hanau later condensed these nine factors and formulated five factors, which are commonly known as *Hanau's quint:*

- Condylar guidance
- Incisal guidance
- Compensating curves
- Relative cusp height
- Plane of orientation of the occlusal plane.

These factors are described in detail later.

Trapozzano's concept of occlusion He reviewed and simplified Hanau's quint and proposed his *Triad of Occlusion*. According to him, only three factors are necessary to produce balanced occlusion. He dismissed the need for determining the plane of occlusion to produce balanced occlusion. He said that the plane of occlusion could be shifted to favour weak ridges, hence, its location is not constant and is variable within the inter-arch distance.

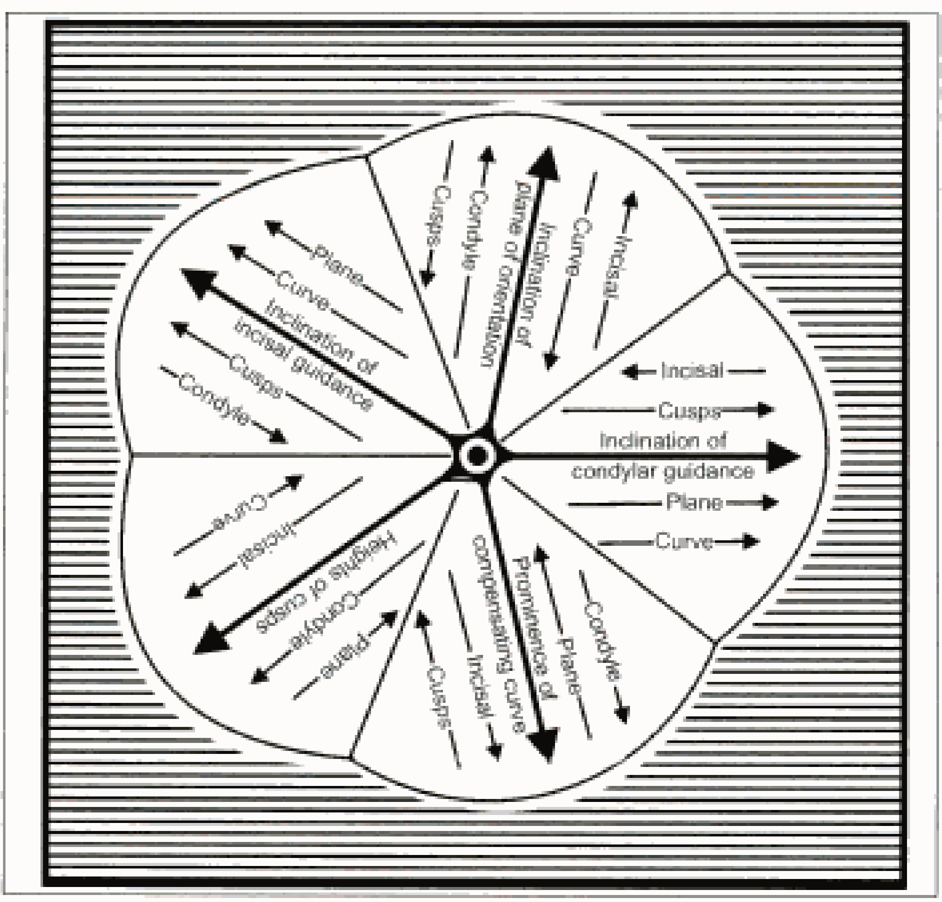


Fig. 10.76: Hanau's quint. Arrows away from the centre increase jaw separation

He also dismissed the need for setting compensating curves, because, he suggested that when we arrange cusped teeth in principle these curves are produced automatically. He considered that compensating curve as a passive factor, which is a resultant of setting cusped teeth.

Though his triad was simpler than the Hanau's quint, it eliminated the important compensating curves and plane of orientation (Fig. 10.77).

Boucher's concept Boucher confronted Trapozzano's concept and proposed the following three factors for balanced occlusion.

- Orientation of the occlusal plane, the incisal guidance and the condylar guidance.
- The angulation of the cusp is more important than the height of the cusp.
- The compensating curve enables one to increase the height of the cusp without changing the form of the teeth.

He also stated that, *"the plane of occlusion should be oriented exactly as it was when natural teeth were present"*. According to him, the plane of occlusion cannot be changed to favour weak ridges and that the teeth should be located in their original position. He believed it was necessary to fulfil the anatomical and physiological needs.

Boucher also emphasized the need for the compensating curve. He stated that, *"the value of the compensating curve is that it permits alteration of cusp height without changing the form of the manufactured teeth... If the teeth themselves do not have any cusps, the equivalence of a cusp can be produced by a compensating curve."*

Lott's concept Lott clarified Hanau's laws of occlusion by relating them to the posterior separation that is a resultant of the guiding factors.

- The greater the angle of the condylar path, the greater is the posterior separation during protrusion (Fig. 10.78).
- The greater the angle of the overbite, the greater is the separation in the anterior and posterior regions irrespective of the angle of the condylar path (Fig. 10.79).
- The greater the separation of the posterior teeth the greater or higher must be the compensating curve (Fig. 10.80).

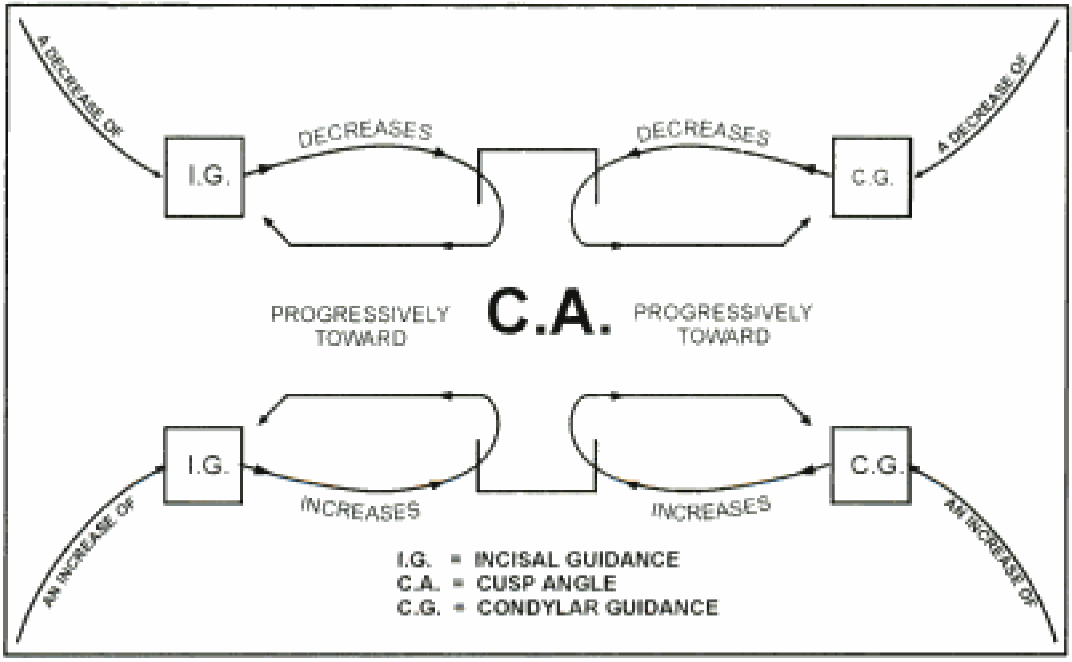
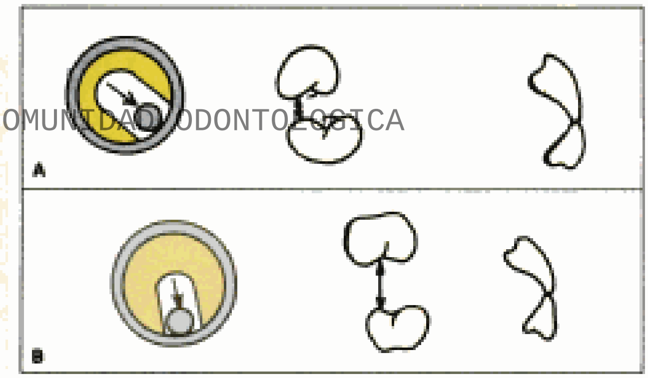


Fig. 10.77: Trapozzano's triad of occlusion



Figs 10.78a and b: (a) Shallow condylar guidance produces lesser tooth separation during protrusion (b) A steep condylar inclination will produce greater tooth separation during protrusion

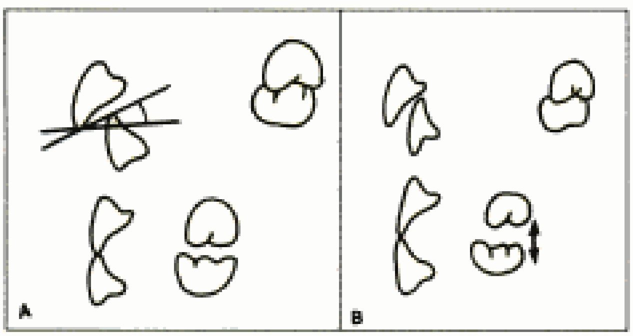
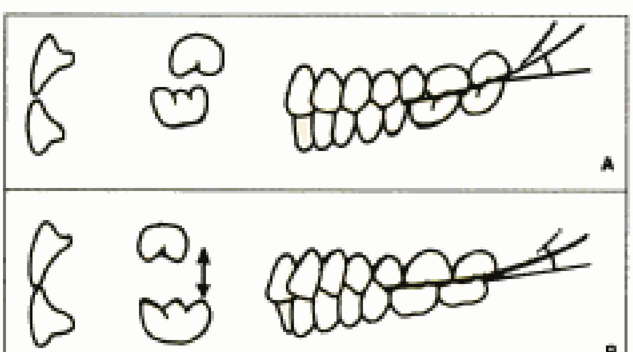
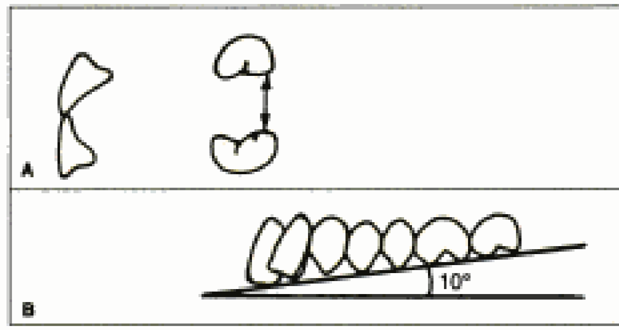


Fig. 10.79: (a) A shallow incisal guidance will produce less posterior teeth separation (b) A steep incisal guidance will produce a greater tooth separation



Figs 10.80a and b: The posterior tooth separation during protrusion can be decreased by increasing the curvature of the curve of Spee

- Posterior separation beyond the balancing ability of the compensating curve can be balanced by the introduction of the plane of orientation (Fig. 10.81).



Figs10.81a and b: The plane of occlusion can also be altered to decrease the posterior tooth separation during protrusion (Note : plane of occlusion should never be tilted more than 10°)

- The greater the separation of the teeth, the greater must be the height of the cusps of the posterior teeth (Fig. 10.82).
- He simplified Hanau's quint using the following chart (Fig. 10.83).

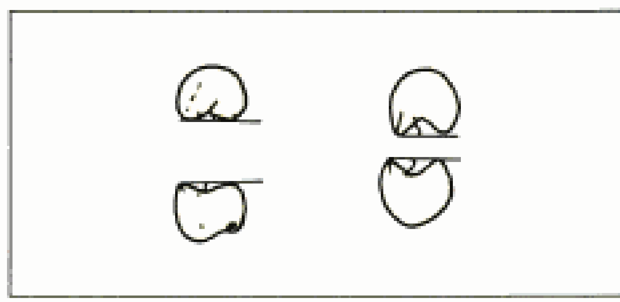


Fig. 10.82: The cuspal angulation should be increased with the increase in tooth separation

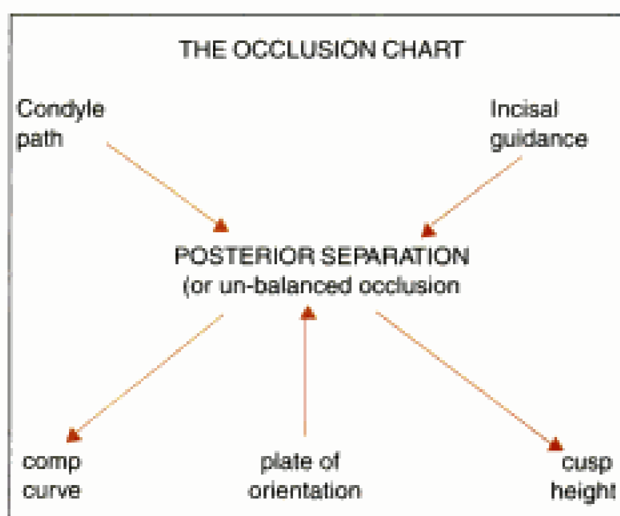


Fig. 10.83: The laws of occlusion as developed by Lott

Levin's concept Bernard Levin believed that it was not necessary to consider the plane of occlusion because it was not very useful practically. Levin also stated that the plane of occlusion can be slightly altered by 1-2 mm in order to improve the stability of a denture.

He named the other four factors of occlusion as the *Quad* (Fig. 10.84). The essentials of a quad are:

- The condylar guidance is fixed and is recorded from the patient. The balancing condylar guidance will include the Bennett movement of the working condyle. This may or may not affect the lateral balance.
- The incisal guidance is usually obtained from patient's aesthetic and phonetic requirements. However, it can be modified for special requirements. E.g. the incisal guidance is decreased for flat ridges.
- The compensating curve is the most important factor in obtaining occlusal balance. Monoplane or low cusp teeth must employ the use of compensating curve.
- Cusp teeth have the inclines necessary for balanced occlusion but nearly always are used with a compensating curve.

Factors Influencing Balanced Occlusion

Though many authors questioned the necessity of all the five factors in a Hanau's quint, it is still considered as the basic determinant of balanced occlusion. The five basic factors that determine the balance of an occlusion are:

- Inclination of the condylar path or condylar guidance.
- Incisal guidance.
- Orientation of the plane of occlusion or occlusal plane.
- Cuspal angulation.
- Compensating curves.

There should be a balance within these five factors. The incisal and condylar guidances produce a similar effect on balanced occlusion (they increase posterior tooth separation). Similarly, the other three factors have a common effect on balanced occlusion (they decrease the posterior tooth separation). The effect of the incisal and condylar guidances should be counteracted by the other three factors to obtain balanced occlusion . If this counteractive mechanism is lost, the balance of occlusion is lost (Fig. 10.85).

Let us discuss in general how these factors affect the balance during protrusion. The incisal

GUIDING FACTORS
As each guiding factor is increased the amount of separation is proportionately increased

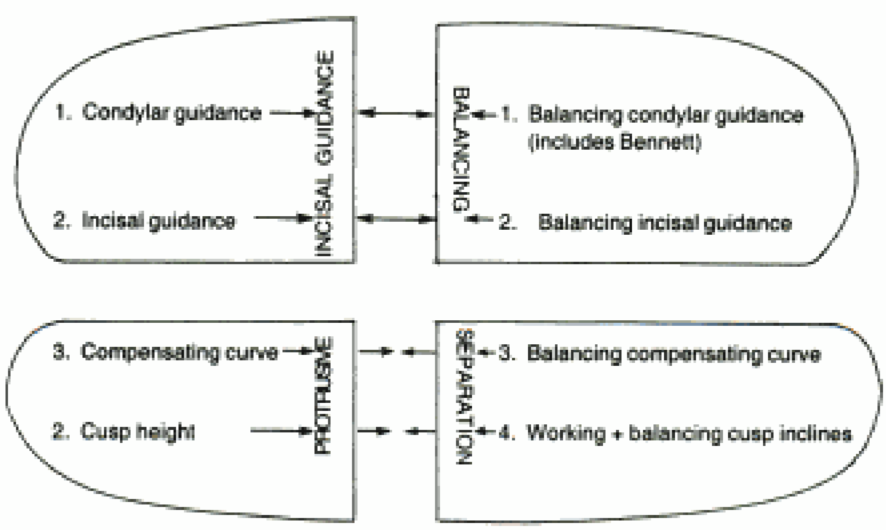


Fig. 10.84: The Quad: The laws of protrusive and lateral balanced occlusion as developed by the author

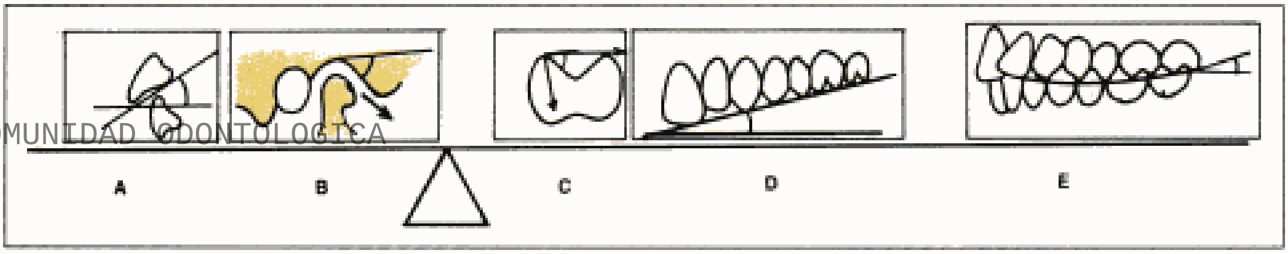


Fig. 10.85: Key (a) Incisal guidance, (b) Condylar guidance, (c) Cuspal angulation (d) Angle of plane of occlusion (e) Compensating curve. A balance of these five factors is required for balanced occlusion

guide angle denotes the angle formed by the palatal surface of the upper anteriors against the horizontal plane. The incisal guidance can be raised by altering the labial proclination, overjet and overbite of the maxillary anteriors, so that the incisal guide angle becomes steeper (Fig. 10.86).

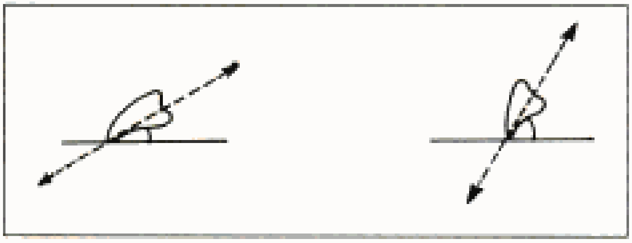


Fig. 10.86: Incisal guidance

When the patient with a steep incisal guidance brings his mandible forward, there will be more jaw separation (Fig. 10.87).This is because the movement of the mandible is controlled by the lingual surface of the upper anteriors (The upper incisors are more vertically placed in cases with a steep incisal guidance). Increase in jaw separation will lead to disocclusion of the posterior teeth leading to loss of tripod contact which will in turn lead to lifting of the posterior part of the denture during incising functions. If the posterior part of the denture lifts during incisal function, it simply means that the balanced occlusion is

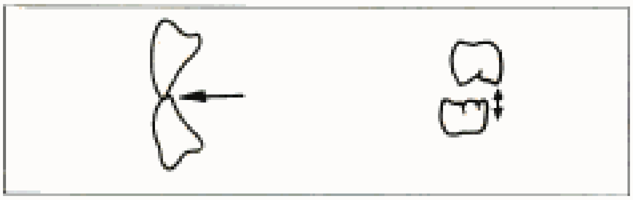
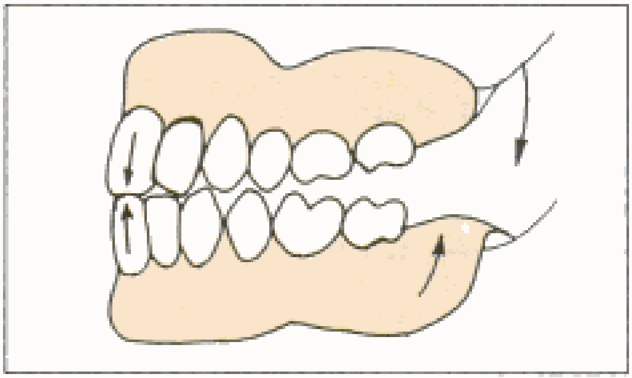
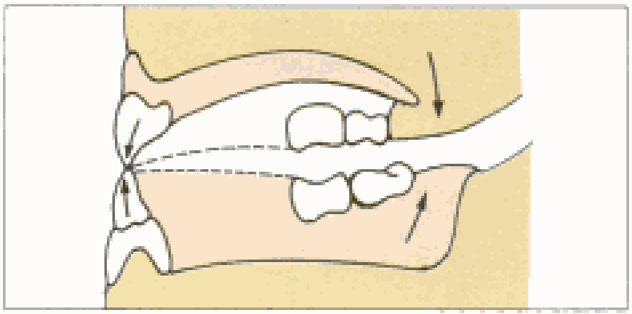


Fig. 10.87: Posterior tooth separation during protrusion

absent (Fig. 10.88). The condylar guidance has a similar effect on the denture.





Figs 10.88a and b: If artificial teeth are arranged similar to natural teeth, the denture may lose stability due to lever action during protrusion

To prevent the lifting of the posterior part of the denture, the compensating curve, cuspal angulation of the teeth, and the plane of occlusion should be modified such that a tripod contact is preserved during protrusion.

If the compensating curve is made steeper (raised), the posterior contact will be preserved during protrusion. If the cuspal height or angulation is increased, again the posterior contact will be maintained during protrusion. Similarly, if the plane of occlusion is oriented/tilted so that it is higher posteriorly, then the posterior contact will be maintained during protrusion (Fig. 10.89).

Thus we understand that when the incisal guidance or condylar guidance is high, the other three factors should also be raised to compensate the effects of the incisal and condylar guidances and vice-versa.

Now we shall discuss in greater detail about the significance of each factor in balanced occlusion.

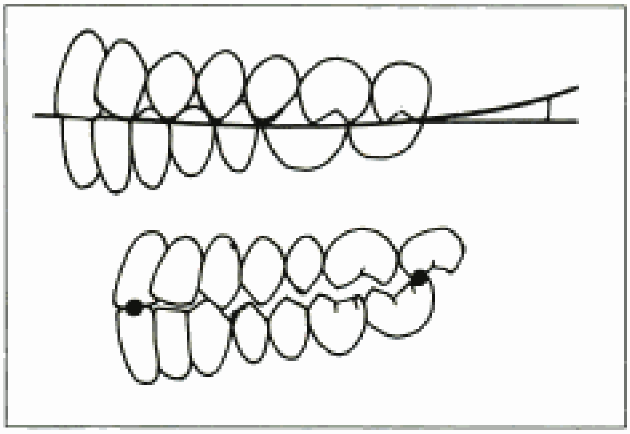


Fig. 10.89: Incorporating the curve of Spee during artificial teeth arrangement will help to provide posterior tooth contact during protrusion. Ability to obtain three point contact during protrusion is called protrusive balance

Inclination of the condylar path It is also called as the first factor of occlusion. This is the only factor, which can be recorded from the patient. *It is registered using protrusive registration (i.e. the patient is asked to protrude with the occlusal rims. Inter-occlusal record material is injected between the occlusal rims in this position. The occlusal rims with the inter-occlusal record are transferred to the articulator. Since the occlusal rims are in a protrusive relation, the upper member of the articulator is moved back to accommodate them. The inter-occlusal record is carefully removed and the upper member is allowed to slide forward to it's original position. The condylar guidance should be adjusted (rotated) till the upper member slides freely into position.* It is transferred to the articulator as the condylar guidance (Fig. 10.90).

Increase in the condylar guidance will increase the jaw separation during protrusion. This factor of balanced occlusion cannot be modified. All the other four factors of occlusion should be modified

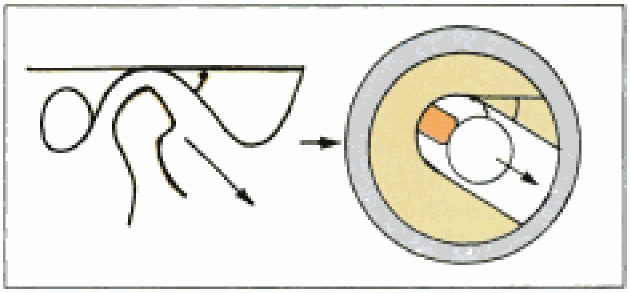


Fig. 10.90: The posterior slope of the articular eminence is represented by the condylar track of the articulator

to compensate the effects of this factor. In patients with a steep condylar guidance, the incisal guidance should be decreased to reduce the amount of jaw separation produced during protrusion and vice versa. But it should be remembered that the incisal guidance cannot be made very steep because it has its own ill effects.

Incisal guidance This is defined as, *"The influence of the contacting surfaces of the mandibular and maxillary anterior teeth on mandibular movements"* –GPT (Fig. 10.91).

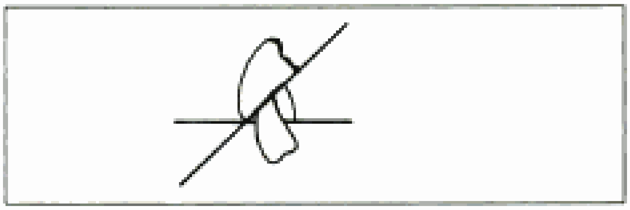


Fig. 10.91: Incisal guidance

It is called as the second factor of occlusion. It is determined by the dentist and customised for the patient during anterior try-in. It acts as a controlling path for the movement of the casts in an articulator. It should be set depending upon the desired overjet and overbite planned for the patient. If the overjet is increased, the inclination of the incisal guidance is decreased. If the overbite is increased, then the incisal inclination increases. The incisal guidance has more influence on the posterior teeth than the condylar guidance. This is because the action of the incisal inclination is closer to the teeth than the action of the condylar guidance.

During protrusive movements, the incisal edge of the mandibular anterior teeth move in a downward and forward path corresponding to

Fig. 10.92: Movement of the lower incisor tooth as determined by the incisal guidance

the palatal surfaces of the upper incisors. This is known as the *protrusive incisal path or incisal guidance*. The angle formed by this protrusive path to the horizontal plane is called as the *protrusive incisal path inclination* or the *incisal guide angle* (Fig. 10.92).

This influences the shape of the posterior teeth. If the incisal guidance is steep, steep cusps or a steep occlusal plane or a steep compensatory curve is needed to produce balanced occlusion (explained previously). In a complete denture, the incisal guide angle should be as flat (more acute) as possible. Hence, while arranging the anterior teeth, for aesthetics, a suitable vertical overlap and a horizontal overlap should be chosen to achieve balanced occlusion. Also, the incisal guidance cannot be altered beyond limits. The location and angulation of the incisors are governed by various factors like aesthetics, function and phonetics, etc.The procedure for setting up the incisal guidance was described under articulation.

Plane of occlusion or occlusal plane It is defined as, "*An imaginary surface which is related anatomically to the cranium and which theoretically touches the incisal edges of the incisors and the tips of the occluding surfaces of the posterior teeth. It is not a plane in the true sense of the word but represents the mean curvature of the surface*" – GPT.

It is established anteriorly by the height of the lower canine, which nearly coincides with the commissure of the mouth and posteriorly by the height of the retromolar pad. It is usually parallel to the ala-tragus line or Camper's line. It can be slightly altered and its role is not as important as other factors. Tilting the plane of occlusion beyond 10° is not advisable (Fig. 10.93).

Compensating curve It is defined as, "*The anteroposterior and lateral curvatures in the alignment of the occluding surfaces and incisal edges of artificial teeth which are used to develop balanced occlusion*" – GPT.

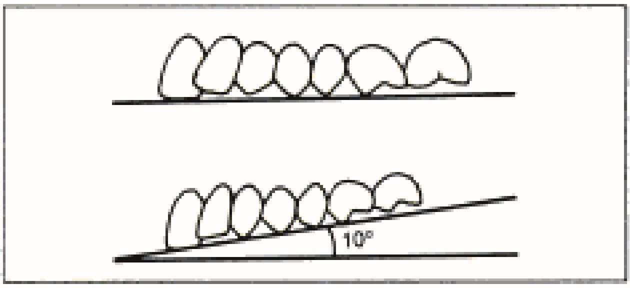


Fig. 10.93: The plane of occlusion can be altered to a maximum of 10°

It is an important factor for establishing balanced occlusion. It is determined by the inclination of the posterior teeth and their vertical relationship to the occlusal plane. The posterior teeth should be arranged such that their occlusal surfaces form a curve. This curve should be in harmony with the movements of the mandible guided posteriorly by the condylar path.

A steep condylar path requires a steep compensatory curve to produce balanced occlusion. If a shallow compensating curve is given for the same situation, there will be loss of balancing molar contacts during protrusion (explained before).

There are two types of compensating curves namely:

- Anteroposterior curves
- Lateral curves

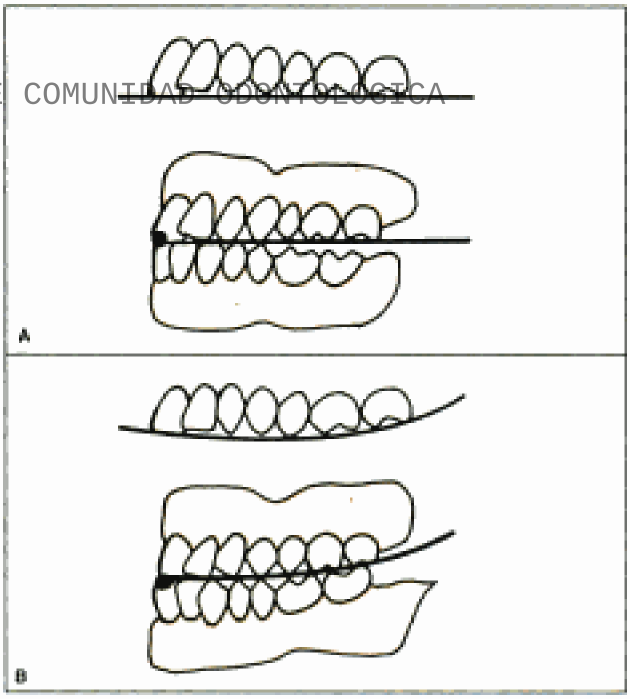
Curve of Spee, Wilson's curve and Monson's curve are associated only with natural dentition. In complete dentures compensating curves similar to these curves should be incorporated to produce balanced occlusion.

Anteroposterior Compensating Curves

These are compensatory curves running in an anteroposterior direction. They compensate for the curve of Spee seen in natural dentition.

Compensating Curve for Curve of Spee

Curve of Spee is defined as, "*Anatomic curvature of the occlusal alignment of teeth beginning at the tip of the lower canine and following the buccal cusps of the natural premolars and molars, continuing to the anterior border of the ramus as described by Graf von Spee*" - GPT.



Figs 10.94a and b: (a) Posterior separation will occur during protrusion if the curve of Spee is not incorporated into the artificial teeth arrangement, (b) Incorporating the curve of Spee will provide posterior tooth contact during protrusion

It is an imaginary curve joining the buccal cusps of the mandibular posterior teeth starting from the canine passing through the head of the condyle (Fig. 10.94). It is seen in the natural dentition and should be reproduced in a CD. The significance of this curve is that, when the patient moves his mandible forward, the posterior teeth set on this curve will continue to remain in contact. If the teeth are not arranged according to this curve, there will be disocclusion during protrusion of the mandible *(Christensen's phenomenon)*.

Lateral Compensating Curves

These curves run transversely from one side of the arch to the other. The following curves fall in this category:

Compensating Curve for Monson Curve

Monson's curve is defined as, *"The curve of occlusion in which each cusp and incisal edge touches or conforms to a segment of a sphere of 8 inches in diameter with its center in the region of the Glabella"*-GPT.

This curve runs across the palatal and buccal cusps of the maxillary molars. During lateral movement the mandibular lingual cusps on the working side should slide along the inner inclines of the maxillary buccal cusp. In the balancing side the mandibular buccal cusps should contact the inner inclines of the maxillary palatal cusp. This relationship forms a balance.

Only if the teeth are set following the Monson's curve there will be lateral balance of occlusion (Fig. 10.95).

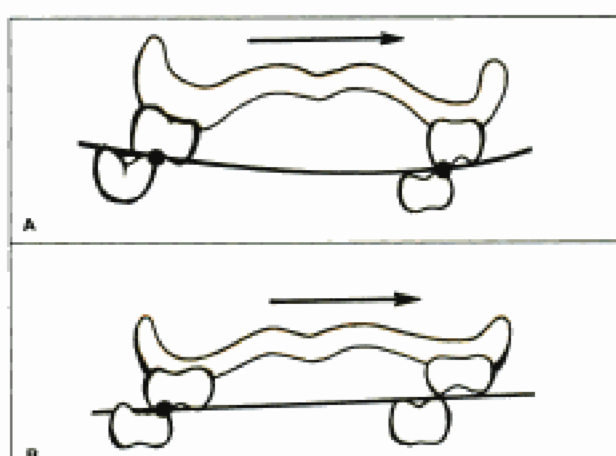
Compensating Curve for Anti-Monson or Wilson's Curve

Wilson's curve is defined as, *"A curve of occlusion which is convex upwards"*-GPT.

This curve runs opposite to the direction of the Monson's curve. This curve is followed when the first premolars are arranged . The premolars are arranged according to this curve so that they do not produce any interference to lateral movements.

Reverse Curve

"A curve of occlusion which in transverse cross-section conforms to a line which is convex upward"-GPT. It was originally developed to improve the stability



Figs 10.95a and b: Incorporating the Monson's curve during posterior teeth arrangement, will aid to provide balancing side contact during laterotrusion

of the denture. It is explained in relation to mandibular posterior teeth. The reverse curve was modified by Max. Pleasure to form the pleasure curve (Fig. 10.95c).

Pleasure Curve

"A curve of occlusion which in transverse cross-section conforms to a line which is convex upward except for the last molars" -GPT.

It was proposed by Max. Pleasure. He proposed this curve to balance the occlusion and increase the stability of the denture. Here the first molar is horizontal and the second premolar is buccally tilted. The second molar independently follows the anteroposterior compensating curve and lingually tilted (Fig. 10.95d). This curve runs from the palatal cusp of the first premolar to the distobuccal cusp of the second molar. The second molar gives occlusal balance and the second premolar gives lever balance.

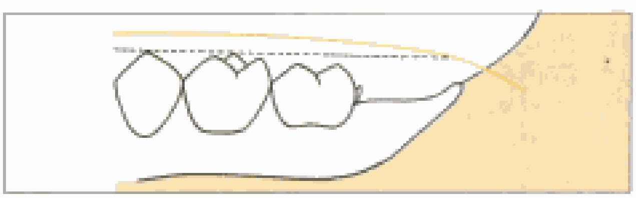


Fig. 10.95c: Reverse lateral curve

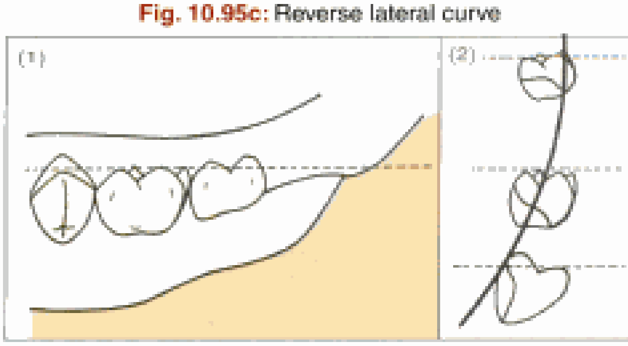


Fig. 10.95d: (1) Pleasure curve: Lateral view. Notice that the second premolar and the first molar follow the reverse curve. While the second molar follows the anteroposterior compensating curve. (2) Pleasure curve: Frontal view. It runs from the lingual cusp of the second premolar to the distobuccal cusp of the second molar

Cuspal angulation Cusp angle is defined as, *"The angle made by the average slope of a cusp with the cusp plane measured mesiodistally or buccolingually"* -GPT (Fig. 10.96a).

The cusps on the teeth or the inclination of the cuspless teeth are important factors that modify the effect of plane of occlusion and the compensating curves. The mesiodistal cusps lock the occlusion, such that repositioning of teeth does not occur due to settling of the base.

In order to prevent the locking of occlusion, the mesiodistal cusps are reduced during occlusal reshaping. In the absence of mesiodistal cusps, the buccolingual cusps are considered as a factor for balanced occlusion.

In cases with a shallow overbite, the cuspal angle should be reduced to balance the incisal guidance. This is done because the jaw separation will be less in cases with decreased overbite. Teeth with steep cusps will produce occlusal interference in these cases.

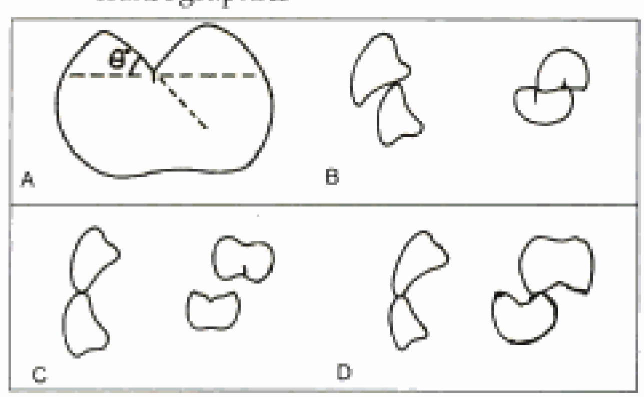
In cases with deep bite (steep incisal guidance), the jaw separation is more during protrusion. Teeth with high cuspal inclines are required in these cases to produce posterior contact during protrusion (Figs 10.96b to 10.96d).

Thus, we discussed the various concepts and factors affecting balanced occlusion. The method of occlusal reshaping is not discussed in detail due to its complexity. It is necessary for a dentist to at least know that occlusal reshaping is done after teeth arrangement to produce balanced occlusion.

Monoplane or Non-Balanced Occlusion

It is an arrangement of teeth with form or purpose. It includes the following concepts of occlusion:

- Spherical theory
- Organic occlusion
- Occlusal balancing ramps for protrusive balance
- Transographics



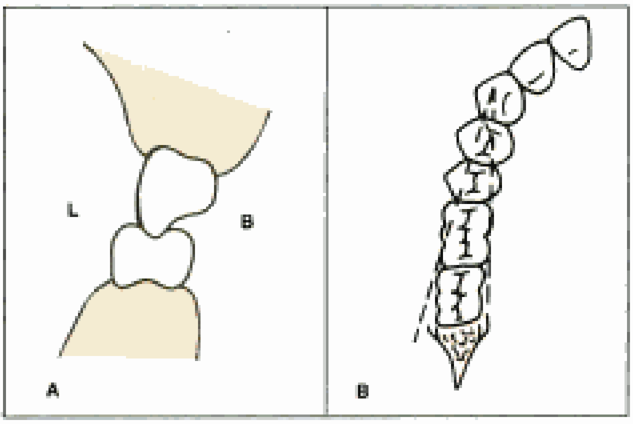
Figs 10.96a to d: (a) Cuspal angulation, (b and c) Teeth with low cuspal inclines do not provide tooth contact during protrusion, (d) Teeth with high cuspal inclines are required to obtain posterior tooth contact during protrusion

Concepts of Non-balanced Occlusion

The concept of monoplane occlusion was a result of Sheppard's statement "*Enter Bolus, Exit Balance*". This statement questioned the need for balanced occlusion (Refer importance of balanced occlusion).

Consecutively many clinicians came with different concepts of non-balanced occlusion for complete dentures.

Pound's concept He proposed a monoplane occlusion which stresses the importance of phonetic and aesthetics for anterior teeth. The posterior teeth on the other hand have a sharp upper lingual cusp and a wide lower central fossa. The buccal cusps of the lower posterior teeth were reduced to avoid non-vertical occlusal forces. Effectively, it was a lingualized occlusion where in there is no buccal contact of upper and lower teeth and the occlusal surfaces are reduced such that they lie in a triangle formed between the mesial end of the canine and the two sides of the retromolar pad (Fig. 10.97).



Figs 10.97a and b: Pound's concept of tooth arrangement

Cusp form gold occlusal concept As the name suggests, it uses teeth with a 33° cusp form made on a gold surface. According to this concept, the anteriors are set by aesthetic and phonetic requirements and the posteriors are set with vertical overlap such that there is disocclusion due to the canine during eccentric movement of the mandible.

Hardy's concept He proposed a flat occlusal plane set with nonanatomical teeth for complete denture occlusion. Metal insert teeth were also proposed.

Occlusal pivot by Sear The pivots were used to place the mandible in equilibrium by concentrating the load in the molar regions. This scheme reduced the injury to the temporomandibular joint and also reduced the stress in the anterior region (Fig. 10.98).

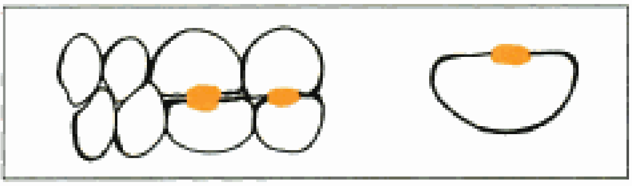


Fig. 10.98: Occlusal pivots by Sear

Kurth's concept He proposed a non-balanced occlusion set with flat posterior teeth in a horizontal plane without any balancing ramps. The teeth were set in a flat plane anteroposteriorly with a reverse lateral curve (Fig. 10.99). **This reverse lateral curve is not a compensating curve.**

Philip M. Jones scheme of non-balanced occlusion In this scheme, non-anatomical teeth were arranged with the following modifications:

- A different articulator that could fit large casts were used.
- The maxillary and mandibular teeth were arranged without any vertical overlap. The jaw relation determined the amount of horizontal overlap.
- The maxillary posteriors were set first. The occlusal plane should fulfil the following requirements:

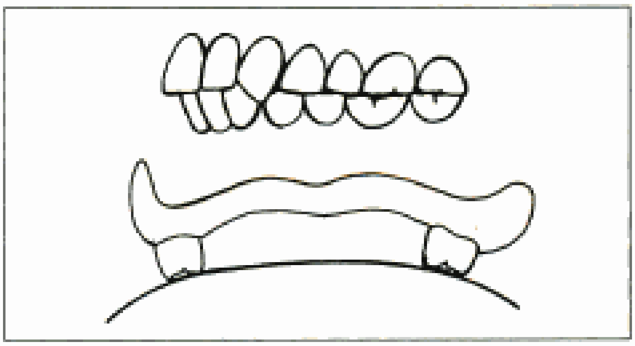


Fig. 10.99: Philip M. Jones concept of non-balanced occlusion

- — The occlusal plane should divide the inter-arch space equally.
- — The occlusal plane should be parallel to the mean denture base foundation.
- — The occlusal plane should lie at the junction of the upper and middle thirds of the retromolar pad.

- During final arrangement, there should be complete intercuspation between the upper and lower posterior teeth except the second molar.
- The occlusal surface of the upper second molar should be 2 mm above the plane of occlusion (hence it is out of occlusion) and parallel to the occlusal surface of the lower second molar.

These modifications are done so that the premolars and the first molars are the primary masticators and the second molars are just non-functional space fillers.

General Considerations

The following points have to be considered while using a non-balanced occlusion for a denture:

- Opposing artificial teeth should not contact when the jaws are in eccentric relation, because it may give destabilizing forces to the basal seat area. The architecture of the basal seat does not allow tooth contact when the mandible is in eccentric position.
- Tooth contact should occur only when the mandible is in centric relation to the maxilla.
- The patient should be encouraged to repeat the mandibular movements till there is no discomfort in centric relation.

Lingualized Occlusion

It was first proposed by Alfred Gysi in 1927. This type of occlusion involves the use of a large upper palatal cusp against a wide lower central fossa (Fig. 10.100). In this scheme, the buccal cusps of the upper and lower teeth do not contact each other. Clough reported that 67% of the patients preferred lingualized occlusion due to its superior chewing efficiency.

Many clinicians contributed to the concept of lingual occlusion. Pound proposed non-balanced lingualized occlusion. Payne proposed the use of 30° anatomical teeth which are later reshaped to

Figs10.100a and b: (a) Normal occlusion (b) lingualized occlusion

obtain lingual occlusion. This scheme had complete intercuspation without any deflective occlusal contacts.

Myerson's Lingualized Integration (MLI)

Myerson proposed specialized tooth moulds for arranging teeth in lingualized occlusion. He proposed two different moulds for the maxillary posteriors namely control contact (cc) mould and maximum contact (MC) mould. The remaining teeth are common for both these moulds.

He advocates the use of 'MC' mould for patients who can reproduce accurate centric position and the 'CC' mould for patients with variations in centric position.

These teeth provide maximal inter cuspation, good cuspal height to perform occlusal reshaping and a natural and pleasing appearance. The 'MC' mold maxillary posteriors have taller cusps with a more anatomical appearance compared to the 'CC' mould. The 'MC' mould also offers a more 'exacting occlusion'.

ARRANGEMENT OF ARTIFICIALTEETH

Now that we have discussed in detail the concepts of occlusion you will understand that the artificial teeth should be arranged according to certain principles to avoid the deflection of any destructive forces towards the supporting tissues.

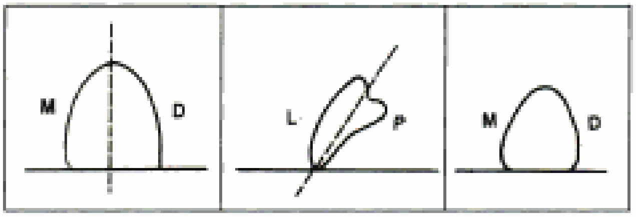
An artificial tooth is set by softening the wax in that portion of the occlusal rim and positioning the tooth on it.

PRINCIPLES OFTEETH ARRANGEMENT

Each tooth is attached/luted/sealed to the occlusal rim based on the following principles.

Maxillary Central Incisor (Fig. 10.101)

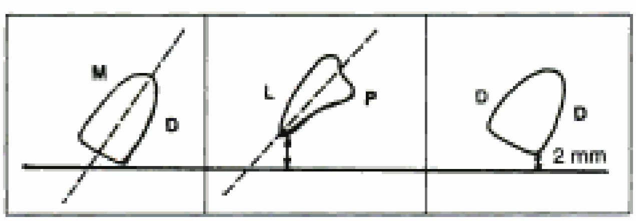
- The long axis of the tooth is parallel to the vertical axis when viewed from the front.
- The long axis of the tooth is sloping labially when viewed from the side.
- The incisal edge of the tooth evenly contacts the occlusal plane.



Figs10.101a to c: M—Mesial, D—Distal, L—Labial, P—Palatal

Maxillary Lateral Incisor (Fig. 10.102)

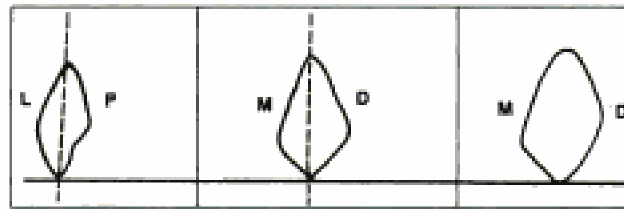
- The long axis of the tooth is tilted towards the midline when viewed from the front.
- The long axis of the tooth is sloping labially when viewed from the side. The inclination of the slope is greater than that of the central incisor.
- The incisal edge is 2 mm above the level of the occlusal plane. And the edge is tilted towards the midline.



Figs10.102a to c: L—Labial, P—Palatal, M—Mesial, D—Distal

Maxillary Canine (Fig. 10.103)

- The long axis of the tooth is parallel to the vertical axis when viewed from the front. A mild mesial tilt is supposed to improve its aesthetics.
- The long axis of the tooth is parallel to the vertical axis when viewed from the side.
- The cuspal tip of the canine touches the plane of occlusion.

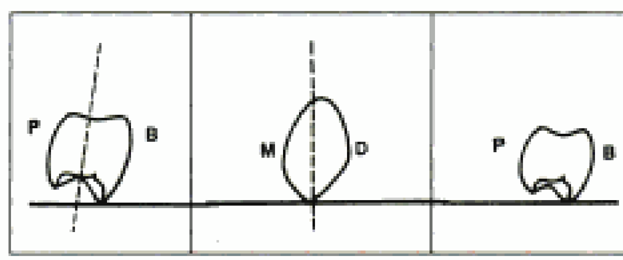


Figs10.103a to c: L—Labial, P—Palatal, M—Mesial, D—Distal

- The cervical third of the canine should be more prominent than the cuspal third.

Maxillary First Premolar (Fig. 10.104)

- The long axis of the tooth is parallel to the vertical axis when viewed from the front.
- The long axis is parallel to the vertical axis when viewed from the side.
- The buccal cusp touches the occlusal plane and the palatal cusp is positioned about 0.5 mm above the occlusal plane.



Figs10.104a to c: P—Palatal, B—Buccal, M—Mesial, D—Distal

Maxillary Second Premolar (Fig. 10.105)

- The long axis of the tooth is parallel to the vertical axis when viewed from the front.
- The long axis of the tooth is parallel to the vertical axis when viewed from the side also.
- Both the buccal and palatal cusps should touch the occlusal plane.

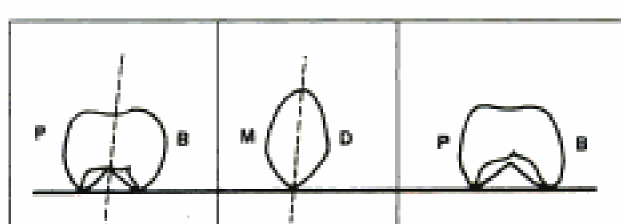
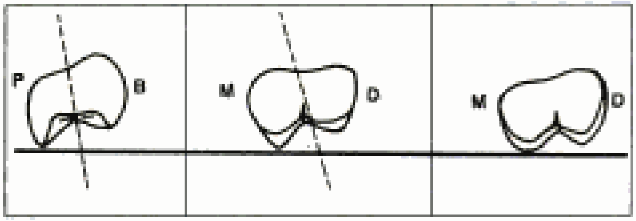


Fig.10.105a to c: P—Palatal, B—Buccal, M—Mesial, D—Distal

Maxillary First Molar (Fig. 10.106)

- The long axis of the tooth is tilted buccally when viewed from the front.

- The long axis of the tooth is tilted distally when viewed from the side.
- The mesio-palatal cusp alone should touch the occlusal plane. This arrangement gives rise to the lateral curves.

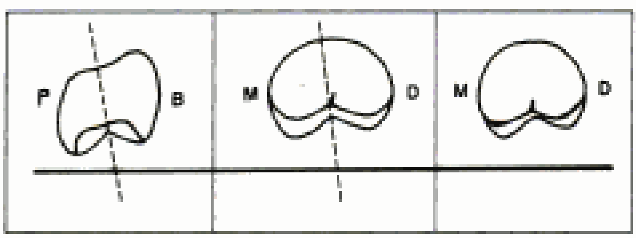


Figs10.106a to c: P—Palatal, B—Buccal, M—Mesial, D—Distal

Maxillary Second Molar (Fig. 10.107)

It is arranged similar to a first molar except in a higher level.

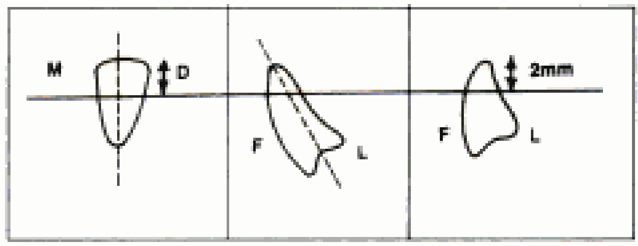
- The long axis of the tooth is tilted buccally when viewed from the front.
- The long axis of the tooth is tilted distally when viewed from the side.
- The mesio-palatal cusp should be the nearest cusp to the occlusal plane.



Figs10.107a to c: P—Palatal, B—Buccal, M—Mesial, D—Distal

Mandibular Central Incisor (Fig. 10.108)

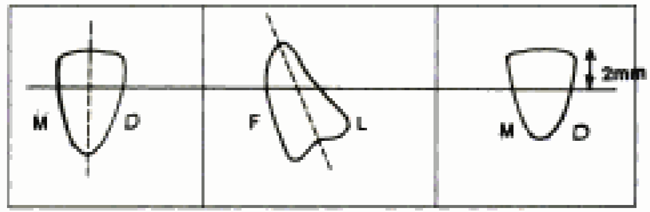
- The long axis of the tooth is parallel to the vertical axis when viewed from the front.
- The long axis of the tooth slopes slightly labially when viewed from the side.
- The incisal edge of the tooth should be 2 mm above the plane of occlusion.



Figs10.108a to c: M—Mesial, D—Distal, F—Facial, L—Lingual

Mandibular Lateral Incisor (Fig. 10.109)

- The long axis of the tooth is parallel to the vertical axis when viewed from the front.

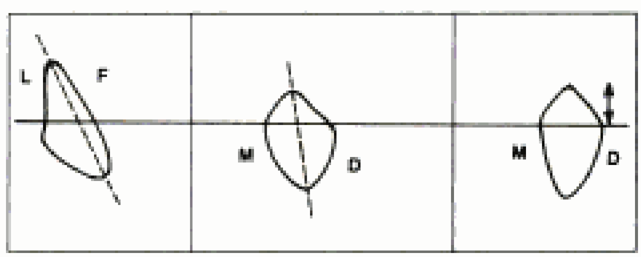


Figs10.109a to c: M—Mesial, D—Distal, F—Facial, L—Lingual

- The long axis of the tooth slopes slightly labially when viewed from the side but not so steeply as the central incisor.
- The incisal edge of the tooth should be 2 mm above the plane of occlusion.

Mandibular Canine (Fig. 10.110)

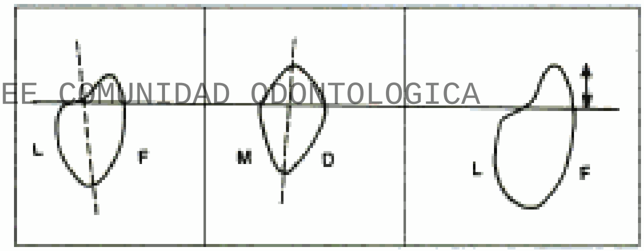
- The long axis of the tooth is very slightly tilted lingually when viewed from the front.
- The long axis of the tooth slopes slightly mesially when viewed from the side.
- The canine tip is slightly more than 2 mm above the occlusal plane.



Figs10.110a to c: M—Mesial, D—Distal, F—Facial, L—Lingual

Mandibular First Premolar (Fig. 10.111)

- The long axis of the tooth slopes slightly lingually when viewed from the front.
- The long axis of the tooth is parallel to the vertical axis when viewed from the side.

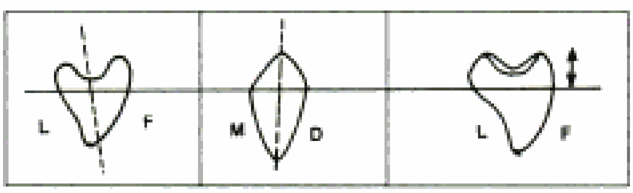


Figs10.111a to c: M—Mesial, D—Distal, F—Facial, L—Lingual

- The lingual cusp is below the occlusal plane and the buccal cusp should be 2 mm above the occlusal plane.

Mandibular Second Premolar (Fig. 10.112)

- The long axis of the tooth slopes slightly lingually when viewed from the front.
- The long axis of the tooth is parallel to the vertical axis when viewed from the side.
- Both the cusps are 2 mm above the level of the occlusal plane.



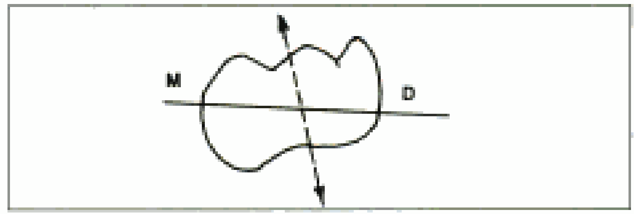
Figs10.112a to c: M—Mesial, D—Distal, F—Facial, L—Lingual

Mandibular First Molar (Fig. 10.113)

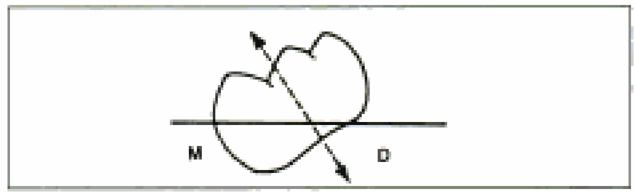
- The long axis of the tooth slopes slightly lingually when viewed from the front.
- The long axis of the tooth is tilted mesially when viewed from the side.
- All the cusps are above the level of the occlusal plane with the mesial and lingual cusps being lower than the distal and buccal cusps.

Mandibular Second Molar (Fig. 10.114)

- The long axis of the tooth slopes slightly lingually when viewed from the front.
- The long axis of the tooth is tilted mesially when viewed from the side.
- All the cusps are above the level of the first molar with the mesial and lingual cusps being lower than the distal and buccal cusps.



Figs10.113a to c: M—Mesial, D—Distal



Figs10.114a to c: L—Lingual, F—Facial, M—Mesial, D—Distal

OTHER GUIDELINES FOR ARRANGEMENT OFTEETH

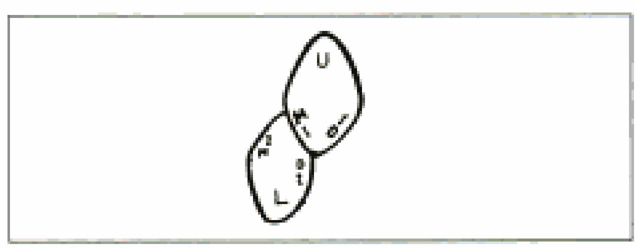
The arrangement of teeth should satisfy the following concepts.

Key of Occlusion

It denotes the relationship of the upper and lower teeth during function.

Canine Key of Occlusion (Fig. 10.115)

According to this principle, usually the distal arm of the lower canine should align with the mesial arm of the upper canine. The artificial teeth should be arranged according to this rule.



Figs10.115: Canine key of occlusion MI—Mesial incline, DI—Distal incline

Molar Key of Occlusion (Fig. 10.116)

According to this principle, the mesiobuccal cusp of the maxillary permanent molars should coincide with the mesiobuccal groove (also called buccal groove) of the mandibular permanent molars.

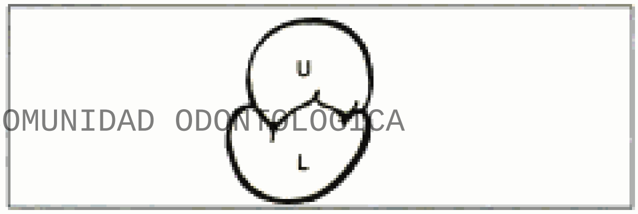


Fig.10.116: Molar key of occlusion

This is class I molar relationship. Artificial teeth should be set according to this principle. Even if there is an abnormal jaw relation the molar relationship is always maintained, as it is the most efficient relationship.

Arch Form

The maxillary arch is usually 'U' shaped and the mandibular arch is 'V' shaped (Fig. 10.117). But it is not mandatory for any one to follow a fixed arch form. Whatever is the shape of the arch, the symmetry should never be lost.

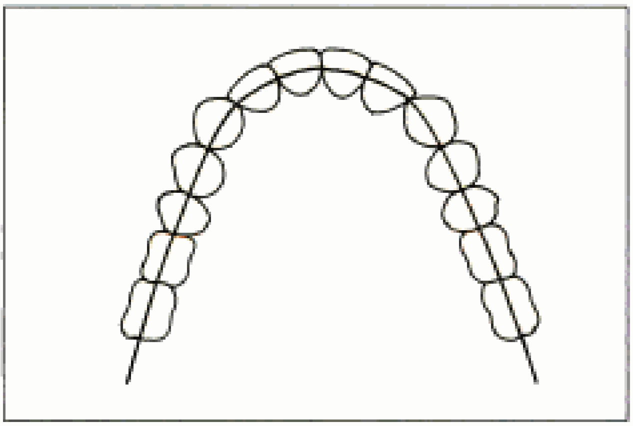


Fig.10.117a: Arch form to be followed while arranging maxillary teeth

The maxillary arch should have a smooth curve formed by the incisal edge of the anteriors. The canine will mark the turn of the arch and is the most prominent tooth among the anteriors.

Regarding the posteriors, there are two concepts followed. The advantage of each concept is not clear.

Aligned Occlusal Groove Concept

The central grooves of all the maxillary posteriors should lie on the straight line joining the tip or

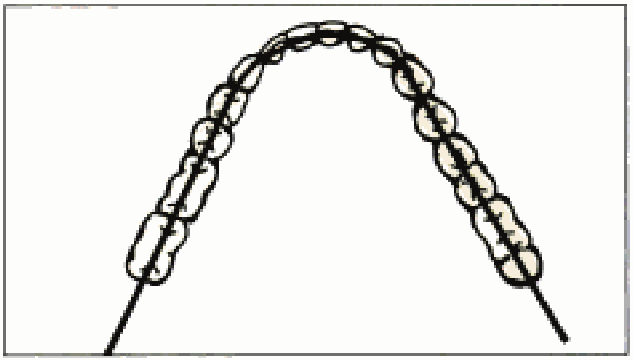


Fig.10.117b: Arch form to be followed while arranging mandibular teeth

distal arm of the canine anteriorly and the midpoint of the occlusal rim posteriorly (Fig. 10.118).

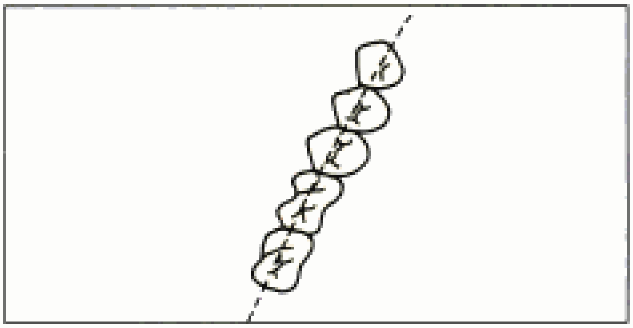


Fig.10.118: Arrangement of posterior teeth according to the arranged occlusal groove concept

Aligned Buccal Ridge Concept

According to this concept the line formed by the central grooves should pass lingual to the canine, and the buccal ridges of the maxillary canine, maxillary first premolar, maxillary second premolar and the mesiobuccal line angle of the maxillary first molar should lie in a straight line. According to this concept, the arch makes a slight medial curvature at the first molar region (Fig. 10.119).

Overjet and Overbite (Fig. 10.120)

Overjet denotes the distance between the upper and lower incisors measured in the horizontal plane. It should be at least 2 mm in a normal individual. Overjet is increased in cases with class II malocclusion and decreased in cases with class III malocclusion.

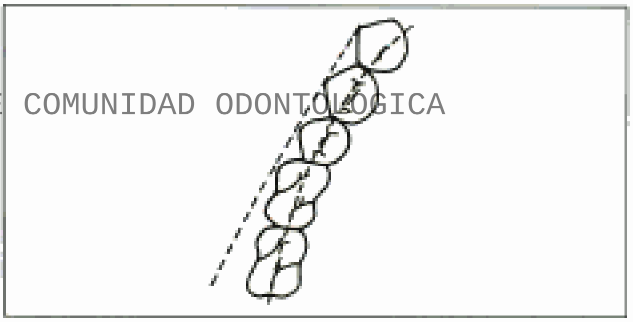


Fig.10.119: Maxillary posterior teeth arranged according to the aligned buccal ridge concept

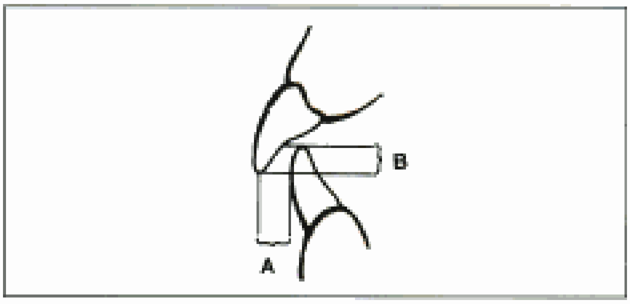


Fig.10.120: (a) Overjet and (b) Overbite

Overbite denotes the vertical overlap of the maxillary and mandibular anteriors. It is usually 0.5 mm in a normal individual.

Increase in overjet or overbite can alter the incisal guidance of the occlusion.

Compensating Curves (Fig. 10.121)

(Refer factors affecting balanced occlusion). The compensating curve for curve of Spee, Wilson's curve and the Monson's curve are normally incorporated to obtain a balanced occlusion. Arranging the teeth according to the previously mentioned setting principles will automatically incorporate the compensating curves.

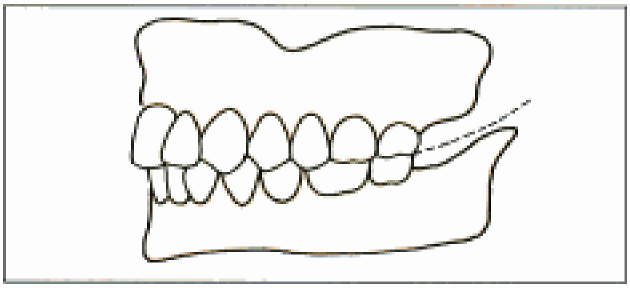


Fig.10.121: Compensated curve of Spee

Neutral Zone

- Teeth should be arranged in the *neutral zone* where the forces of the buccal musculature are compensated by the lingual musculature.
- If the teeth are arranged buccally, the buccinator will destabilize the denture. Similarly, if the teeth are arranged lingually, there will be reduction of the tongue space and the tongue will destabilize the denture.

Tooth to Ridge Relation

The following factors should be considered:

- The mandibular posterior teeth should be arranged on the ridge for more stability.
- The mandibular anteriors should be inclined such that the incisive forces are transferred to the crest of the ridge.
- Generally all posterior teeth should have their long axis co-inciding with the long axis of the residual ridge.

Characterization of Dentures

Artificial teeth have ideal morphology. This frequently imparts an artificial appearance to the denture, because, it is almost impossible for any one to have a perfect set of teeth in the perfect arrangement especially in old age.

Hence the dentist can add his personal touch and produce small imperfections, which make the teeth look natural. These imperfections should not compromise the functions of the denture.

Methods of characterization include mild chipping, occlusal wear facets, small restorations on the teeth, staining to depict the endemic conditions, mild rotations and alteration in anterior teeth arrangement.

Though these characterizations produce a striking resemblance to natural teeth, patient prefer to have white, unaltered artificial looking teeth.

WAX UP

Waxing up is defined as, *"The contouring of a pattern in wax generally applied to shaping in wax of the contours of a trial denture"* – GPT.

Wax up is also defined as the contouring of a wax pattern or the wax base of a trial denture into a desired form.

A proper wax up is necessary for better and easier evaluation of aesthetics and functions of a denture. Wax up should be done prior to aesthetic try-in inorder to give the patient an idea of the treatment outcome. The procedure is simple and carried out using the following steps.

PROCEDURE

- A roll of base plate wax should be softened under open flame (Fig. 10.122).

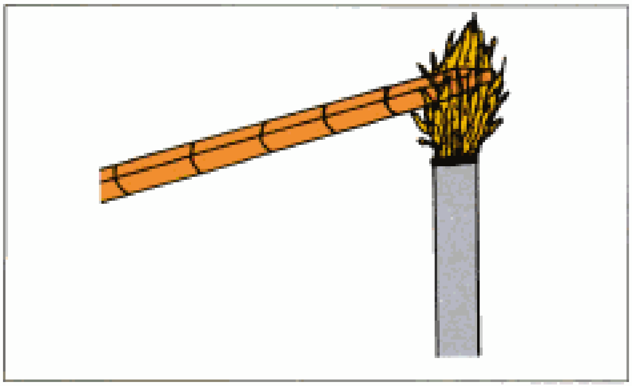


Fig.10.122

- The softened wax is kneaded and adapted over the cervical area of the teeth (Fig. 10.123).

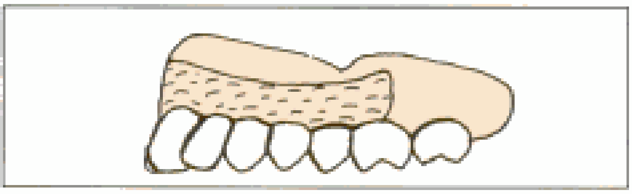


Fig.10.123

- The wax should be adapted and contoured such that it gives a convex contour to the denture flange (Fig. 10.124).
- A depression should be created (carved out) between the central and lateral incisors.
- The buccal gingival bulge should become more prominent near the molar and second molar regions (Fig. 10.125). Many prefer concave flange contour.

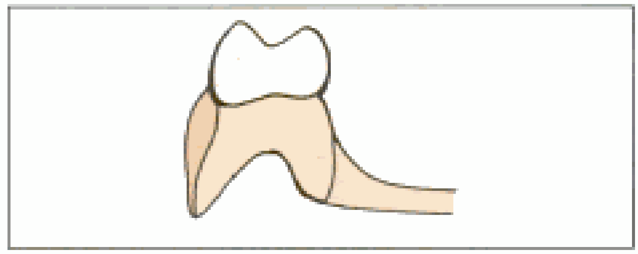


Fig.10.124

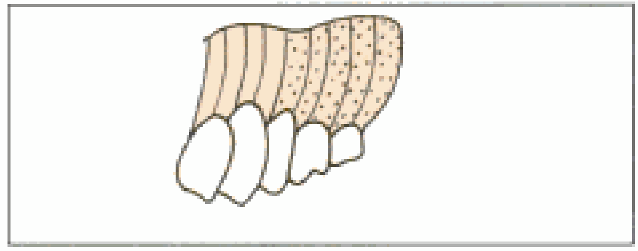


Fig.10.125

- Festooning is produced by creating depressions interdentally (Fig. 10.126).

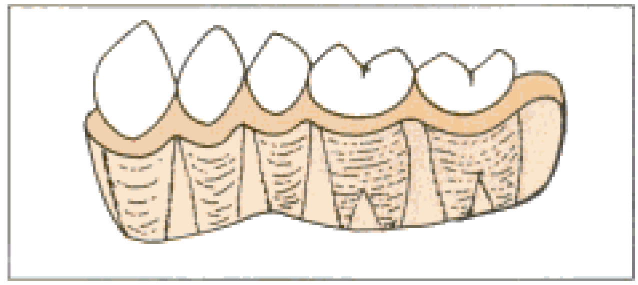


Fig.10.126

- The wax should be carved around the neck of each tooth using a wax spatula.
- Excess wax should be removed till the finish line of the teeth. The carver should be held at an angle of 60° while carving the anterior region and 45° while carving the posterior region.
- The wax should be thinned down near the necks of the teeth. This is done to resemble the free gingiva (Fig. 10.127).
- Stippling can be produced interdentally using a toothbrush (Fig. 10.128).
- The contoured pattern can be polished by flaming it swiftly and immediately wiping with wet cotton under running water (Fig. 10.129).

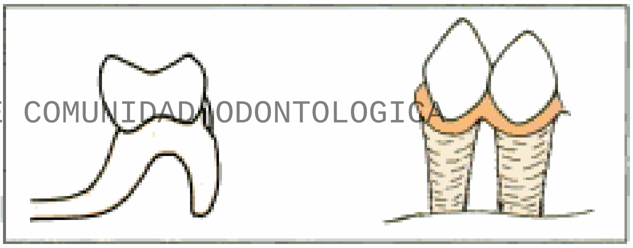


Fig.10.127

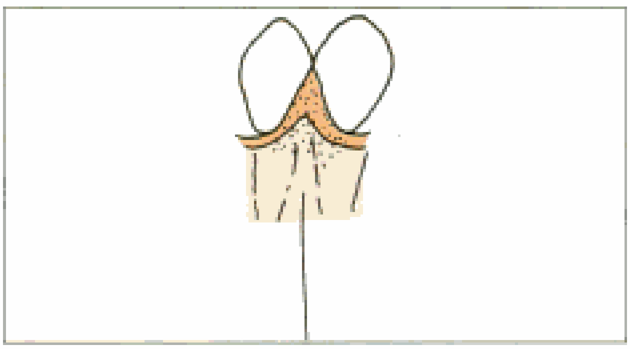


Fig.10.128

- A layer of wax can be added to the palatal surface of the record base to increase its thickness (Fig. 10.130). Normal thickness is 2-2.5 mm.

  After wax up, the trial denture is ready for the try-in appointment. It should be placed on the

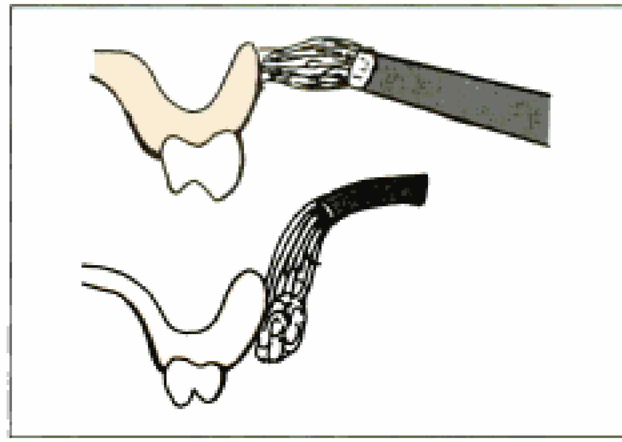


Fig.10.129

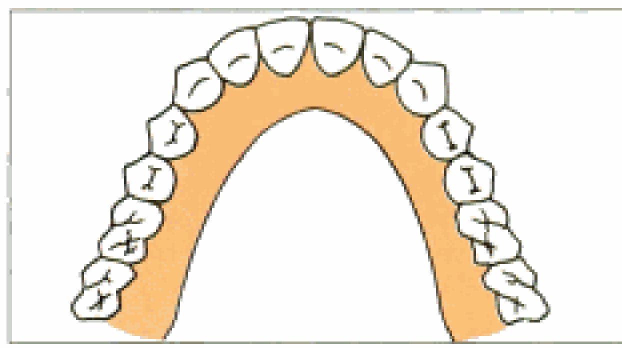


Fig.10.130

cast mounted in an articulator, and preserved carefully till the try-in appointment.

11

Try-In

DEFINITION

Try-in verification or *aesthetic try-in* is defined as, *"A preliminary insertion of a removable denture wax-up or a partial denture casting or a finished restoration to determine the fit, aesthetics, maxillomandibular relation."*-GPT.

It is the verification and perfection of jaw relation. It is the primary evaluation of removable denture wax up or partial denture casting or finished restoration to evaluate fit, aesthetics and maxillomandibular relations.

PROCEDURE

During try-in, all the procedures carried out in the fabrication of the denture are verified. Try-in verification involves the following procedure:

Primary Evaluation

- *Check for adaptation:* Adaptation of base plate is first checked extraorally on an articulator before intraoral try-in.
- *Evaluation of occlusion:* There should be complete intercuspation of the denture teeth in centric relation.
- *Evaluation of vertical height:* The vertical height at rest and occlusion are verified.
- *Evaluation of polished surfaces:* The polished surfaces should be smooth and void-free to avoid discomfort and food entrapment.

Preliminary Evaluation in Articulator

- *Evaluation of impression surface:* The impression surface should be checked for adaptation. It should be free of projections.
- *Evaluation of polished surface:* The polished surfaces should be free of any void and be in harmony with the tissue contour.
- *Evaluation of occlusal surface:* The occlusal surfaces should be free of wax and the gingival margins of the teeth should be carved out properly.

Evaluation in Mouth

- Verification of denture coverage.
- Denture base extension: the denture borders should not extend over the non-supportive structures.

Evaluation of Individual trial Denture (Maxillary and Mandibular) in Mouth

- Evaluation of denture extension.
- Evaluation of retention: Retention is the resistance to removal offered by the denture in a direction opposite to that of insertion.
- Evaluation of stability: It is quality of a denture to be steady, firm and constant in relation to denture bearing area when subjected to forces of mastication. It is checked by application of pressure on one side of denture towards the tissue. If it rotates the denture shows lack of stability.
- Evaluation of support: It is the ability of the denture to withstand forces along the path of insertion.
- Evaluation of aesthetics.

Evaluation of Lip and Cheek Support

The incisal thirds of the anterior teeth should be visible when the upper lip is at rest (low lip line).

The middle third should also be visible while smiling (high lip line). The thickness of the labial and buccal flanges of the trial denture will determine the labial and buccal fullness of the face.

Evaluation of the Occlusal Plane

Occlusal Verification of the maxillary Trial Denture

- Intraoral:
  — *Parotid papilla:* The maxillary occlusal plane should be 1/4th inch below the parotid papilla (Fig. 11.1).
  — Linea alba buccalis (Fig. 11.2).

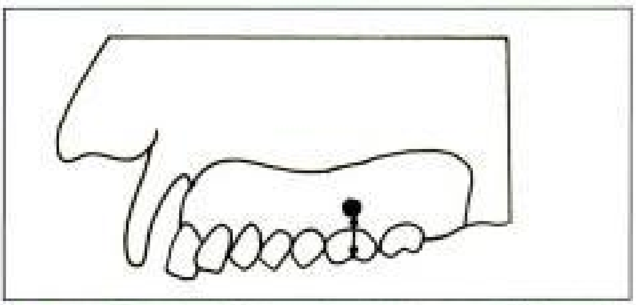


Fig. 11.1: The level of the occlusal plane at the first molar region should be one-fourth of an inch below the opening of the Stensen's duct

Fig. 11.2: Linea alba buccalis is a zone of hyperkeratinization that occurs at the level of occlusal interdigitation. This landmark can be used as a guide to verify the occlusal plane

- Extraoral
  — *Interpupillary line:* The anterior part of the maxillary occlusal plane should be parallel to the inter-pupillary line. It should be 2 mm below the upper lip line or smile line.
  — *Camper's line:* The posterior part of the occlusal plane of maxilla should be parallel to the alatragal line when the patient is in an upright sitting position.

Occlusal Verification of Mandibular Trial Denture

- Intraoral
  — *Retromolar pad area:* The height of mandibular plane is usually placed at level of the junction between anterior two-third and posterior one-third of the retromolar pad area (Fig. 11.3).

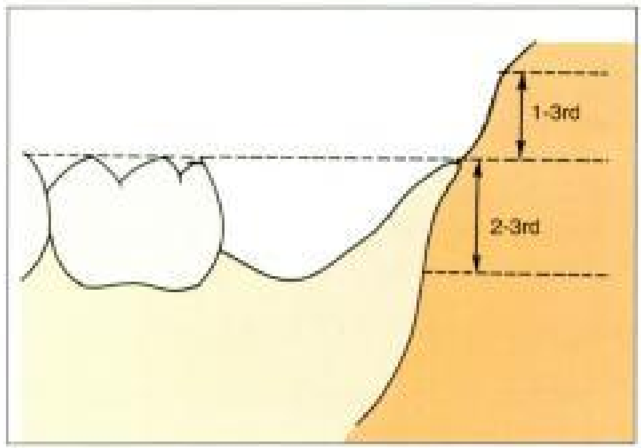


Fig. 11.3: The mandibular occlusal plane when projected behind, should extend to the level of the junction between posterior one-third and anterior two-third of the retromolar pad

  — *Tongue:* The tongue in normal dentition rests on the lingual part of mandibular anteriors.
  —Linea alba buccalis.
- *Extraoral:*
  — The mandibular occlusal plane is kept lower at a level to the corners of the mouth.

Evaluation of Vertical Height

- Physiologic rest position:
  — Patient is seated erect in a dental chair so that the ala-tragus line is parallel to the floor. Two points are marked in the patients face. One at the tip of the nose and the other at the tip of the chin
  — The patient is asked to relax and swallow and the distance between the marked points is measured and recorded. This gives

the physiologic rest position. Subsequently the trial dentures are placed in the patient's mouth and the height is measured again at occlusion. This should be 2-4 mm less than the physiologic rest position.

- Tactile sense method.
- Phonetics.
- Silverman's closest speaking space (explained in Chapter 9).

Evaluation of Centric Relation

Intraoral

Intraorally, centric relation can be determined by asking the patient to keep the tongue at the junction of the hard and soft palate and close till the teeth attain maximum intercuspation.

- Swallowing technique
- Head position (discussed in jaw relation).

Extraoral

Extraorally centric relation can be recorded using a kinematic face-bow.

Aesthetic Arrangement of Anterior Teeth

The following factors are checked:

- Harmony of arch form and residual ridge form.
- Harmony of opposing inclines of labial and lingual surfaces.
- Harmony of teeth and profile.
- Harmony of the incisal edge of maxillary anteriors with smiling line of lower lip.

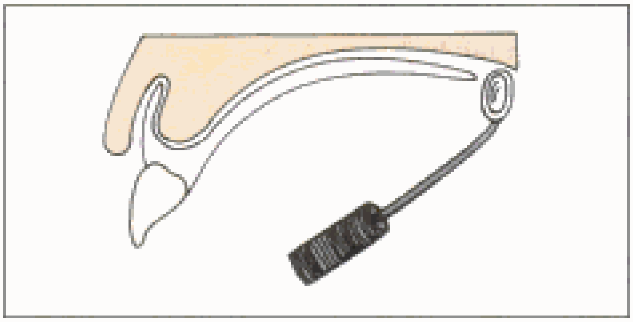


Fig. 11.4: Diagram showing the evaluation of the posterior seal of a denture using a mouth mirror

Eccentric Relation

Protrusive relation: It is the relation of the mandible to the maxillae when the mandible is moved forwards.

Lateral relation: It is the relation of the mandible to the maxillae when the mandible is moved to the left or right. All occlusal interferences should be eradicated in any maxillo-mandibular relation.

Incorporation of Posterior Palatal Seal Area

The patient is asked to keep the mouth open and say 'ah'. A line is drawn in the patient's mouth across the palate extending from one hamular notch to the other. The denture should extend till the posterior palatal seal.

It can be checked by placing a mouth mirror at the distal end of the denture. There should be no gap between the tissues and the denture when the patient says 'ah' (Fig. 11.4).

Phonetics should also be tested along with denture try-in. Significance of phonetics in complete dentures has been discussed under denture insertion (Chapter 13).

Chapter 12
Lab Procedures Prior to Insertion

- Denture Processing
- Compression MouldingTechnique
- Finishing and Polishing the Denture

12

Lab Procedures Prior to Insertion

DENTURE PROCESSING

After aesthetic try-in, the trial dentures are processed in the lab to attain their final form. Commonly, denture processing is done using two techniques namely *compression moulding* and *injection moulding*. Since injection-moulding technique is not commonly followed, I have not discussed it in detail here.

COMPRESSION MOULDING TECHNIQUE

Compression moulding technique is the most commonly used technique in the fabrication of dentures using acrylic resins.

Steps in Compression Moulding Technique

There are various steps involved in the process of compression moulding technique. They include:

- Preparation of the trial denture
- Disarticulation
- Flasking procedure
- Dewaxing
- Placing retentive grooves (Diatorics) on the artificial teeth
- Application of separating medium
- Mixing of powder and liquid
- Packing
- Curing
- Cooling
- Deflasking.

Preparation of the Wax Pattern

After try-in, the trial dentures are placed on the cast and sealed to the cast using additional wax. This is done so that the relationship of the trial denture and the cast is not altered during disarticulation (Fig. 12.1).

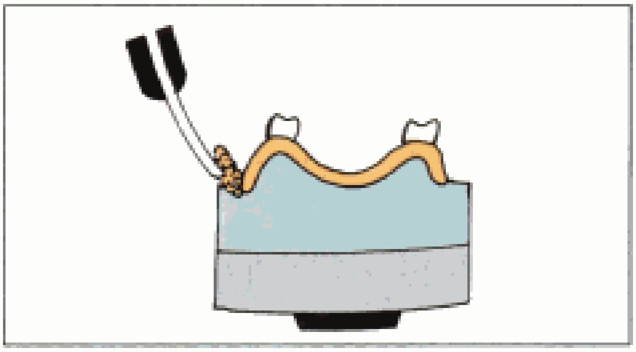


Fig. 12.1: Wax up

Disarticulation

In an articulator with remounting plates, disarticulation is easily carried out by unscrewing the remounting plates. In an articulator without any remounting plates, the mounting plaster is carefully broken away from the cast. The articulator with the trial dentures sealed to their respective casts is opened and tilted sideways (to make it lie down). The articulator is placed on a cloth to avoid damage to the trial denture. Disarticulation is best done in the presence of two people. One person should hold the apparatus carefully the other should try to split the junction between the mounting plaster and the cast with the help of a wax knife and a plastic mallet (Fig. 12.2). Once the casts are separated from the articulator, they are soaked in slurry water.

Flasking Procedure

The pattern is invested in a dental flask with dental stone or plaster using a 2-pour or 3-pour

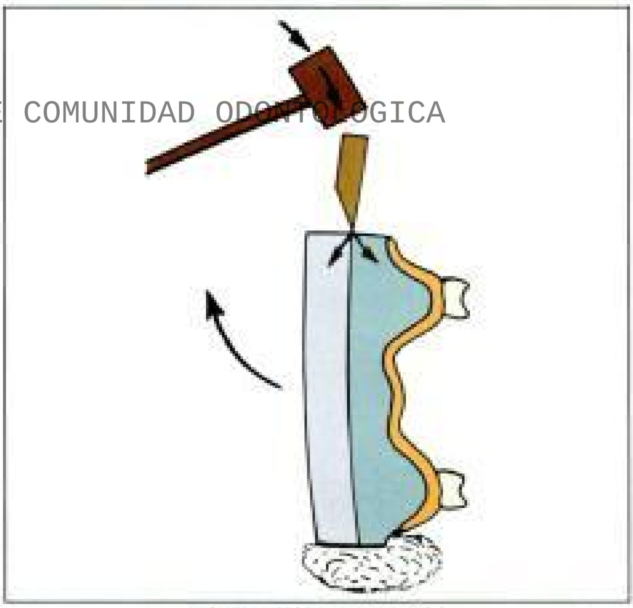


Fig. 12.2: Dearticulation

technique. The flask is made of three components namely a rounded triangular base, counter or body and the lid. When fit together the flask is held in position with the help of a clamp.

- The base of the flask is filled with dental plaster. This is the *first pour*. The cast with the wax pattern is immersed into the plaster-filled base. The cast should be immersed only at the centre of the base. It should be immersed into the base such that the occlusal plane of the trial denture is parallel to the floor (Fig. 12.3).

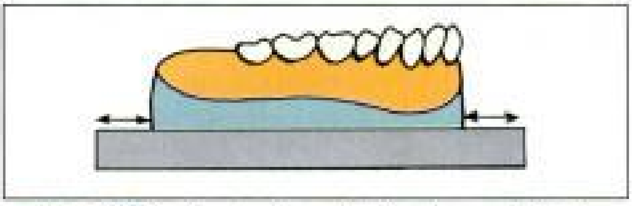


Fig. 12.3: Positioning the cast in the base of a flask

- The plaster in the base (investing plaster) is contoured to form a gradual slope from the land area of the cast to the edge of the base of the flask. In case of lower casts, the retromolar pad is very high and it is difficult to produce a gradual slope with the investing plaster. Hence, care should be taken to obtain the maximum gradual slope possible. The land area of the base of the flask should **not** be covered with investing plaster (Fig. 12.4).

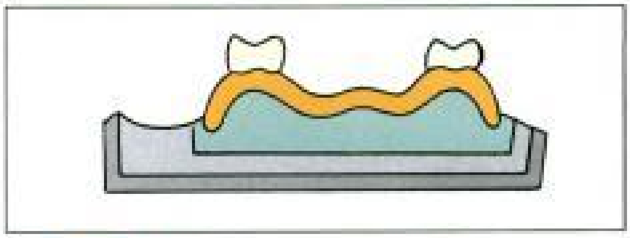


Fig. 12.4: Investing the cast in the base of the flask

- Once the base is invested, a separating medium (discussed in detail below) is applied in all areas where gypsum is exposed. Separating medium should be applied in single-sided strokes in order to protect the continuity of the membrane.
- Surface tension reducing agent can be applied over the wax pattern in order to improve the wettability of the second pour of gypsum over the wax pattern.
- Once the separating medium dries, the body of the flask is placed and fit on to the base.
- A mix of dental plaster and stone in a ratio of 1:1 is poured into the body till the level of the occlusal/incisal surfaces of the teeth. This is the *second pour*. Since the cast was positioned such that the occlusal plane is parallel to the floor, the occlusal surfaces of the teeth will be evenly exposed. If the occlusal surfaces of the teeth are not evenly exposed, it indicates that the occlusal plane is not parallel to the floor (Fig. 12.5).
- The second pour is allowed to set and another layer of separating medium is applied. Care should be taken to *avoid* applying separating medium over the exposed occlusal surfaces of the teeth.

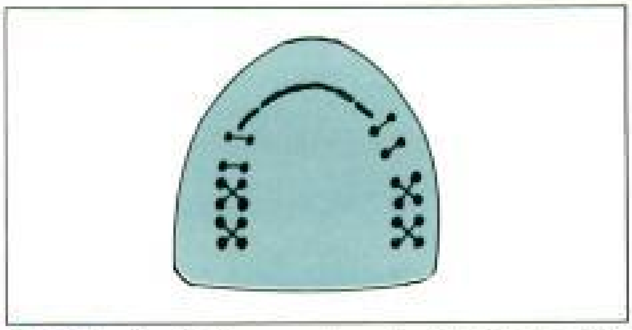


Fig. 12.5a: Level of the second pour in the flask should be at the level of the occlusal surface of the artificial teeth

Fig. 12.5b: Improper positioning of the cast in the flask will produce uneven exposure of the artificial teeth

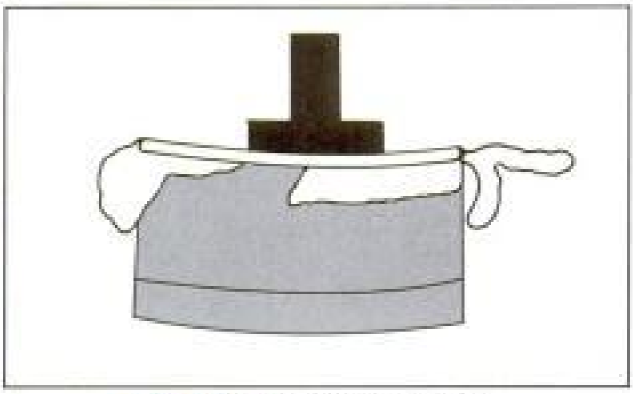


Fig. 12.6: Completion of flasking

- The *third pour* of dental plaster is poured to fill the body. The lid is placed on the body and closed. Excess plaster is allowed to escape out. The clamp is tightened to hold the flask in position (Fig. 12.6)
- The advantage of three-pour technique is that it facilitates easy removal of the denture after curing. If a two-pour technique is to be used, then the second and third pour is replaced by a single pour.
- After flasking, the flask is left undisturbed for 30-60 minutes so that the investing plaster reaches its final setting time.

Dewaxing

Dewaxing is done to remove the wax in the wax pattern so that a mould space is created for acrylic to fill-in. It is carried out by placing the flask in boiling water (100°C) for 5 minutes. Before placing the flask into the water bath, the clamp should be loosened. Dewaxing is done to just soften the wax and not melt it.

Dewaxing for a prolonged time will lead to leaching of the wax into the investing plaster. Once the wax leaches into the gypsum in the flask, it is very difficult to completely eradicate the residual wax.

After 5 minutes, the flask is taken out of the water bath, the base and the body are carefully separated. The softened wax is flushed out using hot water or a wax solvent or soap solution (Fig. 12.7). The soap solution is said to react with the gypsum forming a membrane impervious to wax.

Fig. 12.7: Dewaxing

Even the finest traces of waxes should be removed. Failure to remove wax can lead to the contamination of the denture base during curing.

Placing Retentive Grooves on the Artificial Teeth

The ridge lap portions of the teeth are trimmed using a round bur to create small retentive pot holes (diatorics). This helps to increase the strength of attachment between the denture base and the teeth (Fig. 12.8).

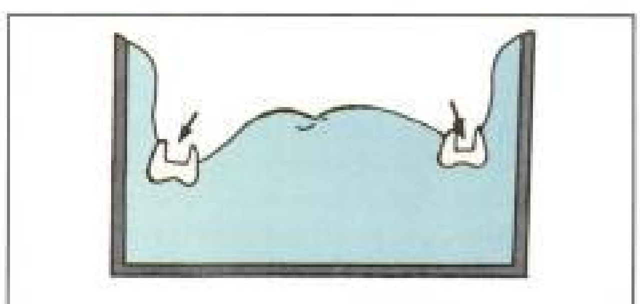


Fig. 12.8: Diatorics

Application of Separating Medium

Separating medium is applied to the dewaxed mould space prior to packing the acrylic resin. The objectives of applying a separating medium are:

- To prevent water from the mould entering into the acrylic resin. This may affect the rate of polymerization and colour. It can also result in crazing.
- To prevent monomer penetrating into the mould material, causing plaster to adhere to the acrylic resin and producing a rough surface.

Types of separating media

Various types of separating media used are:

- Tinfoil.
- Cellulose lacquers.
- Solution of alginated compounds.
- Calcium oleate.
- Soft soaps.
- Sodium silicate.
- Starches.
- Evaporated milk.

Tin foil It was the material of choice earlier and is very effective. However, its manipulation is time-consuming, difficult and technique-sensitive. It has been largely replaced by other separating media known as "tin foil substitutes".

Sodium alginate solution It is commonly known as *"Cold Mould Seal"* and is the widely used separating media because of its effective and easy manipulation.

Composition

- Sodium alginate solution: 2 per cent in H_2O.
- Sodium phosphate
- Glycerine
- Alcohol
- Preservatives

Setting reaction When applied over the cast, the sodium alginate in the solution reacts with calcium on the cast producing insoluble "Calcium alginate" which forms a membrane and serves as the separating medium.

Precautions to be taken

- Waxes or oils remaining on the mould surface will interfere with the action of the separating medium.
- The first layer of separating medium is applied when the flask is warm. This closes the micropores in the cast.
- The first layer is allowed to dry completely.
- The second layer of the separating medium is then applied.
- Mould should be warm, not hot. The continuity of the film will break if the mould is steaming hot.
- Coating the medium over the teeth will prevent bonding of teeth with the denture base. Any such film existing between the necks of the teeth and the denture base may permit penetration of stains into the affected areas when the cured dentures are in use by the patient.
- Excessively thick layers of the separator covering the tissue surfaces of the cast will cause discrepancies that will result in errors in the tissue surface of the denture.
- *Puddling* of the solution around and on the teeth or on the cast surface during application will affect the contours of the denture.
- Other separating media such as evaporated milk, sodium silicate, etc. can be used.

Mixing of Powder and Liquid (Acrylic)

This is the next step in the processing of a denture. Polymer monomer proportion:

- 3:1 by volume
- 2:1 by weight.

The measured liquid is poured into a clean dry mixing jar. Powder is slowly added allowing each powder particle to be wetted by the monomer. The mixture is stirred and later allowed to settle in a closed container.

If too much monomer is used (low polymer monomer ratio) then:

- There will be greater curing or polymerization shrinkage.
- More time is needed to reach the packing consistency.
- Porosity can occur in the denture.

If too little monomer is used (High polymer monomer ratio).

- Not all the polymer beads will be wetted by monomer and the cured acrylic will be granular.
- Dough will be difficult to manage and it may not form a continuous plastic mass during processing.

Physical stages After mixing, the material goes through various physical stages, before polymerization reaction. Plastic dough is formed by a partial solution of the polymer and the monomer.

Stage I: Wet sandy stage During this stage no interaction occurs on a molecular level. Polymer beads remain unaltered and the consistency of the mixture may be described as 'coarse' or 'grainy'. The polymer gradually settles into the monomer forming a fluid, incoherent mass.

Stage II: Early stringy stage The monomer attacks the polymer by penetrating into the polymer. Some polymer chains are dispersed in the liquid monomer. This polymer chains uncoil thereby the viscosity of the mix is increasing. The mass is 'stringy' or 'sticky' when touched or pulled apart.

Stage III: Late stringy stage: The strings break off at this stage when touched or pulled apart and the mass becomes dough-like.

Stage IV: Dough stage: The mass enters a dough-like stage. On a molecular level an increased number of polymer chains enter the solution. Hence, a sea of monomer and dissolved polymer is formed. A large quantity of undissolved polymer also remains.

Clinically the mass behaves as a pliable dough. The physical and chemical characteristics exhibited during the latter phases of this stage are ideal for compression moulding. Hence, the material should be packed into the mould cavity during this stage.

Characters exhibited by the mix during the dough stage:

- The mix is smooth and dough-like.
- The material has lost much of its tackiness and can be separated without the formation of strings.
- The material does not stick to the walls of the mixing jar and is easily mouldable.

Stage V: Rubbery stage After the dough stage, the mixture enters a rubbery or elastic stage. Monomer is dissipated by evaporation and by further penetration into remaining polymer beads.

Clinically, the mass rebounds when compressed or stretched. Because the mass no longer flows freely to assume the shape of its container, it cannot be moulded by conventional compression techniques.

Stage VI: Stiff stage On standing for an extended period, the mixture becomes stiff. This may be attributed to the evaporation of free monomer. Clinically, the mixture appears very dry and is resistant to mechanical deformation.

Dough forming time The time required for the resin mixture to reach a dough-like stage is termed as 'dough forming time'.

Time required to reach the dough stage depends upon the solubility of the polymer pearls in the monomer. The solution rate may increase with increase in temperature. The mixing jar may be heated in warm water, but care must be taken to avoid water contact with the resin. Under no circumstances the jar should be heated above 55°C. Polymerization begins at a rapid rate above this temperature and the resin becomes too difficult to mould for dental procedures.

Another factor, which affects the dough forming time, is the size of polymer particles. Decrease in size of the particles, shorter the dough-forming period. According to ADA specification No: 12, dough should be mouldable for at least 5 minutes.

Working time The working time is the time elapsing between the stringy stage and the beginning of rubbery stage. The working time is affected by temperature. Decrease in temperature increases the working time.

Packing

Introduction of denture base resin into the mould cavity is termed packing. It is essential that the mould cavity is completely filled at the time of polymerization. The introduction of too much material termed 'overpacking' leads to a denture base that has excessive thickness and malpositioned prosthetic teeth. The introduction of too little material called 'underpacking' leads to noticeable denture-base porosity.

The powder liquid mixture should be packed into the flask at the dough consistency for several reasons:

- If it is packed at the sandy or stringy stages, too much monomer will be present between the polymer particles and the material will be of a low viscosity. Low viscosity is not ideal for proper packing, as the material will flow out of the flask too easily. Packing too early may also result in porosity in the final denture base.
- If packed at the rubbery to the stiff stage, the material will be too viscous to flow, and metal-to-metal contact of the flask halves (base and body) will not be obtained. Delayed packing will result in movement or fracture of the teeth, loss of detail and increase in the vertical height of the denture.

Trial closure

The acrylic dough is packed into the flask in slight excess with the help of a hydraulic or mechanical press. The excess is removed by trial packing, with a damp cellophane or polyethylene film used as a separator for the upper half of the flask. The closing force is applied slowly during the trial packing to allow the excess dough known as *flash* to flow out between the halves of the flask (Fig. 12.9). The flask is opened and the flash is trimmed away with a *'Le Cron's wax carver'*. Before final closure, the separating film is removed and discarded. The final closure of the flask or metal-to-metal contact of the flask halves is then completed in the process.

Curing (Polymerization)

After final closure, the flasks are kept at room temperature for 30 to 60 minutes. This is known as *Bench Curing*.

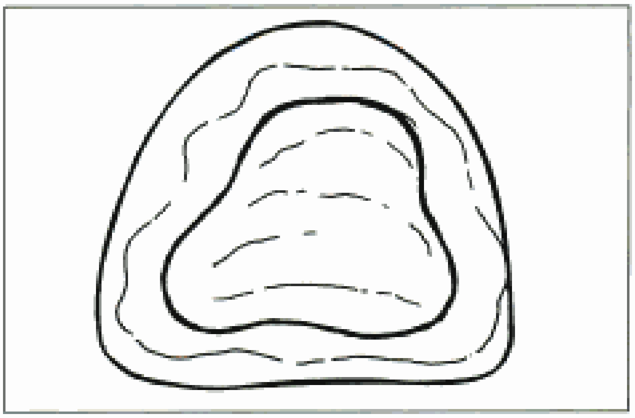


Fig. 12.9: Flash

Purpose of bench curing

- Permits an equalization of pressures throughout the mould space.
- It allows time for a more uniform dispersion of monomer throughout the mass of dough, since the last material added is usually drier than the first added to the flask.
- If resin teeth are used, it provides a longer exposure of resin teeth to monomer in the dough producing a better bond of the teeth with the base material.

Curing cycle The curing or polymerization cycle is the technical name for the heating process used to control the initial propagation and polymerization in the denture mould. The curing cycle selected depends on the thickness of the resin. Following are the recommended curing cycles:

- Heat the flask in water at 60 - 70°C for 9 hours (long curing cycle). It starts from room temperature and slowly increases upto 60-70°C. The rate of increase of temperature is critical.
- Heat the flask at 65°C for 90 minutes, then boil for 1 hour for adequate polymerization of thinner portions (short curing cycle).

Cooling

The flask should be cooled slowly (i.e.) bench cooled. Sudden cooling can result in warpage of the denture due to differential thermal contraction of the resin and the gypsum mould. Cooling overnight is ideal.

However, bench cooling for 30 minutes followed by placing under cold tap water for 15 minutes is sufficient.

Deflasking

- Deflasking is done using a deflasker and a pribar. Using hammer to deflask will ruin the flask and can cause breakage of the denture.
- The lid of the flask should be removed by prying with wax knife.
- The flask is inverted and placed on the deflasker and tightened with a thumbscrew (Fig. 12.10).

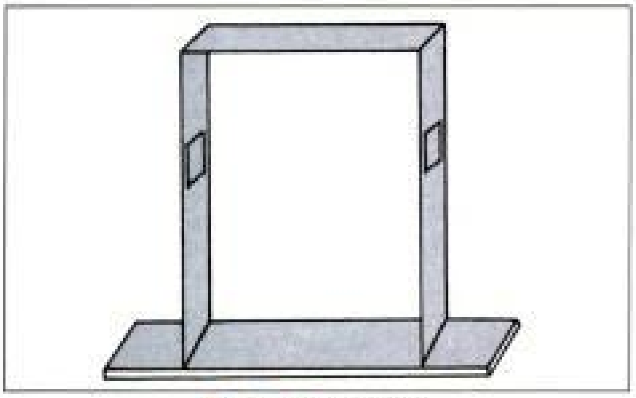


Fig. 12.10: Deflasker

- Pribars are inserted laterally to fit on to the slots of the flask. Once these pribars are engaged, they are lifted up, so that they separate the base and the body by lever action. The body or counter will slide out of the investment (Fig. 12.12).

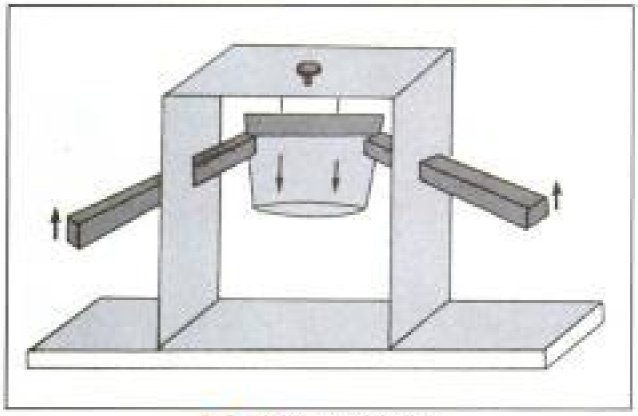


Fig. 12.11: Deflasking

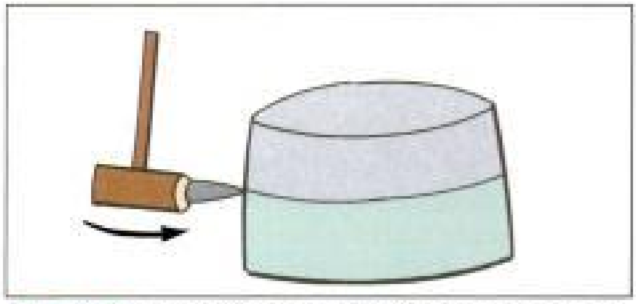


Fig. 12.12: Spliting the second and third pour investment

- The 2nd and 3rd pour investments are separated with the help of a wax knife and a plastic mallet. The middle pour will contain the entire denture.
- Three incisions are made (one in the anterior mid-point and two at the posterior corners) by sawing with a fretsaw blade (Fig. 12.13).

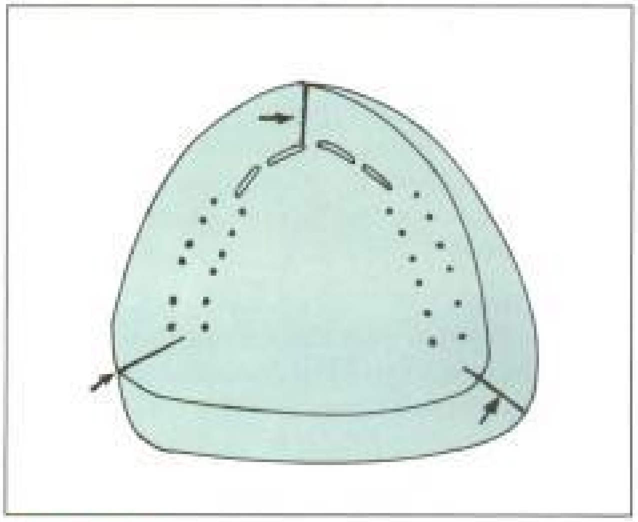


Fig. 12.13: Sawing the second pour investment at its corners

- A plaster knife is used to pryout the investment material between the cuts.
- The plaster around the teeth on the palatal or lingual surface should be trimmed out with a plaster knife.

The entire palatal investment can be removed by prying with a wax knife at the posterior palatal seal area. If it is difficult to remove, it should be sliced and removed in pieces.

It has to be done with care to avoid flexing and breaking of the acrylic dentures. In this aspect the limited strength of gypsum products helps out, as it fractures easily, thereby, not affecting the acrylic denture.

FINISHING AND POLISHING THE DENTURE

Finishing and polishing includes:
a. Trimming
b. Sand papering
c. Pumice wash.

Trimming

- Before trimming, plaster at the necks of the teeth is removed using a chisel.
- Borders are trimmed using a lathe mounted arbor band or a laboratory size carbide bur.
- Frenum relief is given using a straight fissure bur (Fig. 12.14).

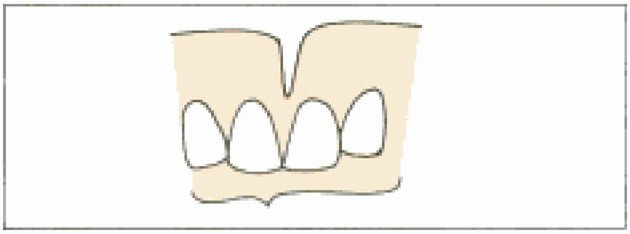


Fig. 12.14: Frenal relief

- Tissue surface nodules are removed with a hand piece or a lathe-mounted bur.
- The thickness of palatal surface is reduced using a large, egg-shaped bur. Reduction should never be carried out on the tissue surface

Guide for trimming

- The denture should be held against the light and checked for translucency. Areas of opacity or darkness indicate excessive thickness of the denture base. Uniform thickness of 2 to 2.5 mm must be maintained.
- Small irregularities should be removed using a 'paintbrush motion' against a lathe mounted acrylic trimmer.

Sand Paper Finishing

- Sand paper should be fixed on to a lathe mounted sand paper mandrel.
- Even the finest of all scratches should be removed during this procedure.
- Some technicians prefer the use of a wet sand paper to improve the finish.

Pumice Wash

- Pumice should be loaded on a lathe-mounted rag wheel (Fig. 12.15). A worn out wheel should be conditioned prior to use.

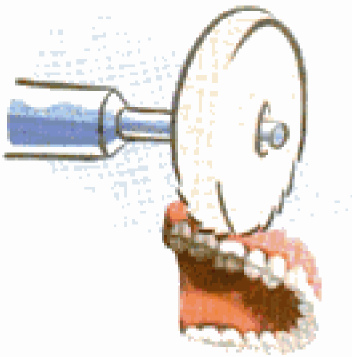


Fig. 12.15: Polishing the denture flange

- Pumice powder mixed with water is coated over the rag wheel.
- The finished denture should be polished by intermittently pressing against the rotating rag wheel. Care should be taken to avoid excessive pressure on the denture to prevent warpage.
- A handpiece mounted rubber cup or a medium bristle brush can be used to polish the inaccessible areas.
- After polishing, the denture should be thoroughly washed in soap water.
- A toothbrush can be used to remove the remaining plaster and pumice.

After finishing, the dentures are stored in water and stored till the day of the insertion appointment.

Chapter 13
Complete Denture Insertion

- Checking for Fit and Function
- Patient Instructions
- Tissue Conditioners
- Use of Denture Adhesives
- Sequelae of Wearing Complete Dentures

13

Complete Denture Insertion

CHECKING FOR FIT AND FUNCTION

During the insertion appointment, all the factors verified during try-in are rechecked. The two major characteristics that determine the success of a denture are its fit and function. Fit includes the proper adaptation, patient comfort, adequate extension and aesthetics of the denture. Function includes occlusal harmony, speech, accurate jaw relation, retention and stability during mastication, etc.

CHECKING FOR THE FIT OF THE PROSTHESIS

Examining the Dentures

- Before inserting the denture, the clinician should feel the borders of the denture to check for any sharp projections or rough ends.
- The tissue surface of the denture is examined for the presence of voids or nodules.

Examining the Patient's Mouth

- The oral mucosa is examined thoroughly to rule out over extension of the denture.

Checking for Adaptation

The denture is placed in the patient's mouth along its path of insertion. First the adaptation of the denture is checked at the posterior palatal seal area using a mouth mirror. There should not be any space left between the posterior border of the denture and the tissues. The patient is asked to say 'ah' in unexaggerated short bursts and the palatal seal is reverified. Refer post-damming (Chapter 7). Adaptation of the mandibular denture should be checked at the distolingual extension.

Checking for Border Extension

- The cheeks are elevated and the denture borders are examined.
- The buccal and labial mucosa are stretched to check for any denture displacement. If the denture has overextended borders, it will get displaced while stretching the mucosa.

Checking for Frenal Relief

Next frenum relief is examined. The labial frenum is thin and hence requires a deep notch-like relief at the middle of the labial flange. The buccal frenum is more compressible (*less sensitive to compression than labial frenum . This frenum tends to bend and adapt to the denture*) hence, it does not require a critical relief. Secondly there are multiple frena on either side, hence providing a shallow notch in this region will be sufficient. It should be remembered that the buccal frena are attached to active muscle fibers and if not relived, may tend to displace the denture during function.

Evaluating the Denture Aesthetics

Patient's lip support, cheek support, vertical height, low lip line, high lip line, smile line, etc. are examined. These factors are usually examined thoroughly during try-in hence, a simple verification would be sufficient.

CHECKING OF THE DENTURE FUNCTION

Evaluating the Retention and Stability of the Denture

After checking for adaptation, border extension and frenal relief, the retention and stability of the denture are evaluated. Retention can be evaluated by checking for the peripheral seal of the denture. First, posterior seal is checked followed by anterior seal. Posterior seal is checked by gently pressing the anterior teeth perpendicular to the path of insertion. This procedure tends to lift the posterior part of the denture. If there is adequate seal, the dentist can feel the resistance offered by the denture against this force.

Anterior seal is evaluated after posterior seal. The denture is pulled against the path of insertion. The resistance offered by the denture against this force gives the anterior seal. Actually this procedure can be used to determine both anterior and posterior peripheral seal.

Stability of the denture is examined by checking for any kind of displacement during the chewing cycle, speech, etc.

Checking the Jaw Relation

Vertical and horizontal jaw relations are examined thoroughly as done in try-in and patient's perception of comfort is also verified.

Speech

One of the most challenging functions that should be reproduced in a denture is speech. Usually denture wearers have a shallow pronunciation because of the smooth palatal surface. In a natural environment, the rugae enhance speech. In a denture, speech is affected due to the absence of rugae.

Using metal denture base, improves speech because the metal can be fabricated thin enough to reproduce the rugae on the external surface. Other factors that affect speech like injury to the external laryngeal nerve, presence of tongue-tie, etc. should also be ruled out.

Dentures play different roles in the production of different sounds.

- *Bilabial sounds (b, p, and m)* are controlled by the lip support and become defective due to the absence of lip support or alteration in the vertical dimension at occlusion.
- *Labiodental sounds (f and v)* are governed by the relation of the incisal edges of the upper anterior teeth to the lower lip. If the teeth are set too high then '*f*' will sound like '*v*' (Fig. 13.1).

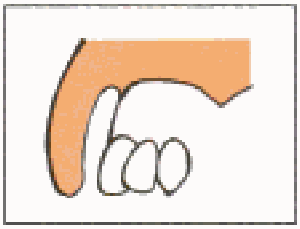


Fig. 13.1a: Normal lip support

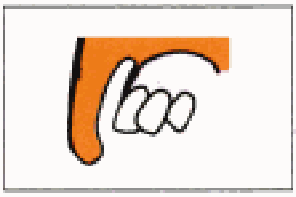


Fig. 13.1b: If the teeth are arranged high, 'F' will sound like 'V'

- *Linguodental sounds ('th')* are governed by the position of the tongue between the upper and lower anteriors. Normally the tongue should project 3 mm anteriorly between the teeth. If the tongue gets positioned about 6 mm in front of the teeth, then, it means, the teeth have been set very lingually (Fig. 13.2).

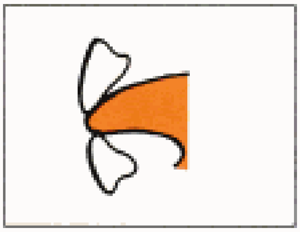


Fig. 13.2a: Normal tongue position indicating normal teeth arrangement

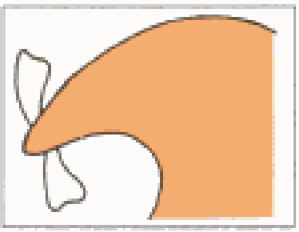


Fig. 13.2b: Abnormal tongue position due to lingualised arrangement of teeth

- *Linguoalveolar sounds (t, d, s, z, v, and l)* are made when the tongue touches the anterior part of the palate. These are the most important of all sounds in a complete denture because it is determined by the thickness of the denture base. If the denture is very thick, the patient is forced to pronounce the sounds in a shallow blunt manner (Fig. 13.2).

- *'S' sound* is controlled by the anterior part of the palatal plate of the denture base. It is considered separately because it is produced in two tongue positions. Hence it is also called as the dental and alveolar sound. A narrow groove formed by the tongue in the midline against the palate, results in a space. The size of this space determines the quality of the sound (Fig. 13.3).

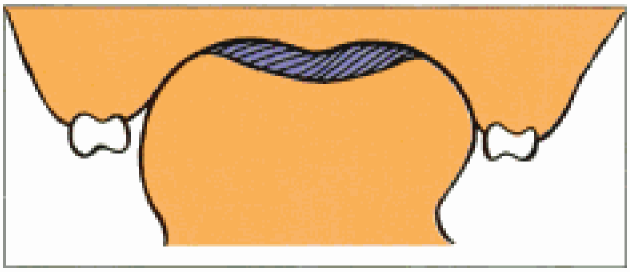


Fig. 13.3

During the *'s'* sound the following articulatory characteristics are noticed. The tip of the tongue is near (not touching) the upper anteriors (Fig. 13.4). The dorsum of the tongue is flat and a groove is formed in the midline of the tongue. The mandible moves forward and upward till the teeth are almost in contact.

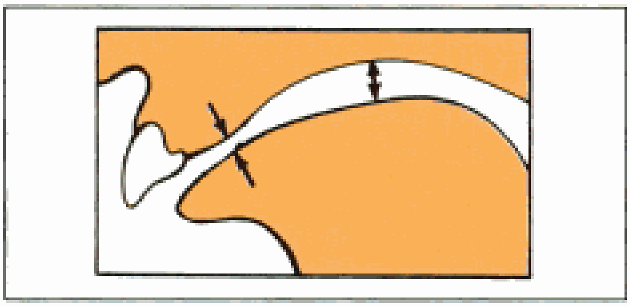


Fig. 13.4: Position of the tongue in relation to maxillary anterior during ' S ' pronounciation

The acoustic character of 's' sound is a strong high frequency sound wave of 3 to 4 Khz. Auditory character of *'s'* sound is a sharp loud sound.

- Linguopalatal and linguoalveolar sounds (*year, she*) are not very important in a complete denture as they are independent of the denture base area.
- *Valar sounds* (*k, g and kg*) are dependant on the posterior part of the palate and are not affected by the prosthesis (Fig. 13.5). The movements of the palate can be traced using a *palatograph*.

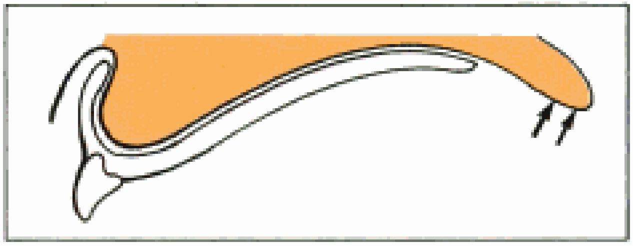


Fig. 13.5: Point of action of valar sounds

Occlusal Harmony

Before insertion, occlusal harmony is evaluated in the lab by remounting in an articulator. All major occlusal errors are usually corrected in the lab itself. Remaining errors are corrected chair side by *selective occlusal grinding*. If the jaw relation is accurate, errors in occlusion are very rare. Usually occlusal disharmony is not corrected during the insertion appointment. The patient is asked to wear the denture continuously for 24 hours and then the occlusal corrections are made. Occlusal disharmony can be identified using an interocclusal check record or an articulating paper.

Using Inter-occlusal Check Records

When the patient reports after 24 hours, an inter-occlusal check record is obtained. Inter-occlusal record material like ZnOE is placed on the teeth and the patient is asked to bite. High points are detected by the presence of perforations in the inter-occlusal records (Fig. 13.6). The high points are reduced carefully using a bur and the occlusion is reverified.

Using Articulating Paper

High points (premature, deflective contacts) can also be detected using an articulating paper. The articulating paper is placed between the teeth and the patient is asked to bite on it. The paper is dragged away slowly. There should be even

Figs 13.6a and b: Inter-occlusal check record

resistance to the movement of the articulating paper. If the paper slides freely, then, it means there is no contact. If the paper does not slide away at any one particular point, it indicates the presence of a high point (Fig. 13.7). The articulating paper itself marks the high points. The high points are reduced till the marking colour fades away and occlusion is rechecked.

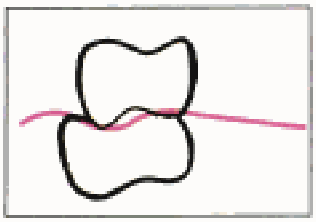


Fig. 13.7a: Checking for occlusal descrepancy using articulating paper

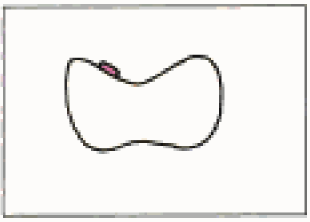


Fig. 13.7b: Occlusal high-point indicated by an articulating paper

If all the above factors are satisfactory, initial insertion is complete. The patient is called after 24 hours to check for any soft tissue reaction. He is then called after a week for review. Finally periodic review is conducted once in every 3 to 6 months to check for soft and hard tissue changes, etc. A detailed explanation of the elimination of the various occlusal errors is described in Chapter 27.

PATIENT INSTRUCTIONS

The following instructions should be given to the patient during the insertion appointment:

Insertion and Removal of the Prosthesis

The patient is taught to remove and wear the prosthesis repeatedly. The patient should insert the prosthesis along the path of insertion. In the presence of a unilateral undercut, the patient is taught to insert the denture into the undercut first, (Fig. 13.8) then rotate the prosthesis into its final position.

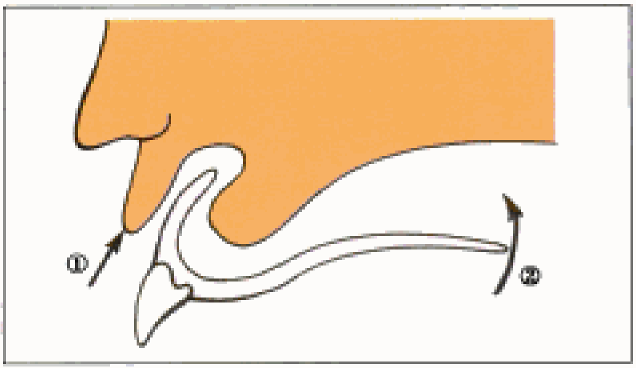


Fig. 13.8: Inserting a denture into a unilateral undercut

The clinician requires more patience to teach patients with neural dysfunction. If the denture is very retentive (very difficult to remove), the patient is asked to blow with his lips closed to break the peripheral seal and remove the denture.

Maintenance of the Prosthesis

The dentures should be cleaned using a denture cleaning brush and tooth paste/soap water (or any cleansing agent). Flossing is also advised but the patient should not do excessive flossing as it may damage the denture and cause the teeth to pop out. The prosthesis can be cleaned using the following agents:

- *Chemical cleansers:* Mineral acids should not be used as they may corrode the metal. Dilute solutions of Chlorhexidine, Sodium perborate or Nystatin can be used to store dentures.
- *Ultrasonic cleaner:* It is a sonic cleaner in which tiny bubbles (which help to clear away the food particles) are bombarded against the denture.
- Soaking and brushing with a denture brush.

Nightwear of the Prosthesis

The patient is advised to avoid nightwear of the prosthesis. The dentures should be stored in water or any dilute medicinal solution at night. If the patient wears the denture during sleep, the mucosa does not have any rest to improve its blood supply. This may lead to bone resorption and mucosal degeneration.

Nightwear may be allowed for the following conditions:

- In patients with bruxism where damage to the oral tissues is more if the prosthesis is not worn.
- In cases where the patient has a maxillary complete denture and mandibular partial denture. If the patient insists on wearing the upper denture for aesthetics, then the lower denture also must be worn along with the upper denture.

Periodic Recall

Regular recall is done to check for proper denture extension and occlusion. The patient is called 24 hours after the insertion appointment to correct occlusal disharmony and to check for immediate tissue reaction.

Next, the patient is called after a week to check for tissue reaction. His/her comfort is also enquired and the problems are corrected.

Next, the patient is recalled every 3 to 6 months to determine tissue reaction and the amount of residual alveolar ridge resorption. Postinsertion instructions should be reinforced during recall visits.

The patient is advised to report immediately whenever there is any problem. In case of tissue reactions like ulcers, soreness, etc. the patient is advised to stop wearing the prosthesis and report to the dentist as soon as possible. Yearly recall visits to check the necessity for relining/rebasing.

Post-insertion management of a denture. Common problem associated with denture wear

Causes	*Correction*
Decreased retention	
I. Lack of seal:	
• Border under extension in depth and width (Fig. 13.9) • Under extension of posterior border.	• Addition of tracing compound to the required extension and processing it with acrylic resin (Fig. 13.10)
• Residual ridge resorption	• Relining of denture
• Inelasticity of cheeks e.g. Ageing, scleroderma, submucous fibrosis.	• Slight reduction in the depth and width of the borders
II. Air beneath the impression surface of the denture/lack of seal	
1. Poor fit to supporting tissues	• Relining the dentures/rebasing
• Deficient impression • Damaged cast • Warped denture • Over-adjustment of impression surface	• Addition of tissue conditioners restores retentive forces
2. Resorption of residual ridge	• Relining of dentures
3. Change of fluid content of supporting tissues due to:	
• Lack of recovery of tissues from pressure of old dentures (latter should not be worn for atleast 72 hours prior to impression making)	• Reline/rebase the denture with minimum pressure technique. Ensure old dentures are not worn for atleast 72 hours prior to making impressions.
• Effect of medication: e.g. Diuretics. • Effect of change in posture of patients with high volume of tissue fluid	
4. Undercut residual ridges. Eg. Bimaxillary tuberosities.	• Add softened tracing compound and extended upto the depth of the undercut area and replaced with acrylic.
5. Excessive relief over areas of reduced tissue displaceability.	• Reline/rebase denture. Outline the area on cast to be relieved and indicate the technician the amount of relief required.
III. Xerostomia: Reduced ability to form seal along borders and the polished surfaces of denture.	• Supplement with artificial saliva. • Modify dentures to maximize retentive forces and minimize displacing forces.
IV. Neuromuscular control: • Forces generated during mastication are sufficient to destabilize dentures.	• Temporary use of denture adhesive may help patient to learn necessary skills.
Decreased stability	
I. Denture borders: (Overextension in depth and width)	• Use pressure indicating paste and correct the borders. (Fig. 13.11)
II. Poor fit to supporting tissues: (Recoil of displaced tissues lifts dentures.)	• Reline/rebase using minimal pressure technique
III. Denture not in optimal space: (Denture borders are not in neutral zone.)	• Reshape overextended regions so that it does not interfere with muscular movement

Contd.

Contd.

IV. Occlusion:	
(Uneven initial contact can cause displacement)	Adjust occlusion by selective grinding either in the mouth or in the articulator after remount procedure
Problems in support (Basically associated with the contour of the ridges)	
I. Lack of ridge support: (Progressive Residual Ridge Resorption.)	• Optimal border extension in the depth and width. • Extend the lingual flange
II. Fibrous displaceable ridge: (During mastication, the denture tends to sink-in)	• Rebase/reline. • Optimize occlusal balance
III. Bony prominence covered with thin mucosa usually seen in: • Prominent maxillary midline suture • Tori • Posterior nasal spine	• Relieve the denture in these areas
IV. Non-resilient soft tissue: (Usually do not adapt to tissue surface of dentures).	• Rebase/reline • Optimal border extension can be produced using low viscosity impression material.

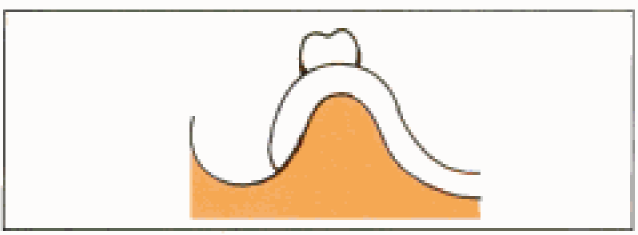


Fig. 13.9: Border extension

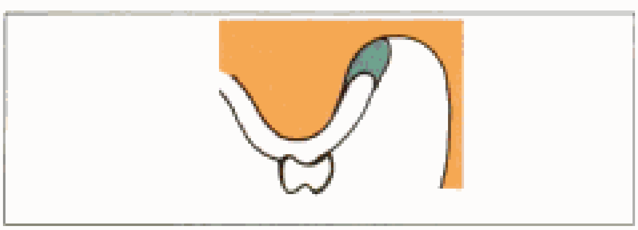


Fig. 13.10: Restoring improper border extension

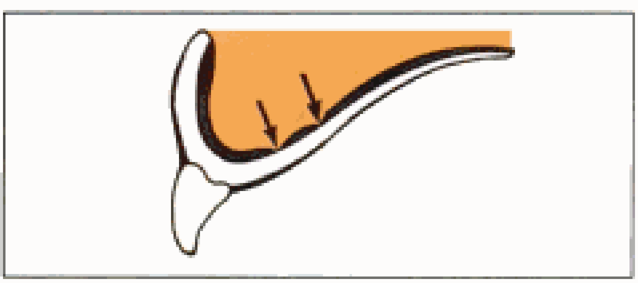


Fig. 13.11: Using pressure indicating paste to determine high points

TISSUE CONDITIONERS

Kydd and Mandley (1967) stated that tissue-lining materials permit wider dispersion of forces and hence, aid to decrease the force per unit area transmitted to the supporting tissues. Such soft liners could serve as an analog of the mucoperiosteum with its relatively low elastic modulus.

Currently for practical purposes, denture base materials are made of rigid materials. The dentist must recognize that the prolonged contact of these bases with the underlying tissues is bound to elicit changes in the tissues. Mucosal health may be promoted by hygienic and therapeutic measures and tissue-conditioning techniques may be applied when appropriate.

Composition

Tissue conditioners are composed of polyethylmethacrylate and a mixture of aromatic ester and ethyl alcohol. Tissue conditioners are available as three component systems.

- Polymer (Powder)
- Monomer (Liquid)
- Liquid plasticizer (Flow control)

A gel is formed when these materials are mixed, with the ethyl alcohol having a greater affinity for the polymer.

Uses of Tissue Conditioners

The major uses of these tissue conditioning materials include:

- Tissue treatment
- Temporary obturator
- Baseplate stabilization
- To diagnose the outcome of resilient liners
- Liners in surgical splints
- Trial denture base
- Functional impression material.

Adjuncts for Tissue Healing

The merit of using a tissue conditioner is that they prepare the selected oral structures to withstand all the stress from the prosthesis. Tissue conditioners are generally used to preserve the residual ridge. They are also used to heal irritated hyperemic tissues prior to denture fabrication.

Temporary Obturator

Tissue conditioners may be added as a temporary obturator over the existing complete or partial denture. This may be done directly in the mouth or indirectly after an impression of the surgical area has been made (Fig. 13.12).

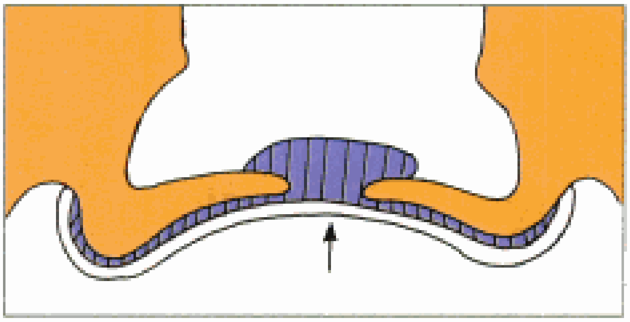


Fig. 13.12: Tissue conditioner as a temporary obturator

Stabilization of Baseplates and Surgical Splints or Stents

When undercuts are present on an edentulous cast, an acrylic temporary denture base cannot be used as it may get locked into the undercut and break the cast during removal. In these cases tissue conditioners of a stiffer consistency may be used to stabilize the record bases and prevent breakage of the cast (Fig. 13.13).

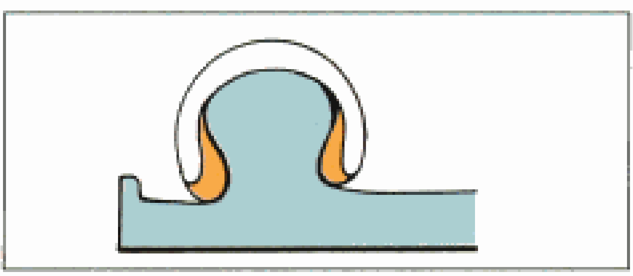


Fig. 13.13: Tissue conditioner used to fill undercuts while fabricating a temporary denture base

Adjunct to an Impression or as a Final Impression Material

These materials are used when it is difficult to determine the extent of the denture base due to the presence of movable oral structures. These materials record the extensions of the denture in a dynamic form that will later help in preparing an impression tray for the final impression.

Adjunct to Determine the Potential Benefits of a Treatment Modality

Sometimes patients with well-constructed dentures develop chronic soreness and find it difficult to wear the dentures comfortably. Tissue conditioners can be used to determine if this problem can be resolved with the use of a resilient liner.

Procedure for Applying Tissue Conditioners

The following steps should be considered while applying a tissue conditioner on a denture.

Preparation of the dentures The tissue part of the denture base, which crosses an undercut, should be reduced. The tissue surface of the denture, which covers the crest of the ridge, should be reduced by 1 mm (Fig. 13.14). It should be remembered that the dentures should allow sufficient room for the placement of the tissue conditioner in order to promote the recovery of displaced and traumatized tissues.

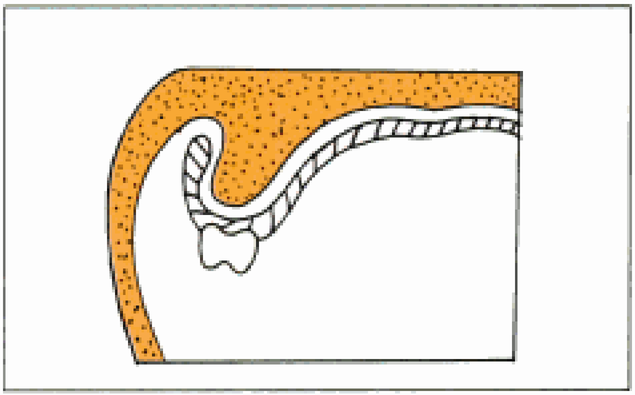


Fig. 13.14: Tissue surface of a denture reduced to fill tissue conditioner

Mixing and placement of the tissue conditioner Tissue conditioners are available as three component systems.

- Polymer (Powder)
- Monomer (Liquid)
- Liquid plasticizer (Flow control).

The mixing ratio can be changed according to the consistency required. A ratio of 1.25 parts of polymer, 1 part monomer and 0.5cc plasticizer is usually recommended. The plasticizer should be added to the monomer. The ingredients are mixed to form a gel, which is applied in sufficient thickness to the tissue surface of the denture. The denture is inserted and border movements are carried out to mould the setting material. This method is similar to functional relining explained in Chapter 14.

Care and Maintenance

Tissue conditioners should not be cleaned by scrubbing with a hard brush in order to prevent tearing of the material. The use of soft brush under running water is recommended.

The greatest virtue of tissue conditioners is their versatility and ease of use. Their biggest flaw is that they are so easily misused. Their longevity against wear is very limited and they tend to harden and roughen within 4 to 8 weeks due to the loss of plasticizer. Hence, they require close observation.

USE OF DENTURE ADHESIVES

Dental professionals have been slow to accept denture adhesives as a means to enhance denture retention, stability and function. Despite considerable documentation advocating patient's use of adhesives, many view adhesive usage as a poor reflection of a clinician's skills and prosthetic expertise.

Denture adhesives were first used in the late 18th century. Till the early 19th century denture adhesives were used only for the following situation:

- To hold base plates while recording jaw relations.
- In immediate denture construction until a well-fitting denture is fabricated.
- When the dentist is incompetent or incapable of making a tight-fitting denture.

However, presently statistical data shows an increase in the use of denture adhesives. It helps in initial retention of the denture increasing the psychological comfort of the patient.

Available Forms

It is available as soluble and insoluble powders, gels, pastes, or soluble and insoluble wafers.

According to the ADA, a denture adhesive should have the following characters:

- Product composition should be supplied.
- Should not affect the integrity of the denture.
- Biologically acceptable.
- Effective function as adherent.

Composition

All denture adhesives have seven basic ingredients, which are listed below. Commercially available products are different recipes of these ingredients.

Basic Ingredients

They swell and become viscous. E.g. Carbonyl methyl cellulose (CMC), Vegetable gums e.g. Karaya (food additive) Tragacanth, Xantham acacia, Vinyl methyl ether/maleic anhydride compounds (PVM/MA salts), Polyethylene oxide polymers, Cationic polyacryl amide polymers and Polyvinyl pyrrolidone (povidone). Long acting (slow releasing) less soluble gantrez salts (Ca-2n Gantrez) which display molecular cross linking can also be used.

Colouring Agents

E.g. Red dye.

Flavoring Agents

Menthol, peppermint, etc.

Wetting Agents

Preservatives

Sodium borate, methyl paraffin, polyparaffin.

Plasticizers

They are added to improve the handling properties of the material. E.g. polyethylene, mineral oil or petrolatum.

Dispersion Agents

They are used to prevent powders from clumping.

- Magnesium oxide
- Sodium phosphate

- Calcium stearate
- Calcium silicate
- Silicone dioxide

Availability

The material is available in both powder and cream forms. Powder forms are not long lasting. But they have the following advantages:

- Easier to clean out. Not messy to work with.
- Used in smaller qualities.
- Initial hold of dentures is sooner but shorter in powder, where as creams retain their effect longer.

The amount of mateiral required for efficient retention of a denture is around 0.5 to 1.5 g.

Mode of Action

Effectiveness of a denture adhesive depends on both physical and chemical factors of the material.

Water Absorption

The adhesive tends to swell from 50 to 150 per cent by volume in the presence of water. Water absorption of the adhesive results in the formation of anions that are attracted to cationic proteins in the mucus membrane producing "stickiness"

Bio-adhesion by Carbonyl Groups

Carbonyl groups in the adhesive material provide strong bio-adhesive and bio-cohesive forces, which improve the retention of the denture. E.g. polymethyl vinyl ether maleic-anhydride or PVM/MA has a high level of these carbonyl groups.

PVM/MA and Zinc and Calcium salts with CMC have superior retention because of the stronger covalent bond that develops due to its divalent interaction.

Indications for the Use of Denture Adhesives

Adhesives can be indicated for both well fitting and moderately ill-fitting dentures to:

- Improve retention and stability of the dentures (that are poorly retained or unstable).
- To improve stability of a denture for a new or in-experienced patient.
- To stabilize trial bases during fabrication and insertion of the trial denture.
- For handicapped patients:
  - — Patients with xerostomia.
  - — Geriatric patients
  - — Patients with poor muscle tone (such as those with Parkinson's disease, Tardive dyskinesia and Dysarthria)
- To provide a psychological sense of security for specific patients (Such as actors, teachers).
- To simplify the insertion for patients with tactile or movement deficiency. E.g. cerebral trauma patients.
- As an adjunct to the maxillary prosthesis.

Contraindications for the Use of Denture Adhesives

- A denture adhesive should not be used for patients with ill-fitting dentures or by patients who tend to overuse denture adhesives.
- It should not to be used by patients who have medication-induced xerostomia because the adhesives require ample saliva to provide retention.
- It should not be used for patients with worn out dentures.
- It should not be used as a substitute to a reliner or tissue conditioner.
- It should not be used for patients with physical inability to clean dentures.
- It should not be used in patients with temporary or immediate dentures where infection (disease) could result from inadequate hygiene or adherence to dentures.
- It should not be used in patients allergic to components of adhesive.
  E.g. 'Karaya' a vegetable additive is known to cause allergy in some patients.

Advantages of using Adhesives

- Reduces likelihood of irritation in case of a new denture.

- Increases retention and stability initially during chewing, speaking, swallowing.
- Increases the masticatory efficiency.

- Provides psychological benefits of wearing a secure denture.
- Reduces vertical and horizontal movement of the denture.
- Provides a cushioning effect to the denture.
- Enhances denture service.
- It can be used as a vehicle to apply medications on the oral mucosa along with the denture.
- Improve the adhesion and cohesion of the denture-bearing surface.

Disadvantages or Limitations for Use

- Insoluble adhesives like denture pads (synthetic wafers) can cause tissue destruction. It is generally recommended to use soluble denture adhesives.
- Denture adhesives are believed to support bacterial growth that lead to oral pathosis.
- Failure of denture adhesives is usually due to illiteracy of the patient and improper or overuse of denture adhesives along with improper oral hygiene.

Procedure

The denture must be thoroughly cleaned prior to the application of the material. The technique of application varies according to the available form of the material.

Powder Form

- The prosthesis should be moistened.
- Even coating of the adhesive is sprayed on the tissue surface of the denture (Fig. 13.15).
- Excess material wiped away.
- If patient has inadequate saliva, the denture must be moistened before insertion.

Cream Form

It can be applied using two approaches.

Ist Approach

Thin beads or drops of adhesive are placed along the depth of the dry denture in the incisor and

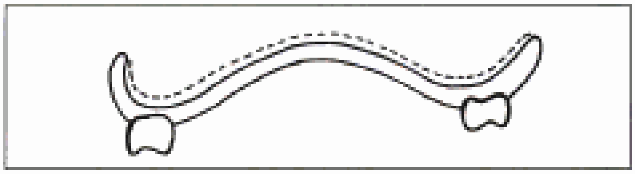


Fig. 13.15: Placement of powder denture adhesive

molar regions. In the maxillary unit an antero-posterior bead should be applied along the mid-palatine groove (Fig. 13.16).

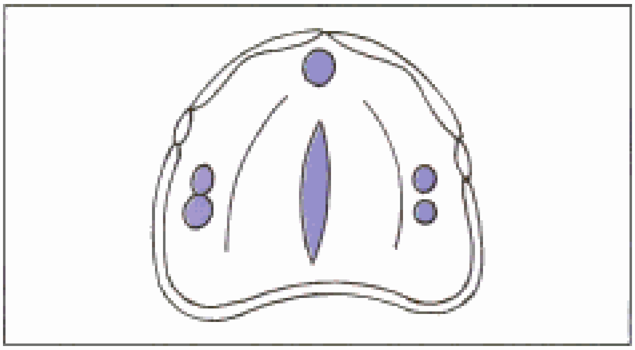


Fig. 13.16: Placement of cream denture adhesive in the form of beads

IInd Approach

Small drops or masses of cream are placed at 5 mm intervals throughout the tissue surface of the denture prior to insertion. (Fig. 13.17).

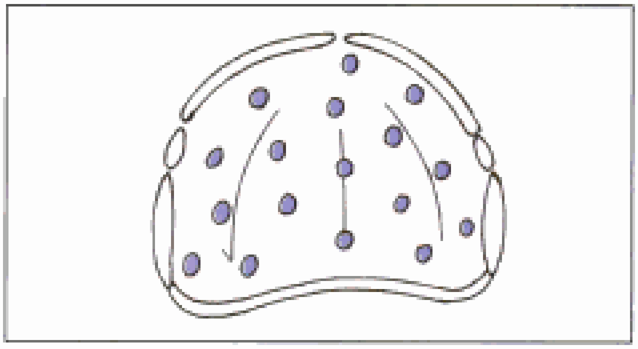


Fig. 13.17: Placement of cream denture adhesive in the form of drops

Instructions

- The patient should be advised to clean the residual adhesive on the surface of the denture everyday.
- As usual the dentures should be soaked in water or medicinal solution overnight. If the

denture is soaked overnight, the adhesive absorbs more water and becomes more soluble. It can be easily rinsed away the next morning.

- Rinsing the denture in hot water and scrubbing with a brush is sufficient to remove the adhesive on the denture.
- Adhesive can be removed from the alveolar ridge by washing with warm or hot water and then firmly wiping with a piece of gauze or a wash cloth soaked in hot water.
- Annual recall should be conducted to evaluate the condition of the oral mucosa.

Denture adhesives can improve patient acceptance, comfort and function. They are an integral part of professional service and their adjunctive benefits must be recognized.

SEQUELAE OF WEARING COMPLETE DENTURES

The use of complete dentures is not free of trouble. The dentures can produce severe side effects, which if left unchecked will produce:

- Destabilization of occlusion.
- Loss of retention.
- Decreased masticatory efficiency.
- Poor aesthetics.
- Increased ridge resorption.
- Tissue injury.

These problems will progress till the stage where the patient will be considered *'prosthetically maladaptive'* and cannot wear dentures any more.

The interaction of prosthesis and oral environment has several aspects. The surface properties of the prosthesis may affect plaque formation. Surface irregularities and microporosities can enhance microbial colonization. Plaque formation is also influenced by:

- Design of prosthesis.
- Health of adjacent mucosa.
- Composition of saliva.
- Salivary secretion rate.
- Oral hygiene.
- Denture wearing habits.

Thus, a prosthesis may promote infection of the underlying mucosa, caries and periodontal diseases of the overdenture abutments, peri-implantitis (inflammation of the peri-implantal membrane), chemical degradation or corrosion of prosthesis. All these disorders produced/accelerated in the oral tissues due to the presence of a denture are grouped as sequelae of wearing complete dentures.

Sequelae of complete denture wear can be divided into direct and indirect types depending on the effect of the prosthesis on the tissues.

DIRECT SEQUELAE OF WEARING COMPLETE DENTURES

Denture Stomatitis

It is the pathological reaction of the palatal portion of the denture-bearing mucosa. It is commonly known as *'Denture induced stomatitis'*, *'Denture sore mouth'*, *'Denture stomatitis'*, *'Inflammatory papillary hyperplasia'* (or) *'Chronic atrophic candidiasis'*.

It is seen in 50% of the complete denture wearers. According to Newton, denture stomatitis can be classified as:

- *Type I:* Localized simple infection with pinpoint hyperemia (Fig. 13.18).

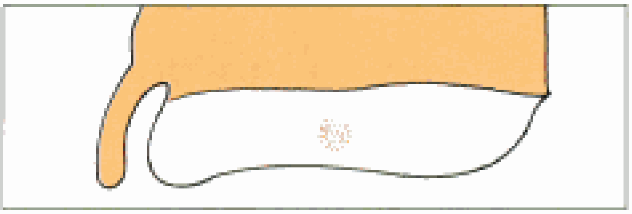


Fig. 13.18

- *Type II:* (Erythematous type) Generalized simple type presenting a more diffuse erythema involving a part or the entire denture covered mucosa (Fig. 13.19).
- *Type III:* Granular type involving the central part of the hard palate and alveolar ridge. Often seen in association with type I and II (Fig. 13.20).

Type I is usually trauma induced, type II and III are associated microbial plaque accumulation. Candida associated denture stomatitis is often seen along with angular cheilitis (or) glossitis.

Fig. 13.19

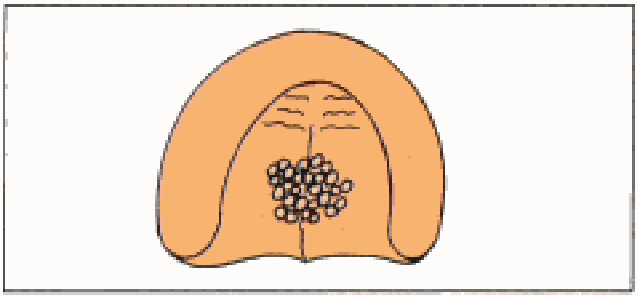


Fig. 13.20

Diagnosis

The presence of Candida associated denture stomatitis (CADS) is confirmed by the presence of mycelia or the pseudohyphae in a direct smear. It can also be diagnosed by the isolation of more than 50 candidial colonies from the lesions. The candida usually resides on the fitting surface of the denture.

Etiology

One of the direct factors that produce denture stomatitis is the presence of the denture in the oral cavity. It is usually seen in patients who wear their dentures both day and night. Trauma from the denture in addition to plaque accumulation can stimulate the turnover of palatal epithelial cells there by reducing the degree of keratinization and barrier function.

'CADS' is also correlated with angular cheilitis. The infection may start beneath the maxillary denture and later spread to the angle of the mouth. The clinical manifestations of the disease gives an idea about the overall health of the patient.

Predisposing Factors

These factors do not directly produce denture stomatitis but they favour the progress or initiation of the lesion.

Systemic factors

- Old age
- Diabetes mellitus
- Nutritional deficiency: Iron, folate, Vit.B_{12}, etc.
- Malignancy: Acute leukemia, agranulocytosis etc.
- Immune defects: Due to the use of corticosteroids and other immune suppressants.

Local factors

- Dentures:
  - — Environmental changes due to dentures.
  - — Trauma.
  - — Denture usage, nightwear.
  - — Denture cleanliness.
- Xerostomia:
  - — Sjögren's syndrome
  - — Irradiation
  - — Drug therapy
- High carbohydrate diet: Increases plaque accumulation.
- Use of broad-spectrum antibiotics: They destroy normal symbiotic colonies leading to the formation of pathological colonies.
- Smoking tobacco: Affects oral hygiene and also produces other effects.

Management and Preventive Measures

Supportive measures

- Institution of efficient oral and denture hygiene habits. Correction of denture wearing habits. The patient is advised to store the dentures in 0.2 to 2% chlorhexidine during the night.
- The patient should be instructed to remove the denture after meals and scrub before reinserting it. The mucosa in contact with the denture should be hygienically maintained and massaged with a soft toothbrush.
- Patient is advised not to use the dentures at night or leave it exposed to air. Rough areas in the tissue surface of the denture should be smoothened or relined using a soft tissue conditioner.
- Polishing of the external surface of the dentures should be done routinely in order to facilitate denture cleansing.

Drug therapy

- Local therapy with Nystatin, Amphotericin B, Micorazole and Clotrimazole are usually preferred to systemic therapy.

- Anti-fungal drugs that remove *Candida albicans* are given mainly,
  — After the clinical diagnosis has been confirmed by mycological examination.
  — In patients with associated burning sensation in the mucosa.
  — In patients where the infection has spread to other sites of the oral cavity and the pharynx.
  — In patients at increased risk of systemic mycotic infections due to systemic diseases.
- To reduce the risk of relapse, the following precautions are followed:
  — Antifungal treatment should continue for four weeks.
  — When lozenges are prescribed the patient should be instructed to retain the dentures during its use.

Surgical Management

- Surgical management includes the elimination of deep crypts in Type III denture stomatitis. This is preferably done by cryosurgery.

Flabby Ridge

The alveolar ridge may become mobile and extremely resilient due to the replacement of bone by fibrous tissue. Flabby ridges are most commonly seen in the anterior part of maxilla opposing natural mandibular anterior teeth (Fig. 13.21). This is due to the presence of excessive load on the ridge and unstable occlusal conditions. Histopathology reveals marked fibrosis, inflammation and resorption of the underlying bone.

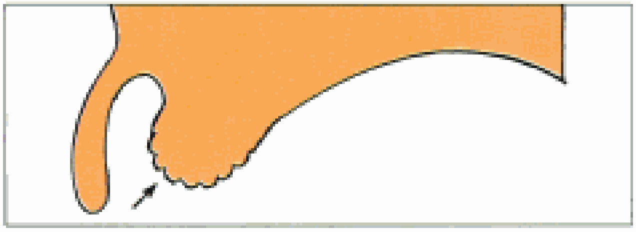


Fig. 13.21: Flabby ridge

Flabby ridges provide poor support for the denture. Hence, they should be surgically removed. If there is extreme ridge atrophy, complete removal of the flabby ridge will eliminate the vestibule. Hence, in such cases it is advisable to preserve the tissue because the resilient ridge may help to provide some retention for the denture.

Traumatic Ulcers

They are commonly known as '*sore spots*'. They usually develop within 1 to 2 days after placement of new dentures. They are small, painful lesions covered with a grey necrotic membrane and surrounded by an inflammatory halo with firm, elevated borders.

Aetiology

The direct cause for this lesion include overextended denture flanges (and/or) unbalanced occlusion. Predisposing factors like use of immunocompromised drugs, etc. suppress the resistance of mucosa to the mechanical irritation.

Treatment

In normal patients, these ulcers heal within few days after correcting the dentures. If no treatment is administered, it may progress to denture irritation hyperplasia.

Denture Irritation Hyperplasia (Epulis Fissuratum)

It is a hyperplastic reaction of the mucosa occurring along the borders of the denture. These lesions result from trauma due to unstable dentures with thin denture flanges.

Symptoms are very mild with single or numerous lesions showing flaps of hyperplastic connective tissue. Deep ulcerations, fissuring and inflammation may occur at the depth of the sulcus.

The lesions usually subside after surgical excision of the tissues and correction of the dentures. Recurrence is rare. These lesions produce marked discomfort under pressure and microbial irritation. They may produce severe lymphadenopathy mimicking a neoplasm.

Oral Cancer in Denture Wearers

Cases showing association of oral carcinoma in relation to chronic irritation of mucosa due to an ill-fitting denture have been reported. They usually manifest as non-healing ulcers or infected aberrant hyperplastic tissues. It should be remembered that the carcinomas in the floor of the mouth have very poor prognosis.

The predisposing factors include heavy use of alcohol, tobacco smoking/chewing, illiteracy and poverty, etc.

Patients should be recalled every six months for a comprehensive oral examination. If denture sore spots do not heal after correcting the dentures, malignancy should be suspected. Large lesions of denture irritation hyperplasia should be referred to the pathologist.

Burning Mouth Syndrome (BMS)

It is characterized by burning sensation in the structures in contact with the dentures without any visible changes in the mucosa.

This lesion is different from burning mouth sensation where the mucosa is often inflamed due to mechanical irritation, infection or an allergic reaction. The mucosa is clinically healthy in BMS.

Epidemiology

It is common in post-menopausal women above 50 years of age. The general complaint includes burning sensation of the supporting structures of the denture and the tongue. The syndrome is aggravated by fatigue, tension, and intake of hot foods. The intensity of pain and burning sensation is reduced during eating, sleeping, mental distraction, etc.

Clinical Features

- This condition does not have any overt clinical signs or symptoms.
- Pain starts in the morning and aggravates during the day.
- Burning sensation is usually accompanied with dry mouth and persistant altered taste sensation.
- Other associated symptoms include headache, insomnia, decreased libido and irritability or depression.

Aetiology

Local factors

- Mechanical irritation caused by ill-fitting dentures.
- Prolonged period of masticatory muscle activity.
- Constant parafunctional movements of the tongue.
- Constant excessive friction on the mucosa.
- Candidal infections and allergic reactions can produce symptoms similar to BMS.
- Myofacial pain.

Systemic factors

- Vitamin and iron deficiency
- Xerostomia
- Menopause
- Diabetes
- Medication.

Psychogenic Factors

- Anxiety
- Depression

Treatment

Generally BMS patients are more psychologically affected. They consider that their psychiatric disorders are due to poor dentures. These patients may need counselling to understand the irrelevance of the dentures with regard to their mental health and also to eliminate their fears. The patient's symptoms are given first priority.

Gagging

- The gag reflex is a normal, healthy defense mechanism, which functions to prevent foreign bodies from entering the trachea.
- It can be triggered by tactile stimulation of the soft palate, posterior part of tongue and fauces.
- Other stimuli like sight, smell, taste, noise, and psychological factors can produce gagging.

These stimuli may occur alone or in a combination.

- In sensitive patients, new dentures may stimulate gagging but this will disappear as the patient adapts to the dentures.
- Persistent gagging can occur due to overextended denture borders especially in the posterior part of maxillary denture and the distolingual part of mandibular denture (Fig. 13.22). Gagging usually produces displacement of the denture.

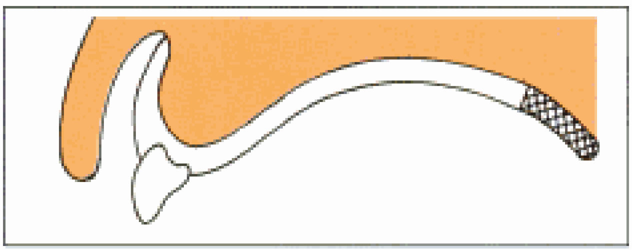


Fig. 13.22a: Palatal overextension of a maxillary denture

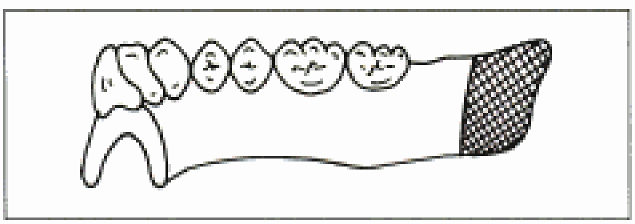


Fig. 13.22b: Distolingual overextension of a mandibular denture

- Commonly, gagging may occur due to unstable occlusal conditions. E.g. increase in vertical dimension of occlusion is predisposed to gagging because the unbalanced occlusal contacts may displace the denture and trigger gagging.
- Gagging can also result from other systemic conditions like GIT disorders, adenoids or tumors in the upper respiratory tract, alcoholism and severe smoking.
- Limiting the posterior extension of the dentures and exercises help to decrease gagging.

Residual Ridge Resorption (RRR)

This is the most common and important sequel of wearing complete dentures. There is continuous loss of bone after tooth extraction and even after the placement of a complete denture. RRR is more common in women due to osteoporotic changes in the bone.

RRR is nothing but alveolar remodeling, which occurs due to change in the functional stimulus of bone tissue. Ridge resorption is a chronic progressive change in the bone structure, which results in severe impairment in the fit and function of the prosthesis. Alveolar remodeling is more important in areas with thick cortical bone especially the buccal parts of the maxilla and lingual parts of the mandible which are load-bearing regions.

Etiopathogenesis

The pathogenesis of residual ridge resorption is very simple. Wherever there is pressure, bone resorbs due to activation of osteoclasts. We have learned that resorption due to pressure is minimal at the stress-bearing areas of the jaws. Hence, excessive pressure applied to the non-stress bearing areas can produce RRR.

Continuous pressure is required for activation of osteoclasts, hence, RRR is common in patients who wear their dentures continuously overnight.

Pattern of Resorption

- Resorption occurs more rapidly in the first six months after extraction of teeth and at a slower pace till 12 months.
- The rate of resorption progresses after 65 years of age.
- In general, residual ridge resorb more rapidly in females than males.
- It can be precipitated by certain systemic diseases or ill-fitting dentures.

All denture patients should be examined periodically on an annual basis. Rate of osseous changes can be retarded when complete dentures are readapted during the first signs and symptoms of loss of adaptation. When such changes are observed, the dentist may choose to reline or rebase the dentures.

Rate of RRR

During the first year after extraction, the amount of RRR is about 2-3 mm in the maxilla and 4-5 mm in mandible. Later the annual rate of reduction of height in mandible is 0.1 to 0.2 mm and it is four times less in the edentulous maxilla. The degree of RRR results from a combination of anatomical, metabolical and mechanical determinants. Severe RRR of mandible can be related to a small gonial angle.

The main factor that affects the rate of residual ridge remodeling is the mechanical force transferred from the denture base and the tongue to the tissues. The rate of RRR is increased in patients who wear their dentures throughout the night without giving rest to the tissues.

Clinical Features

- The depth and width of the sulcus is reduced due to the resorption of the ridge till the level of the muscle attachment. Hence the muscles appear to be inserted on the crest of the ridge obliterating the sulcus.
- Decreased vertical dimension at occlusion.
- Reduction of the lower facial height (due to decreased VDO).
- Anterior rotation of the mandible (explained later).
- Increase in relative prognathism.
- Resorption is centripetal (towards the centre) in the maxilla, and centrifugal (away from the centre) in the mandible (Fig. 13.23). Hence, the size of the maxillary arch will decrease with resorption and the size of the mandibular arch will increase with resorption.
- Sharp, spiny and uneven ridge crest due to difference in rate of resorption from one place to another.

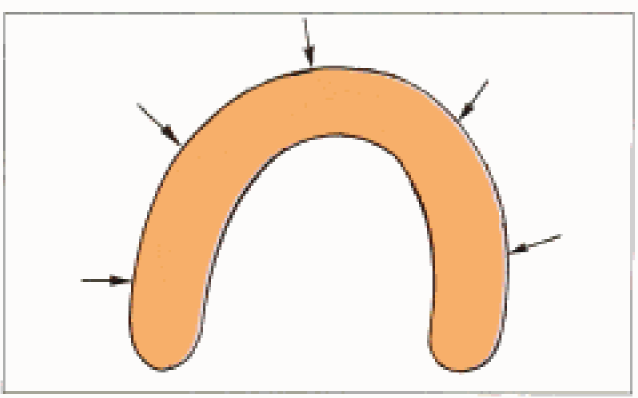


Fig. 13.23a: Pattern of resorbtion in a maxillary ridge

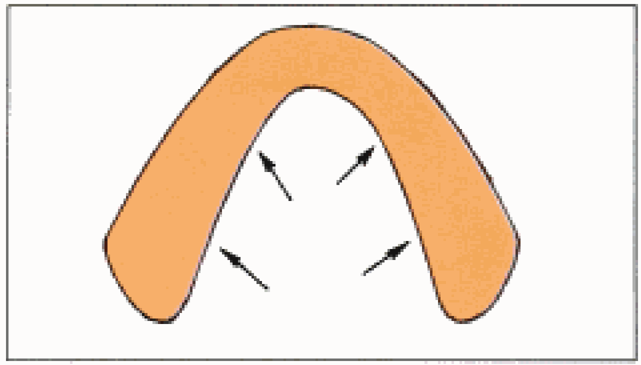


Fig. 13.23b: Pattern of resorption in a mandibular ridge

- Long-term resorption affects support stability and retention of dentures.

Changes in the maxilla Resorption of the bone of the maxillae usually permits the upper denture to move up and back in relation to its original position. However, the occlusion also may force the maxillary denture forward (Fig. 13.24).

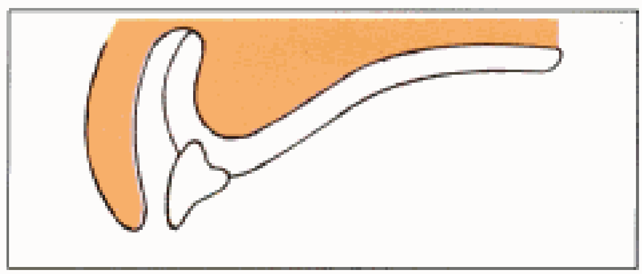


Fig. 13.24a: Normal maxillary ridge

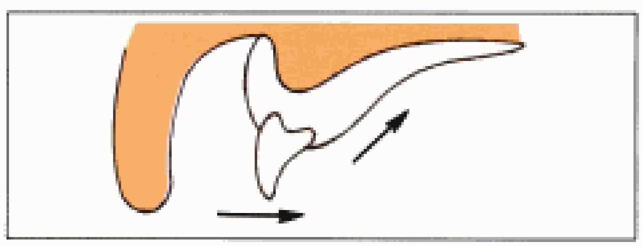


Fig. 13.24b: Resorbed ridge producing backward and upward movement of the ridge

Changes in the mandible The mandible will move to a higher position during occlusion than the one it occupied before the resorption. This will lead to a decrease in the inter-arch space. The mandibular movement is rotatory around a line approximately passing through the condyles.

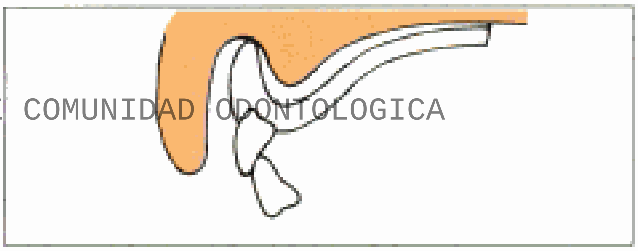


Fig. 13.24c: In such cases, occlusion will produce forward movement of the denture

The effect of this rotatory movement varies from patient to patient and appears to result from a complex interaction of several features:

- The duration and magnitude of bone resorption.
- The mandibular postural habit.
- Tooth morphology.
- The amount of material present.

The mandible's rotation may produce the following consequences:

- Loss of centric occlusion in the dentures.
- Changes in the structures that support the upper denture.
- Movement of the lower denture in a backward direction. This may lead to traumatic changes in the supporting structures of the mandible.
- Movement of the lower jaw anteriorly, with an ensuing prognathic appearance.

We know that mandibular rotation can elicit severe damage in the denture-supporting tissues over a long period of unsupervised denture wear. Since the mandible moves anteriorly, one may expect the denture to move along with it. But this is prevented by the locking mechanism of the cusped teeth. Consequentively the denture shows posterior displacement in relation to the mandible.

Treatment

- Preprosthetic surgery can be done to increase the height of the ridge (ridge augmentation) or depth of the sulcus (vestibuloplasty).

Overdenture Abutments: Caries and Periodontal Diseases

Overdentures are nothing but tooth supported complete dentures. They have been described in detail in Chapter 15. The teeth, which support the complete denture are called over-denture abutments. These abutments are usually endodontically treated and reduced in size so that a denture can be fabricated to fit over them.

In this section, we shall see about the ill-effects that may be produced on these abutments due to the denture. Common problems associated with overdenture abutments are caries and periodontal diseases. Overdenture abutments have high-risk to caries and periodontal diseases because it is difficult to achieve good plaque control in the presence of a denture base all around it (Fig. 13.25).

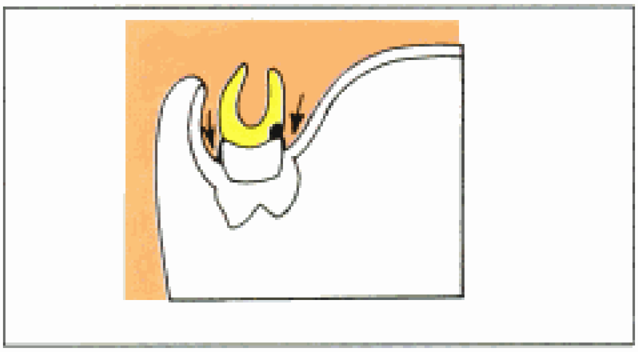


Fig. 13.25: Caries in an over denture abutment

Pathogenesis

Bacterial colonization may easily be left unchecked due to the presence of an overdenture. Gingivitis is produced within three days of colonization of *Streptococcus*.sp and *Actinomyces.sp*. Caries is initiated in the presence of a high proportion of lactobacilli and *Streptococcus mutans*.

Preventive Measures and Management

- Plaque control: It can be established using mechanical methods like brushing, flossing, etc. and chemical methods using mouthwashes, etc. The dentures should also be cleaned effectively to provide better plaque control.
- Fluoride application and chlorhexidine mouthwashes are sufficient to maintain the abutments without caries or any periodontal disease.
- Avoiding nightwear of dentures: This helps the saliva (with its buffering capacity,

antibodies and antibacterial enzymes-lysozyme) to clean and guard the abutments.

- Metal copings can be placed around the teeth in order to protect the tooth structure from caries.

- Periodontal therapy can be done to eliminate periodontal pockets.

INDIRECT SEQUELAE OF WEARING COMPLETE DENTURES

Atrophy of Masticatory Muscles

The masticatory function of a muscle depends on the skeletal muscle force and co-ordination of orofunctional movements. The skeletal force or the bite force decreases with age. Hence, most denture wearers use less biting force. Thus, we can conclude that denture wearers do not use their muscles to their maximum function. Any part of the body that is underused undergoes atrophic degeneration.

Atrophy of a muscle due to poor usage is called *disuse atrophy*. It is more common in women and older people. Common muscles that undergo disuse atrophy are the masseter and the medial pterygoids.

Diagnosis

- The patient is asked to chew a specific quantity of test food and the time taken to chew the test food into small particles is measured. The number of chewing cycles taken to crush the test food is recorded. (*Generally complete denture patients take around seven times more effort than dentulous patients to obtain the same result. In other words what a dentulous person can do with one chewing cycle, will take seven chewing cycles in a complete denture wearer).*
- These patients prefer soft diet and try to swallow them as large pieces.

Preventive Measures and Management

- Overdentures do not produce disuse atrophy, since the propriceptive impulses are generated from the abutment teeth and the biting force is not decreased as much as in a conventional complete denture patient.
- In the absence of overdenture abutments, implants can be inserted and an implant supported complete denture can be fabricated in order to preserve the biting force.

Nutritional Deficiencies

Epidemiology

Ageing is often associated with decrease in energy needs. Old patients show a decrease in muscle mass and decreased physical activity and reduced food intake. Old people reduce their food intake by almost 30%. They also have an altered taste perception, which will ultimately affect their dietary habits. All these factors together make the patient weak and show symptoms of malnourishment.

Masticatory Ability

It is an individual's own assessment of his masticatory function. Masticatory efficiency is the capacity of a person to reduce food during mastication. Edentulous women take in more of fat and coffee and less of ascorbic acid.

Nutritional Status and Masticatory Function

The four factors that relate diet selection to the nutritional status of a patient are:

- Masticatory function and oral health.
- General health.
- Socioeconomic status.
- Dietary habits.

Causes for Malnutrition in Old People

The principal causes of proteocaloric malnutrition among elderly denture wearers are:

- Poor general health.
- Poor absorption.
- Intestinal, anabolic and catabolic disturbances.
- Anorexia.
- Reduced rate of salivary secretion during mastication.

GENERAL PRECAUTIONSTO PREVENT AND/ OR CONTROL OF SEQUELAE FROM COMPLETE DENTURES

Patient cooperation is very important for such conditions. General precautions, which will help prevent and/or control the sequelae of complete dentures are listed below.

- Modified dietary habits wherein balanced diet is administered.
- Food particles can be mechanically broken down before eating to reduce the burden on the oral musculature.
- The dentist should try to preserve the remaining teeth as much as possible and at least fabricate an overdenture in order to reduce the sequelae. This is more necessary for the mandible, as destabilization occurs more easily due to excessive ridge resorption.
- In the absence of overdenture abutments, the dentist should try to atleast plan an implant supported complete denture. Implant-supported dentures also help to reduce the rate of resorption of the ridge.
- Regular follow up should be conducted so that a stable occlusion can be maintained.
- Overdenture patients should be frequently recalled to examine the status of the abutment.
- Patient should be motivated to follow optimum denture wearing and maintaining habits.
- As mentioned before the importance of patient's cooperation in the success of treatment should be explained and emphasized.

14

Relining and Rebasing in Complete Dentures

INTRODUCTION

Sometimes, the residual ridge contour changes so rapidly that the repeated construction of new dentures becomes a financial burden to the patient. Maintenance of the adaptation of denture base to these ever resorbing tissues is a critical part of a complete denture service.

A number of changes can occur in the tissues that support complete dentures. They are more common under the mandibular dentures than the maxillary dentures. They are also common in maxillary dentures opposing natural teeth. These changes may be insidious or rapid, but they are progressive and inevitable, and are usually accompanied by the following signs:

- Loss of retention and stability
- Loss of vertical dimension at occlusion
- Loss of facial support
- Shift of dentures
- Reorientation of occlusal plane

The resultant spatial (3-d) orientation of the dentures on their supporting tissues and occlusal surfaces leads to changes in circum-oral support and, consequently, in the patient's appearance. Changes in occlusal relationship also induce more adverse stresses on the supporting tissues, which increases the risk of further ridge resorption.

The need for relining and rebasing are governed by factors like pattern of residual ridge resorption, vertical/horizontal changes in the basal seat area and changes in the edentulous maxilla/mandible.

Pattern of Resorption

As described in the previous chapter:

- Resorption occurs more rapidly in the first six months after extraction of teeth and at a slower pace till 12 months.
- The rate of resorption progresses after 65 years of age.
- In general, residual ridges resorb more rapidly in females than in males.
- It can be precipitated by certain systemic diseases or ill-fitting dentures.

Every denture patient should be examined periodically on an annual basis. Rate of osseous changes can be retarded when complete dentures are readapted at the first signs and symptoms of loss of adaptation. When such changes are observed, the dentist may choose to reline or rebase the dentures.

Vertical Changes in the Basal Seat Area

These problems are usually not a simple change in the occlusal vertical dimension. It also can result in a change in the horizontal relation of the dentures to each other and to their basal seats. A loss of vertical dimension will automatically move the mandible to a more forward position in relation to the maxillae. We must not overlook the unpredictability of bone morphological changes. This outcome will in turn influence the position of the denture.

Horizontal Changes in the Basal Seat Area

The horizontal position of each denture in relation to its own supporting ridge must be considered, so a determination can be made as to whether the denture has moved forward or backward because of occlusal forces applied to it. Furthermore, one or both dentures may have rotated in relation to the supporting structures.

The occlusion in the mouth cannot, therefore, be used as a guide to the horizontal repositioning of either dentures. A new vertical dimension should be measured with a correct inter-occlusal distance. The relation of the teeth to the ridges must be observed for accuracy. If shrinkage has been only in the vertical direction *(allowing the jaws to approach each other more closely than they should when occlusal contacts are made)*, the occlusion cannot be corrected, even though there has been no anterior or posterior movement of the dentures.

Changes in the Maxilla

Resorption of the bone of the maxillae usually permits the upper denture to move up and back in relation to its original position. However, the occlusion also may force the maxillary denture forward. The lower denture usually moves down and forward, but it may move down and backward relative to the mandible as resorption occurs (Refer Chapter 13).

Changes in the Mandible

Concurrently, the mandible moves to a higher position when the teeth are in occlusion than the position it occupied before resorption. This leads to a decrease in the inter-arch space. This movement is rotatory around a line approximately through the condyles. (Refer Chapter 13).

RELINING

Definitions

Relining is defined as, "*A procedure to resurface the tissue surface of the denture with new base material to make the denture fit more accurately*" - GPT.

"*It refers to the process of adding base material to the tissue surface of the denture in a quantity sufficient to fill the space, which exists between the original denture contour and the altered tissue contour.*" (Sharry)

Indications for Relining

- Immediate dentures after 3-6 months where maximum residual ridge resorption would have occurred.
- When the adaptation of the denture to the ridge is poor due to residual ridge resorption
- Economical reasons where the patient cannot afford a new denture.
- Geriatric or chronically ill patients who cannot withstand physical and mental stress of construction of new dentures

Contraindications for Relining and Rebasing

- When the residual ridge has resorbed excessively.
- Abused soft tissues due to an ill-fitting denture.
- Temporo-mandibular joint problems.
- Patient dissatisfied with the appearance of the existing dentures.
- Unsatisfactory jaw relationships in the denture.
- Dentures causing major speech problems.
- Severe osseous undercuts.

Advantages

- Eliminates frequency of patient visits.
- Economical for the patient.
- Improves fit of the denture.
- A soft liner can be incorporated in this denture, if necessary.

Disadvantages

- Likelihood of altering the jaw relationship during the process.
- Cannot correct aesthetics, or jaw relations.
- Cannot correct occlusal arrangement.
- Cannot be used when excessive resorption has occurred. Hence it cannot be a substitute for a new denture.

Treatment Rationale: When should one Reline or Rebase

The magnitude of the soft and hard tissue changes observed during the recall is what determines the treatment plan. If a new thin layer of resin is added to the denture base, the resurfacing procedure is termed *Relining*. If more material is added, extensive refitting is necessary, it is called *Rebasing*.

Relining or rebasing should be carried out based on a careful diagnosis and treatment plan.

Diagnosis

Diagnosing the problems that have occurred is essential to determine the choice of treatment. The nature of tissue changes, their extent and location should also be studied.

Tissue changes may be due to:

- Incorrect or unbalanced occlusion: For such cases, correction of occlusal disharmony is sufficient.
- Changes in supporting structures: *If the vertical dimension is changed rebasing is required or else relining would be sufficient*. Other factors like amount of resorption, etc also determine the treatment requisite.

Treatment Plan

- Dentures with in-built occlusal errors may not need relining – only occlusal correction will be required.
- Change in the basal seat of the denture is revealed by looseness, general soreness and inflammation, loss of vertical dimension and aesthetics or disharmonious occlusal contacts.
- If the supporting tissues are traumatized, surgical correction (to eliminate the hyperplasia) may be needed before making the reline impression.

With the aid of a proper diagnosis and treatment plan, the choice of relining or rebasing can be confirmed.

General Considerations Prior to Relining

- A thorough examination of the patient and dentures is necessary.
- Vertical dimension at occlusion should be satisfactory (neither increased nor decresaed).
- Centric occlusion should coincide with centric relation.
- Aesthetics should be acceptable.
- Oral tissues should be in optimum health.
- Hyperplastic tissues or severe osseous undercuts should be eliminated.
- Posterior limit of the dentures should be correct.
- Denture base extensions should be adequate.
- Inter-occlusal distance (freeway space) should be adequate.
- Speech should be satisfactory.
- It should be understood that:
  — The closed mouth impressions made for relining do not record the tissues at rest position. Hence, relining may not give total relief to the denture bearing area.
  — The patient cannot determine the amount of pressure that is required to maintain the denture in position. Hence the tissues might be displaced beyond acceptance. In such cases, the prognosis of relining treatment will be poor.
  — The record bases may move before the relining material sets. If there are premature contacts at occlusion, the resultant impression may become inaccurate. All premature contacts must be eliminated prior to the making of a closed mouth impression.
  — Remounting of denture in the articulator is necessary to reestablish an acceptable inter-occlusal distance and harmonize the occlusion with jaw movements.
- When both maxillary and mandibular dentures are to be relined or rebased, it is better to handle maxillary denture first, make occlusal corrections, allow an adjustment period and then proceed with mandibular denture.

Armamentarium Required

- Existing dentures
- Impression material of choice, either metallic oxides or elastomers or tissue conditioners.
- Facebow and semi-adjustable articulator or Hooper's duplicator or Jectron Jig.
- Dental flask (Optional)
- Border moulding material
- Utility wax
- Denture base material of choice.

Pretreatment Procedures

Preparation of Tissues for Impression

- Hyperplastic tissues should be surgically excised and the existing dentures can be used as surgical splints.
- Oral mucosa should be free of irritations.

- Dentures should not be worn during sleep.
- Dentures should not be worn for at least 2 to 3 days prior to final impression appointment.

Preparation of the Dentures for Impression

- Pressure areas on the tissue surface of the denture should be relieved.
- Minor occlusal disharmony should be corrected by selective grinding.
- Border inadequacies should be corrected.
- Borders should be shortened by 1 mm, to allow space for new impression material.
- Posterior palatal seal area should be established using greenstick compound or autopolymerizing resin.
- All large undercuts should be removed.

Relining Procedures

- Clinical procedures:
  - Static methods:
    - Open-mouth technique.
    - Closed-mouth technique.
  - Functional methods
  - Chair-side technique
- Laboratory procedures:
  - Articulator method
  - Jig method
  - Flask method

Clinical Procedures

Clinical procedures for relining and rebasing are similar. Only the laboratory procedures vary.

Static Methods

Open-mouth technique Carl.O.Boucher

Boucher's technique is the only one described in the literature that explains a method for relining the mandibular and maxillary denture at the same time. It has been emphasised that in this technique the impressions are made independently without utilising the existing centric occlusion.

Actually, the dentures are used as special trays for making the secondary impression. ZnOE is the material of choice. It is loaded on the tissue surface of the denture and the impression is made using the denture as the special tray. After the maxillary and mandibular impressions are made a new centric relation record is accomplished. All these procedures are done in one appointment.

Exactly 15 seconds after the denture has been placed in the mouth, the patient is asked to pull the upper lip down and to open his mouth wide these actions mould the impression material over the border of the denture. The lower impression is made after making the upper impression.

Advantages

- Selective trimming helps to make a selective pressure impression.
- Making a separate inter-occlusal record will allow the operator to concentrate on recording the jaw relation.
- It is possible to verify the centric relation record if necessary.
- The inter-occlusal record is reliable.

Disadvantages

- Difficult procedure.
- It requires more clinical and laboratory time.

Laboratory procedures are carried out as explained in the later part of the chapter.

Closed-mouth Technique

Maxillary and mandibular relining/rebasing should be done separately. Various techniques have been explained.

- Technique A
- Technique B
- Technique C
- Technique D

Technique A requires recording a new centric relation record using modeling wax or compound. Techniques B, C and D, use the existing centric relation record in the existing denture.

Technique A It is a two step technique wherein the centric relation is recorded using an inter-occlusal record and is used to guide the dentures in to position while making the reline impression. Centric relation (inter-occlusal record) is recorded using wax or compound. 1.5 to 2 mm relief should be given to large undercuts. Borders are reduced by 1 to 2 mm except in the posterior region (Fig. 14.1).

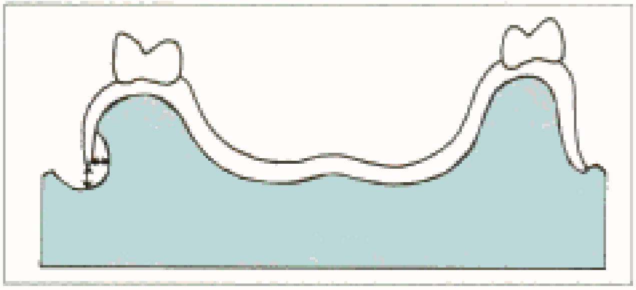


Fig. 14.1: Relieving the denture flange near the undercut

The centre portion of the palate in the denture can be removed (optional) for visibility in positioning the maxillary denture during impression making (Fig. 14.2). Borders are reformed to their functional contours using low-fusing compound. ZnOE is the impression material of choice. During impression making, patient is asked to close lightly into the newly-made inter-occlusal record. If the palatal portion has been cut, quick setting plaster should be used to make impression.

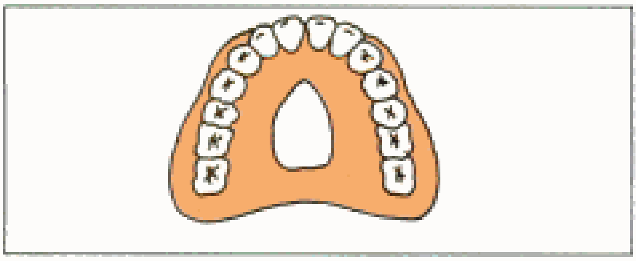


Fig. 14.2: Palatal relief for visibility

Advantages

- Palatal opening will allow better seating of the denture and alleviate the increase in vertical dimension.
- Pre-made inter-occlusal record helps to position the denture during impression making.
- It also helps in orienting dentures in an articulator.
- It is a two-step procedure and it reduces the possibility of moving the maxillary denture forward during final impression making. Hence, its more reliable

Disadvantages

- This procedure cannot be used to reline or rebase the dentures simultaneously.
- Wax inter-occlusal record is not very accurate.

Technique B No new centric relation record is made here. Denture is prepared as explained in technique A. Border moulding is done using low fusing compound. Impression wax (Iowa wax) is the material of choice for making impressions. Impression is made in two stages. In the first step all areas except the labial flange and the alveolar crest in-between the canines are recorded. The labial flange and alveolar crest between canines are recorded in the second step (Fig. 14.3).

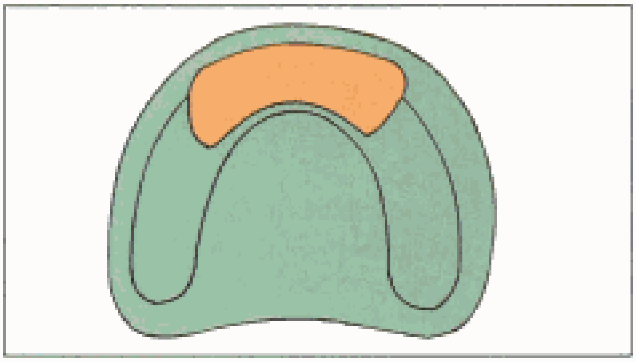


Fig. 14.3: Area shaded in red are recorded during the second step in technique 'A'

Advantages

It will reduce the possibility of extreme forward movement of the maxillary denture.

Disadvantages

Wax impression materials are difficult to work with and can distort easily. If the existing centric relation record is wrong then the impression becomes inaccurate.

Technique C Centric relation record is obtained as in Technique B. The denture is prepared as in Technique A. Also, labial and palatal flanges are perforated to decrease the pressure inside dentures during impression making (Fig. 14.4). Border moulding is the same as in technique A. Advantages and disadvantages are same as in techniques A and B because this technique is a combination of both A and B.

Figs 14.4a and b: Providing relief holes for the reline material

Technique D Existing centric relation record is used here. Denture is prepared as described in other techniques. The borders are shortened and made flat. A large opening is made in the mid palatal region. Adhesive tape is attached over the buccal and labial surfaces of both dentures 2 mm above the denture borders (Fig. 14.5). Dental plaster or ZnOE is suggested for recording most areas and plaster of Paris is used to record the palatal portion. After impression making, a deep groove is cut into labial and buccal surfaces of the dentures at the junction of the impression material and is filled with molten wax (Fig. 14.6). The wax at the edge of the denture is used to record the sulcus (Fig. 14.7). This technique shares the advantages of technique A.

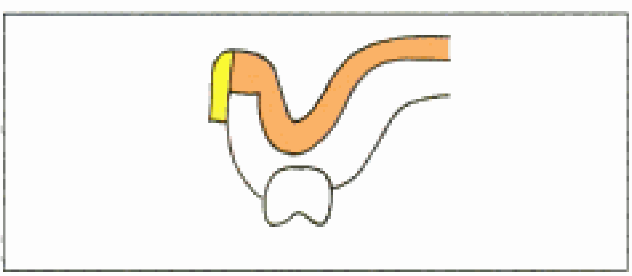


Fig. 14.5: Attaching adhesive tape and making a reline impression for technique 'D'

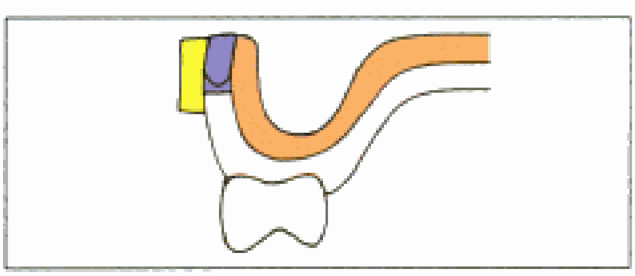


Fig. 14.6: Grooving in the region between the reline impression and adhesive tape and filling it with molten wax (blue)

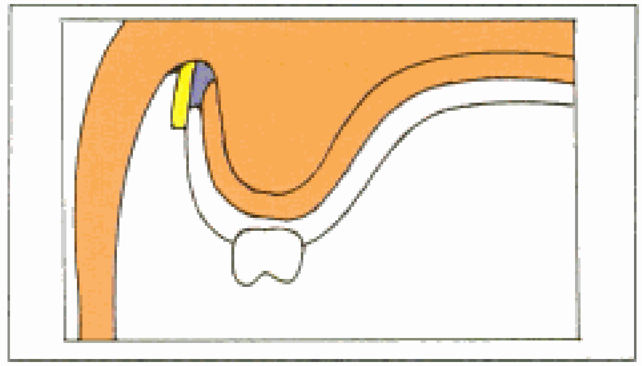


Fig. 14.7: Border moulding using the molten wax

Disadvantages

Existing centric occlusion may cause some pressure points and faulty impressions.

Functional Method

It was suggested by **Winkler**. Here, the patient need not be without dentures unlike previous techniques (i.e. dentures are not required for laboratory procedures). Fluid resins (tissue conditioners) are used as impression material. It is a simple and practical procedure and is more popular.

Tissue conditioners are temporary soft liners with the following characteristics:

- Easy to use.
- Excellent for refitting complete dentures.
- Capable of retaining for many weeks.
- Good in dimensional stability.
- Good in bonding to resin denture bases.

Procedure

- The patient is advised to avoid nightwear of dentures.
- Occlusal errors in the dentures are corrected to obtain centric occlusion that coincides with the centric relation.
- Flange overextensions/underextensions and posterior palatal seal areas should be corrected.
- The tissue surface should be reduced to accommodate the tissue-conditioning material (Fig. 14.8).

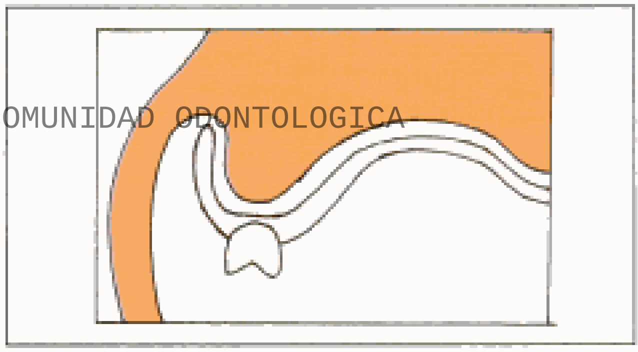


Fig. 14.8: Reducing the tissue surface of the denture prior to functional method

- The tissue surface of the denture is dried and tissue-conditioning material is placed. It should flow evenly as a thin layer to cover the entire impression surface of the denture and its borders.
- Next, the denture is inserted and the patient's mandible is guided to centric relation in order to stabilize the denture and the material is allowed to set. Once it sets, the impression is removed and excess material is trimmed. Overextensions and voids are corrected (Fig. 14.9).
- Unsupported areas in the dentures will show the overflow of the liner and poor recording of the borders. This indicates the need for localized border moulding with green stick compound. The lining material will slump during setting if not adequately supported by the denture.
- After making the corrections, the dentures are inserted with the material and the patient is dismissed. After 3 to 5 days, dentures are examined for denuded (depressed) areas, which should be relieved. Areas of under-extension are corrected by adding more material. The material should be renewed periodically (once a week) till the tissue healing is complete.

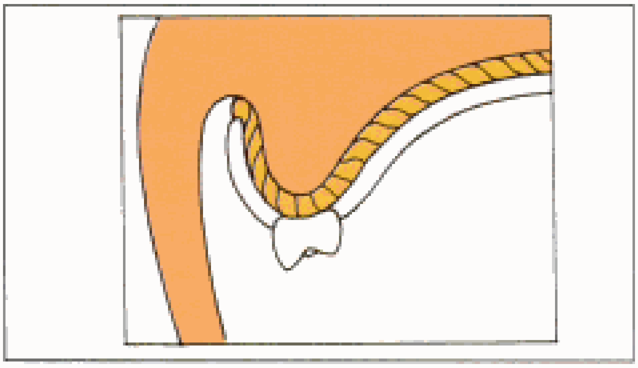


Fig. 14.9a: Making the tissue conditioner impression

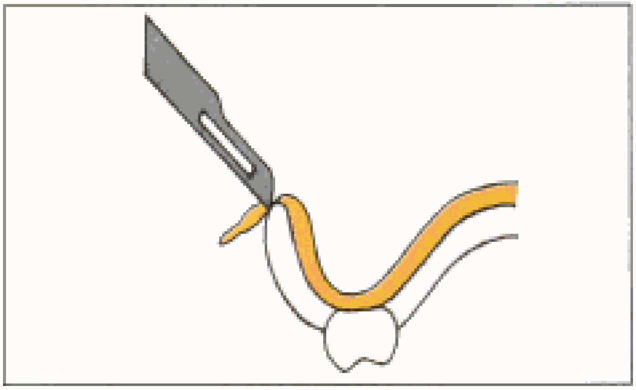


Fig. 14.9b: Trimming the excess impression material

- Once the tissues are normal, impression is made with ZnOE or a light bodied elastomer over the tissue conditioner material and a cast is poured immediately. During one of the previous visits, an accurate orientation record of the maxillary denture should be recorded using a face-bow.
- The tissue conditioner material undergoes some physical changes during its use, which help the dentist use it for different purposes. In its *plastic* and *elastic* stages it is used as tissue conditioner, whereas in its *firm* stage it is used as reline impression material. Hence, for relining procedures, it should be left in place for about 10-14 days to allow them to become firm and then reline procedure is carried out.

Chair Side Procedure

This method makes use of acrylic that could be added to the denture and allowed to set in the mouth to produce instant relining / rebasing.

Disadvantages

- Material produces a chemical burn in oral mucosa.
- Material is porous and develops a bad odour.
- Poor colour stability.

- Material is not easy to remove if not placed correctly.

Recently, visible light cure (VLC) resin has been developed which is similar to tissue conditioners. This material can be regulated by selection of appropriate viscosity and partial intraoral polymerization with a hand-held curing light. It is then taken to the laboratory for curing the unpolymerized molecules. This material seems to hold considerable promise.

Laboratory Procedures

Laboratory procedures for relining include articulator method, jig, and flask methods. It is common for both relining and rebasing except for a few differences.

Articulator Method

Once the impression is received, a cast is poured immediately. Maxillary cast is mounted on a semi-adjustable articulator with the help of a face-bow transfer (Fig. 14.10). A jig can be used for this purpose, but additional occlusal adjustments will be required later. Mandibular denture is mounted using an inter-occlusal record. If occlusal discrepancies exist, selective grinding is done before the denture with the impression is seperated from the casts.

The procedure is common for both relining and rebasing upto this stage. For relining, the required amount of tissue surface of the existing denture is trimmed away using an acrylic bur. If rebasing is to be done, the denture base should be trimmed to just leave 2 mm of acrylic around the existing teeth (Fig. 14.11). After trimming, the dentures are placed in the articulator and waxed up without altering the vertical height.

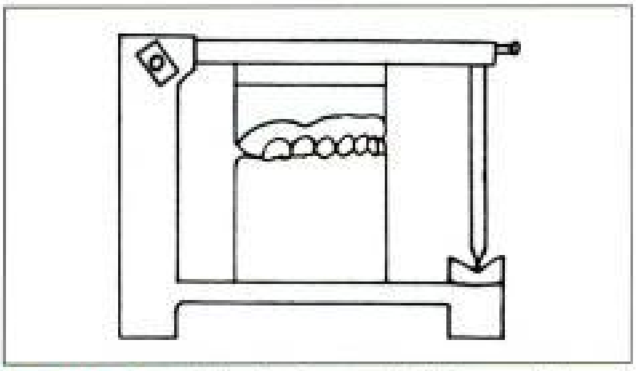


Fig. 14.10: Articulating the denture (with impression) and cast against a plaster template

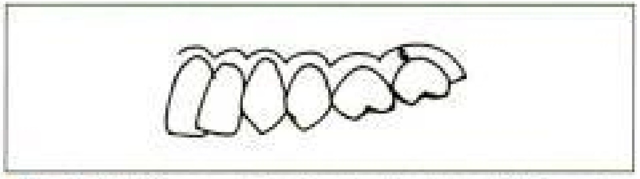


Fig. 14.11: After mounting, the denture base is trimmed to upto 2 mm near cervical margins of the artificial teeth

Jig Method

Here the impression is boxed and a cast is poured. A reline jig is used in this method. There are two types of jigs for this purpose:

- Hooper's duplicator (A favourite university short note is Hooper's duplicator (Fig. 14.12).
- Jectron jig (Fig. 14.13).

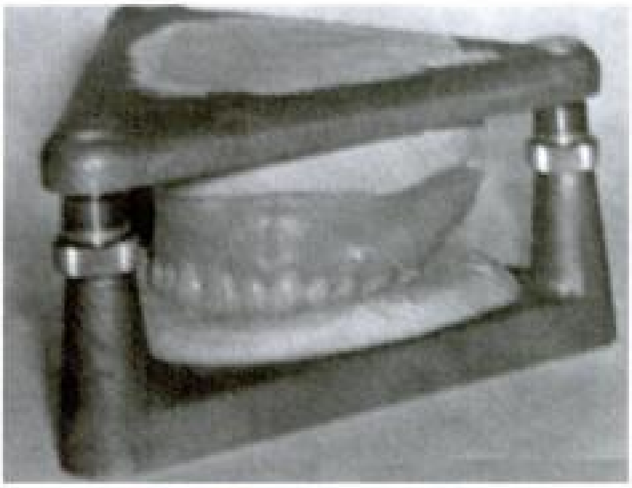


Fig. 14.12: Hooper's duplicator

About these jigs

- They function to maintain the occlusomucosal relation.
- The cast alongwith the impression is mounted on the upper member of these instruments.
- Hooper's duplicator is an instrument that has two triangular parts connected by three pillars in each corner. Whereas, Jectron Jig uses only two pillars.

Fig. 14.13: Jectron jig

- A plaster index is made on the lower platform with the denture teeth penetrating the depth of about 2 mm. When the plaster sets the indentations made by the denture teeth act as a key into which the denture teeth can be repeatedly positioned to maintain a fixed distance and relation between the cast and the occlusal surfaces (Fig. 14.14).

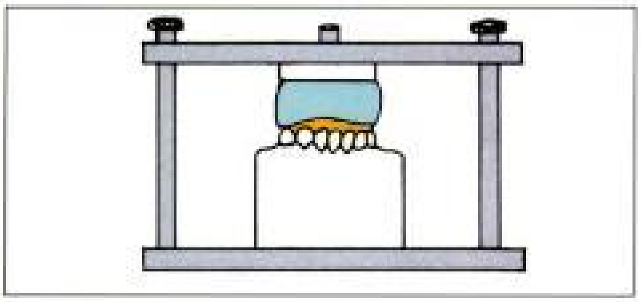


Fig. 14.14: Mounting a denture (with impression) in a jig against a plaster template

- When the key has set, the top and the bottom members of the jig are separated. Denture is removed from the cast.
- All of the impression material is removed from the denture and the denture is prepared (trimmed) according to the treatment selected (relining or rebasing).
- If rebasing is selected, the entire denture base is removed from the teeth (if they are porcelain), and all but a small connecting bridge of acrylic is removed (if the teeth are plastic or acrylic).
- The trimmed dentures are then set into the plaster key and the top of the instrument is replaced. The denture is waxed to the cast, processed and finished as usual. The cured denture should be repositioned on the jig to correct the occlusion prior to insertion.
- If relining is opted, auto-polymerizing resin is used on the tissue surface of the denture and the upper member of the jig is closed. The denture is cured in a pressure container of warm water at 15 psi for 30 minutes. Use of auto-polymerizing resin is controversial due to its irritation to the tissues but it avoids the use of excess heat (required for heat curing resins), which may warp the original base material.

Problem Areas

- The denture cannot be separated from the cast without breaking the cast or itself.
- Occlusal errors may occur if the flask is not closed properly while curing.
- Relined/Rebased denture may not be retentive.

Causes

- Failure to remove denture undercuts before impression making.
- Denture teeth not seated properly into the indentations.
- Wax shrinkage withdrew teeth from indentations, resulting in lack of occlusal contact.
- Occlusion not properly maintained while making the rebase impression.
- Flask halves have a poor fit.
- Posterior palatal seal not placed in cast.
- Initial impression not adequate.

Solution

- Remove undercuts using bur prior to making the rebase impression.
- Seat the denture firmly.
- Add chips of cooled wax to the space between tooth ridge laps and cast, in order to minimize wax shrinkage.
- Make rebase impression at proper occlusal relationship.

- Use accurately fitting casts.
- Scrape the posterior palatal seal in the cast prior to adding resin.

- Inspect impression for any damage during transit to laboratory.

Flask Method

- The poured impression alongwith denture is invested into the base of a flask (Fig. 14.15).

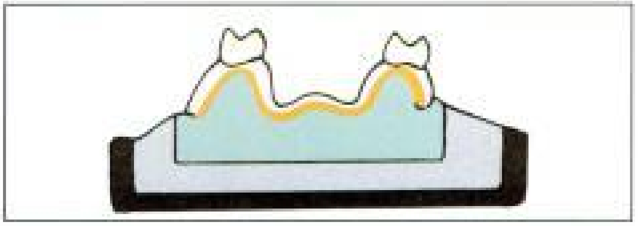


Fig. 14.15: Investing the denture (with impression) and cast on the base of a flask

- A silicone mould material is painted over the denture prior to investing the body. This is done to create a flexible mould. Flasking is completed as usual (14.16).

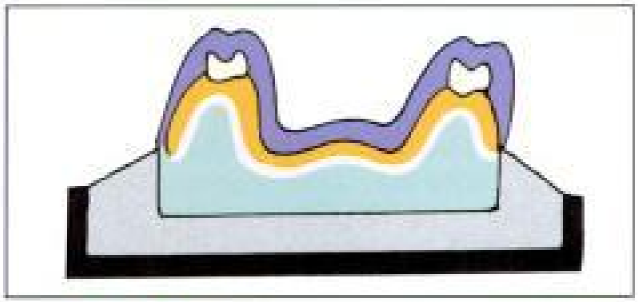


Fig. 14.16: Coating silicone mould material

- Since silicone provides a flexible mold, the denture can be removed carefully after opening the flask (Fig. 14.17).
- The denture base is trimmed as required (a portion of the tissue surface in relining and the entire denture base in rebasing). And placed back into the mould (Fig. 14.18).
- The invested stone present in the base of the flask is the cast for the denture. If it is a maxillary denture then the posterior palatal seal should be marked using a sharp instrument on the invested stone.

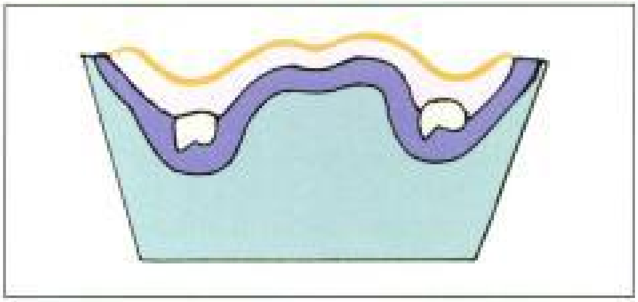


Fig. 14.17: Investing the counter of the flask

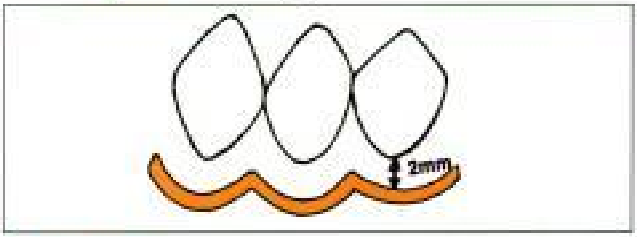


Fig. 14.18a: After trimming the denture it is placed back into the silicone mould

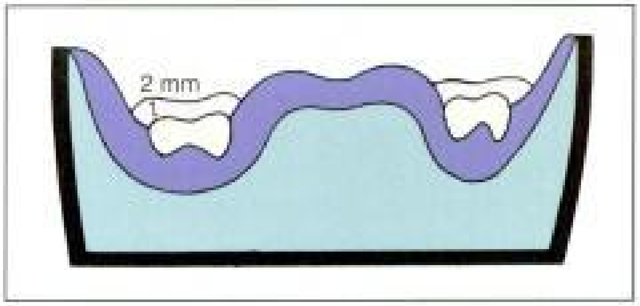


Fig. 14.18b: The denture is removed carefully and the denture base is trimmed upto 2 mm near the artificial teeth

- Separating medium is painted over the mould space of the denture.
- The resin is packed, cured, finished and polished as described in compression moulding technique.
- The finished dentures are remounted to check for occlusal disharmony.

Problem Areas

- Nodules on tissue surface of dentures.
- Incorrect occlusion.

Causes

- Air incorporated in silicone during mixing.
- Flasks do not fit properly
- Resin not trial packed adequately.
- Initial impression not related to proper jaw relation.

Solutions

- Do not whip air into mix during mixing resin.
- Use accurately fitting flasks.
- Eliminate all flash by trial closures.
- Make sure that impression is related to proper occlusal position.
- Examine impression for damage that may occur during transit.

Once the dentures are relined satisfactorily, they are inserted in the mouth with all the necessary instructions.

REBASING

Definitions

"A process of refitting a denture by the replacement of the denture base material" - GPT.

Sharry defined as, *"It consists of replacing all of the denture base with new material."*

Rebasing is similar to relining except that there is extensive replacement of the denture base material. The clinical procedure is similar to that of relining. Denture is prepared and border moulding is done as described in relining. A new vertical and centric relation should be recorded. The impression made using the dentures are processed as described in relining. The only difference is that only a layer of acrylic is removed before wax-up in relining but in rebasing the entire denture base is removed prior to wax-up.

Indications and Contraindications, Advantages and Disadvantages

The indications and contraindications for rebasing is similar to relining. Generally one must keep in mind that when tissue damage is excessive the treatment shifts from relining to rebasing. Another thumb rule is that rebasing should be done if the vertical dimension of the patient is changed. Relining is not sufficient for these cases. Rebasing can be done properly only in dentures with porcelain teeth. Rebasing has the same advantages and disadvantages of relining.

Armamentarium Required

(Refer relining)

Pretreatment Formalities

(Refer relining)

Clinical Management

Clinical management includes impression making and insertion. Both these procedures are similar to the ones explained in relining. (Refer relining)

The denture is usually functionally relined prior to rebasing in order to establish (increase) a new vertical dimension.

Laboratory Procedures

The laboratory procedures used for rebasing are the same as the ones used for relining. They include articulator method, flasking method and jig method. Irrespective of the methods used, rebasing differs from relining only in denture trimming prior to wax-up.

Denture Trimming Prior to Wax-up

This is the only step where rebasing differs from relining. After articulating or flasking the cast (depending of the method) the denture is removed from the cast and the entire denture base is trimmed leaving just 2 mm of acrylic around the porcelain teeth. The acrylic is retained to preserve the positions of the denture teeth. After trimming the denture wax up is done over all the supporting structures of the cast (Fig. 14.18).

Processing the Denture

It is similar to relining.

SUMMARY

Methods of relining and rebasing complete dentures were discussed in this chapter. Each of these methods can produce a satisfactory result. Impression materials involve both auto-polymerizing resin and tissue conditioners. Various techniques of impression making were explained. Different laboratory procedures were also explained. Success depends on both clinical and laboratory skills of the operator.

Chapter 15
Special Complete Dentures

- Introduction
- Conventional Complete Dentures with Mechanical Retentive Components
- Single Complete Dentures
- Immediate Denture
- Tooth-Supported Overdentures
- Implant-Supported Overdentures
- Obturators

15

Special Complete Dentures

INTRODUCTION

We read in detail about the fabrication of a conventional complete denture in the previous chapters. In this chapter we shall discuss complete dentures with certain special modifications to suit patient needs.

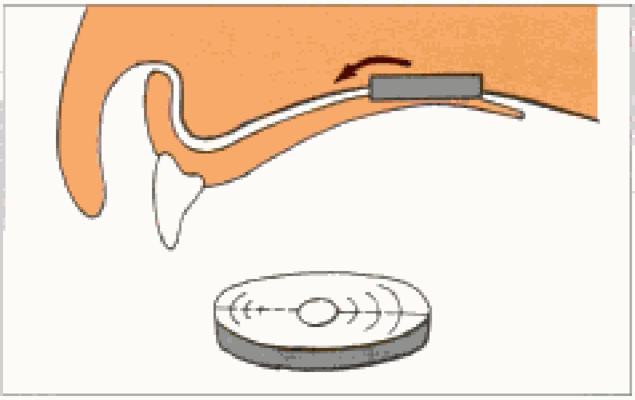
Various design modifications are available to suit the specific needs of the patient. The most commonly used special complete dentures are:

- Conventional complete dentures with mechanical retentive components.
- Single complete dentures:
  - — Maxillary complete denture opposing a mandibular natural dentition.
  - — Maxillary complete denture opposing a mandibular partial denture.
  - — Mandibular complete denture opposing a maxillary natural dentition.
  - — Mandibular complete denture opposing a maxillary partial denture.
- Immediate dentures:
  - — Interim immediate denture or interim denture.
  - — Conventional immediate denture.
- Overdentures:
  - —Tooth-supported overdentures.
    - Conventional overdentures
    - Immediate overdentures
  - —Implant supported overdentures.
- Obturators.

CONVENTIONAL COMPLETE DENTURES WITH MECHANICAL RETENTIVE COMPONENTS

In cases where retention is compromised due to residual ridge resorption, mechanical retentive components can be added to improve the retention of the denture. (These components are avoided because they produce tissue damages).

The most commonly used mechanical components in the fabrication of a denture include springs, intra-mucosal magnets and suction discs. All these methods do not have any norms or specifications, hence various companies have come out with different products. The structure of the component manufactured by each company differs significantly. Refer mechanical factors of retention discussed in Chapter 5 (Fig. 15.1).



Figs 15.1a and b: Mechanical denture retention using suction discs

SINGLE COMPLETE DENTURES

Some patients may have a completely edentulous maxilla with a partially edentulous or completely dentulous mandible. These patients will require a maxillary complete denture opposing a complete mandibular dentition or a mandibular partial denture.

Single complete dentures always pose a problem to the dentist. Patients using this design have the tendency to confine their masticatory load to areas where natural teeth are present. This produces an unfavourable force distribution, which can lead to adverse soft tissue reactions like hyperplasia, ridge resorption, etc.

Indications

- In patients with discrepancies in jaw size who require a complete denture, it is advisable to retain teeth on the retrognathic mandible.
- In patients with inoperable cleft or perforated palates, it is advisable to retain teeth in the maxillary arch. This is because the conventional maxillary complete denture would be a failure in this case due to the absence of peripheral seal.

Disadvantages

- Malposed, tipped or supra-erupted teeth in the lower arch will interfere with balanced occlusion. This imbalance may produce soreness, mucosal changes and ridge resorption in the maxilla and the maxillary denture will tend to get displaced.
- As the lower anteriors are present in a fixed position, it is difficult to obtain an aesthetic teeth arrangement.
- Use of acrylic teeth opposing natural teeth will produce abrasion of the acrylic teeth whereas use of porcelain teeth opposing natural teeth will produce abrasion of the natural teeth.

Occlusal Modification

Occlusal modification of the remaining natural teeth is usually required prior to the construction of a single complete denture. It is a preprosthetic procedure where in occlusal discrepancies present in the natural teeth are corrected. It can be done in one of the following methods:

Swenson Technique

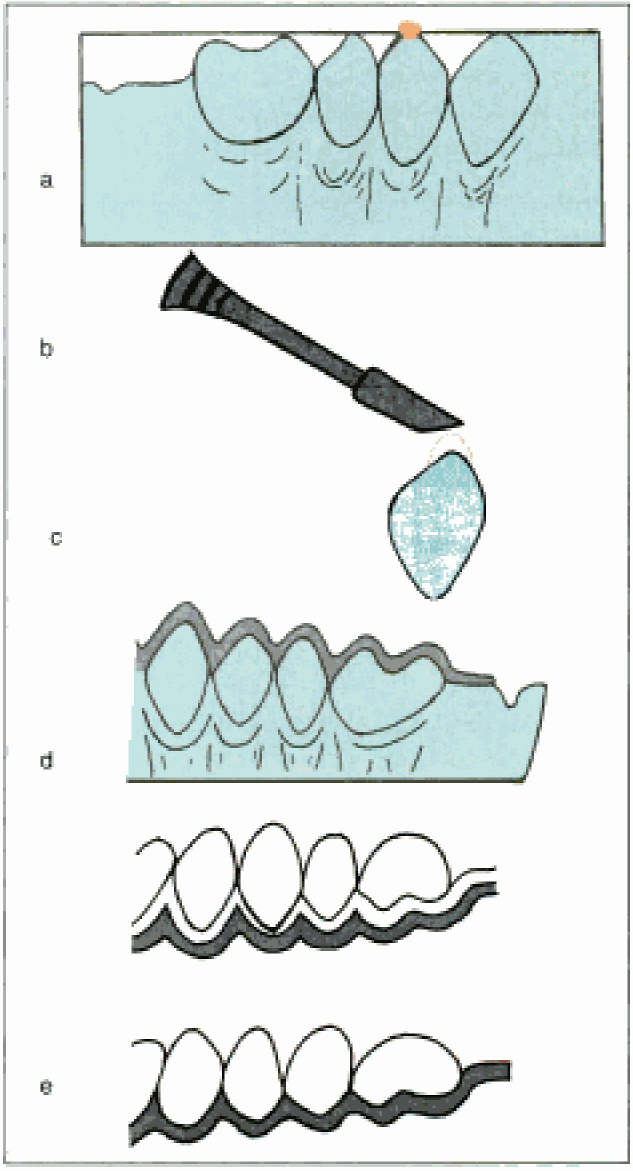
A tentative teeth arrangement is done using a diagnostic cast and the occlusal discrepancies are marked and reduction is done in the patient's mouth.

Yurkstas Technique

A 'U' shaped slightly convex metal plate is positioned over the natural teeth and the occlusal discrepancies (e.g. High points) are recorded. These discrepancies are reduced in the diagnostic cast. The reduced cast is used as a guide to reduce the natural teeth.

Bruce Technique

The occlusal discrepancies are arbitrarily reduced in the diagnostic cast. An acrylic resin template is made over the reduced cast (Fig. 15.2). The

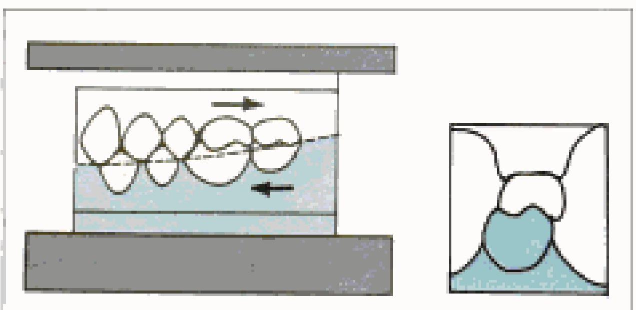


Figs 15.2a to e: (a and b) Reducing occlusal discrepancies in the diagnostic cast, (c) Preparing an acrylic template in accordance to the reduced discrepancies (d) Inserting the template in to the patients mouth (e) Reducing the opposing natural teeth with relation to the acrylic template

natural teeth are reduced till the acrylic template seats properly against them.

Boucher et al Technique

The casts are articulated using a tentative jaw relation. Artificial porcelain teeth are set on the edentulous cast and this arrangement is made to move against the teeth of the opposing cast (made of dental stone). (Fig. 15.3). As the porcelain is hard, it will abrade the occlusal discrepancies. The denture is processed and finished. During insertion, the abraded opposing cast is used as a guide to reduce the occlusal discrepancies of the natural teeth in the patient's mouth.



Figs 15.3a and b: Boucher's technique of reducing occlusal discrepancies

Single complete dentures can be of the following types:

- Maxillary complete denture opposing a complete mandibular natural dentition.
- Maxillary complete denture opposing a mandibular partial denture.
- Mandibular complete denture opposing a maxillary natural dentition.
- Mandibular complete denture opposing a maxillary partial denture.

Maxillary Complete Denture Opposing a Complete Mandibular Natural Dentition

These dentures are maxillary complete dentures opposing a complete set of mandibular natural teeth. Gross occlusal discrepancies are very common and require occlusal adjustment and orthodontic correction. Some important points to be considered during the construction of these dentures are:

- The morphology of the natural teeth will determine the selection of the artifical teeth. E.g. the size and shade of the artificial teeth should match the natural teeth.
- If the mandibular teeth are attrited, 0° or cuspless teeth are preferred.
- If the mandibular teeth are not attrited, anatomic teeth are preferred.

Maxillary Complete Denture Opposing A Mandibular Partial Denture

These dentures are clinically very significant due to their complications. Teeth selection is very important in the fabrication of the denture. Artificial teeth for these dentures should be selected based on the following factors:

- If the opposing partial denture has porcelain teeth, porcelain teeth are preferred.
- If the opposing natural teeth have gold or metal crowns then acrylic teeth are preferred.
- Acrylic teeth are preferred in dentures opposing normal natural teeth or a partial denture with artificial acrylic teeth.

Complications

- Combination syndrome.
- Wear of the natural teeth.
- Fracture of the denture.

Combination Syndrome

It was identified by Kelly in 1972 in patients wearing a maxillary complete denture opposing a mandibular distal extension prosthesis. This complication is not seen in cases of complete dentures opposing natural mandibular posterior teeth (Fig. 15.4).

Pathogenesis

Combination syndrome progresses in a sequential manner. The group of complications which represent as a syndrome are interlinked to one another. The progress of the disease can occur in any one of the following sequences.

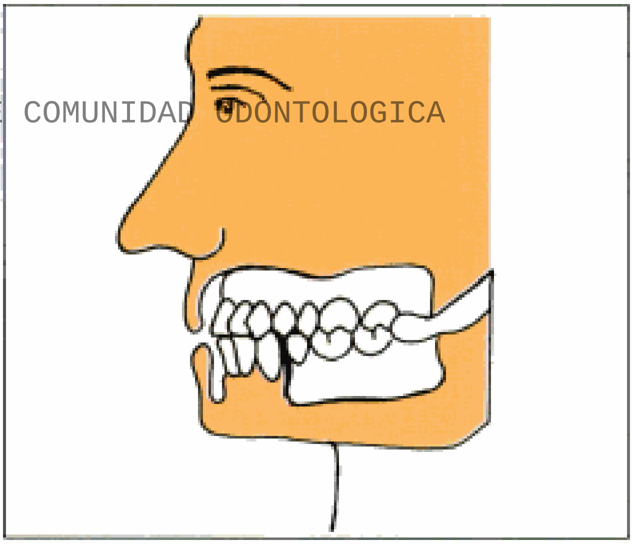
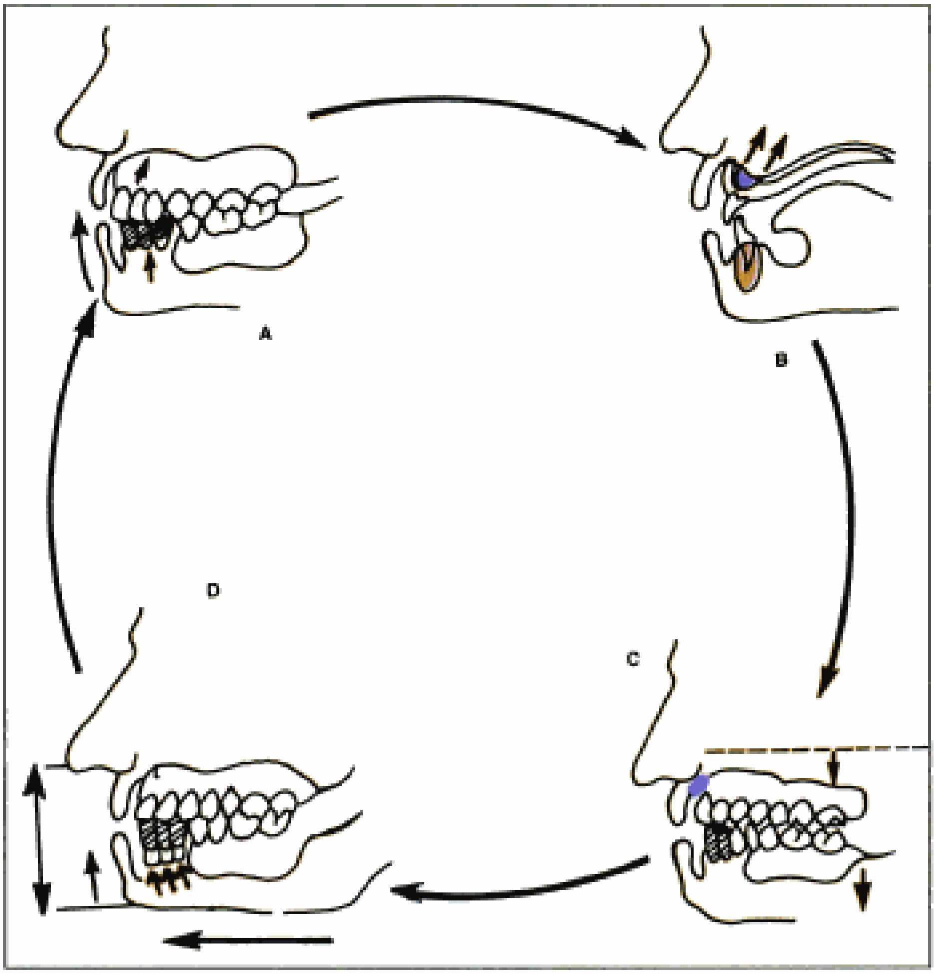


Fig. 15.4: Maxillary complete denture opposing a mandibular distal extension denture base

Sequence 1 (Fig. 15.5)

- The patient will tend to concentrate the occlusal load on the remaining natural teeth (mandibular anteriors) for proprioception. Hence, there is more force acting on the anterior portion of the maxillary denture.
- This leads to increased resorption of the anterior part of the maxilla which gets replaced by flabby tissue. The occlusal plane gets tilted anteriorly upwards and posteriorly downwards due to lack of anterior support.
- The labial flange will displace and irritate the labial vestibule leading to the formation of *epulis fissuratum*.
- Posteriorly there will be fibrous overgrowth of the tissues in the maxillary tuberosity.

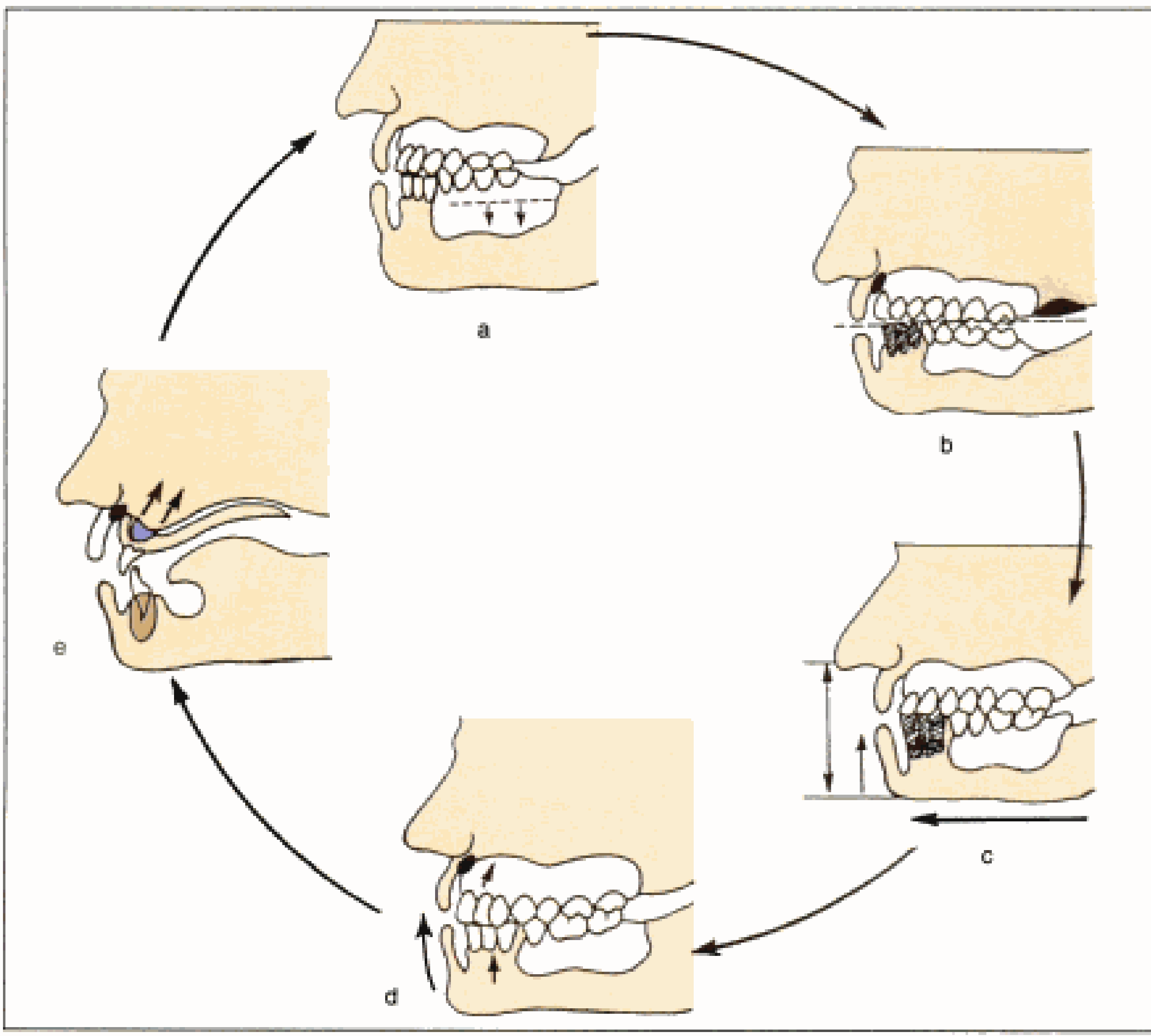


Figs 15.5a to d: **Sequence 1** of combination syndrome (a) Excessive load on the anterior region of the complete denture (b) Ridge resorption in the maxillary anterior region. Epulis fissuratum is formed at the maxillary labial sulcus (c) Downward movement of posterior plane of occlusion producing excessive resorption of the mandibular posterior region (d) Downward tilting of the occlusal plane in the posterior region produces an anterior openbite which leads to supraeruption of the lower anteriors. This increases the load on the anterior region of the upper denture producing a vicious cycle

- The shift of the occlusal plane posteriorly downwards produces resorption in the mandibular distal extension denture bearing area.
- Due to the tilt of the occlusal plane, the mandible shifts anteriorly during occlusion.
- The vertical dimension at occlusion is decreased. The retention and stability of the denture is also decreased.
- The tilt in the occlusal plane disoccludes the lower anteriors causing them to supra-erupt. This reduces the periodontal support of the anterior teeth.
- The supra-erupted anteriors increase the amount of force acting on the anterior part of the complete denture and the vicious cycle continues.

Sequence 2 (Fig. 15.6) *(Craddock)*

- There is gradual resorption of the distal extension residual ridge in the mandible.
- This leads to tilting of the occlusal plane posteriorly downwards and anteriorly upwards.
- Rest of the vicious cycle continues as in sequence 1.



Figs 15.6a to e: Sequence 2 of combination syndrome (a) Ridge resorption in the mandibular edentulous area (b) Downward movement of the posterior part of maxillary denture and the formation of flabby tissue (c) Supra-eruption of lower anteriors (d) Increased load in the anterior maxillary region of the complete denture (e) Resorption in the anterior portion of maxillary ridge and the formation of flabby tissue

Combination syndrome should be identified at an early stage and prevented. Planning over-dentures and designing implant-supported dentures are some methods to prevent combination syndrome.

Wear of Natural Teeth

When porcelain teeth are used, severe abrasion of the opposing natural teeth will occur. Hence, a proper selection of the tooth material is very important. Care should be taken to avoid any occlusal discrepancies.

Denture Fracture

Denture fracture is common in cases with single complete dentures. This is because the denture will receive excessive load from the natural teeth. The precipitating factors, which produce denture fracture, are:

- Excessive anterior occlusal load.
- Deep labial frenal notches.
- High occlusal load due to excessive action of the masseter.

Precautions

- Check for the occlusion.
- Maintain adequate thickness of the denture base.
- Never deepen the labial notch.
- For cases with high fracture potential, use a cast metal denture base.

Mandibular Single Dentures

They can be either opposing a fully dentulous maxilla or opposing a maxillary partial denture. In any case, there will be severe ridge resorption of the edentulous mandible. This is because of two reasons:

- The constant movement of the tongue adds to the forces on the residual ridge increasing the amount of resorption.
- The amount of firmly attached mucosa to the denture, bearing area is less in the mandible than in the maxilla.

A conventional denture is usually avoided opposing maxillary natural teeth . This condition can be best treated with endosseous implants after thorough evaluation of the patient. Some cases may be treated along with a resilient liner to reduce the load on the ridge. Anyhow some authors firmly believe that a mandibular single denture have a very poor prognosis.

IMMEDIATE DENTURE

Immediate denture is defined as, *"A complete or removable partial denture constructed for insertion immediately following the removal of natural teeth"* - GPT. An immediate denture is one that is fabricated before all the remaining teeth have been removed and inserted immediately after the removal of the teeth. They can also be over-dentures. Generally immediate dentures can be classified into two types namely:

- Interim immediate denture.
- Conventional immediate denture.

Interim Immediate Denture

Interim denture is defined as, *"A dental prosthesis to be used for a short interval of time for reasons of aesthetics, mastication, occlusal support, or convenience or to condition the patient to the acceptance of an artificial substitute for missing natural teeth until more definitive prosthetic therapy can be provided"* - GPT.

These are immediate dentures used temporarily, during the healing period of the patient to preserve ridge contour, until the permanent denture can be fabricated. They are mainly indicated in patients with periodontal disease going in for total extraction. They help to preserve the contour of the ridge until a permanent denture can be fabricated.

Advantages of Interim Dentures

- The shape and height of the ridge is preserved.
- Psychologically beneficial to the patient.
- It can be used as a temporary replacement when the permanent denture is being fabricated or undergoing any repair or rebasing.
- The dentist will be able to get an idea of the vertical dimension and jaw relation of the patient.

- For patients who show atrophic changes due to long-term edentulousness the interim denture helps to rehabilitate the temporomandibular joint and the oral musculature.

Treatment Procedure

- An alginate impression is made and duplicated. One impression is used to make a cast for processing the denture (duplicate cast). The other impression is used to make a cast to prepare the base plate, occlusal rims, record jaw relation and teeth arrangement (master cast).
- Before pouring the duplicate cast, molten wax is poured into the teeth (to be extracted) of the refractory impression (Fig. 15.7). Once the wax cools; the duplicate cast is poured in dental stone. The duplicate cast will have all the anatomical structures in dental stone except the teeth to be extracted, which will be in wax (Fig. 15.8).

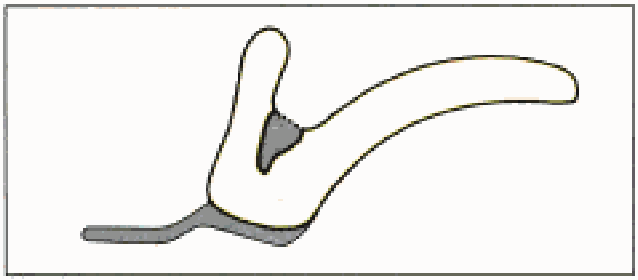


Fig. 15.7: Filling the sockets of teeth to be replaced, with wax

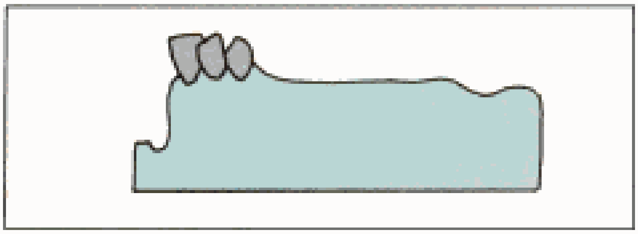


Fig. 15.8: Resulting duplicate cast with teeth to be replaced in wax

- The master cast is poured directly into the master impression using dental stone without filling any wax. The master cast which is totally made of dental stone is the one used for adapting the base plate, fabricating the occlusal rim, and teeth arrangement.
- A base plate is adapted and occlusal rims are fabricated on the master cast.
- Jaw relation is recorded. The master casts are articulated using the jaw relation records and the artificial teeth are arranged (Fig. 15.9).

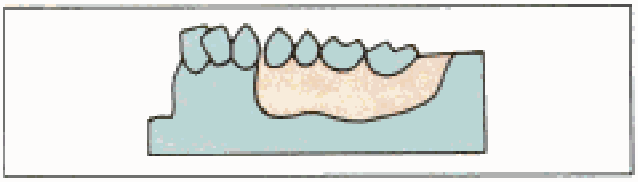


Fig. 15.9: Wax pattern fabricated on a refractory cast

- Try-in verification is carried out
- After try-in, the trial denture is shifted to the refractory cast. Remember the teeth to be replaced are composed of wax in the refractory cast. Hence, we have a trial denture, which replaces the missing teeth and a wax form, which replaces the teeth to be extracted (Fig. 15.10).

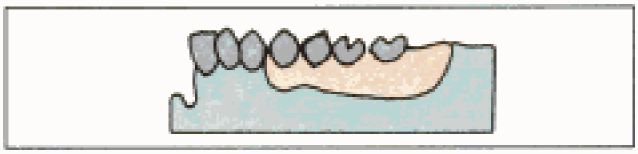


Fig. 15.10: The wax pattern should be transferred from the refractory cast to the master cast

- The wax pattern is flasked and de-waxed. The teeth to be extracted will be hollow in the flask mould. Even the arranged prosthetic teeth are removed. Self-cure acrylic is placed into all the teeth moulds (the ones to be extracted and the ones already extracted) in the flask using sprinkle-on method (Fig. 15.11). This is done so that all the teeth have the same shade because it is impossible to match a self-cure teeth with factory made teeth.
- Heat-cure denture base resin is packed into the remaining mould space and polymerized. The finished denture will contain even the teeth to be extracted.
- Extraction of teeth is done during the insertion appointment. The teeth should be extracted as atraumatically as possible. Care should be taken to preserve soft tissues and avoid open methods, suturing, alveoloplasty, etc. (Fig. 15.12a).

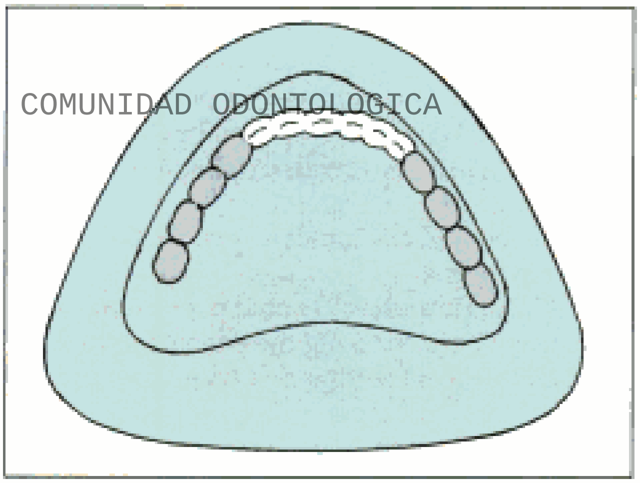


Fig. 15.11a: Dewaxing

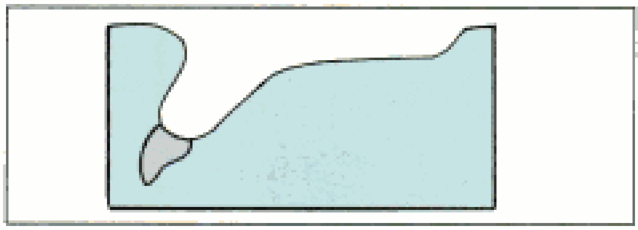


Fig. 15.11b: Filling the sockets of teeth to be replaced with acrylic

- Insertion of the interim denture is the beginning and not the end of treatment. The patient should be recalled frequently to make occlusal adjustments and placement of tissue conditioning materials, etc. (Fig. 15.12b).

Conventional Immediate Denture

It is an immediate denture, which can be later modified to serve as the permanent prosthesis. It is usually done for patients undergoing total extraction. The treatment outline while preparing a conventional immediate denture consists of the extraction of the posterior teeth followed by the extraction of the anterior teeth. The ridges in the posterior region are allowed to heal before the extraction of the anterior teeth. The denture is inserted on the appointment of extraction of the anterior teeth.

Indications

- For patients with periodontally weak teeth indicated for extraction.

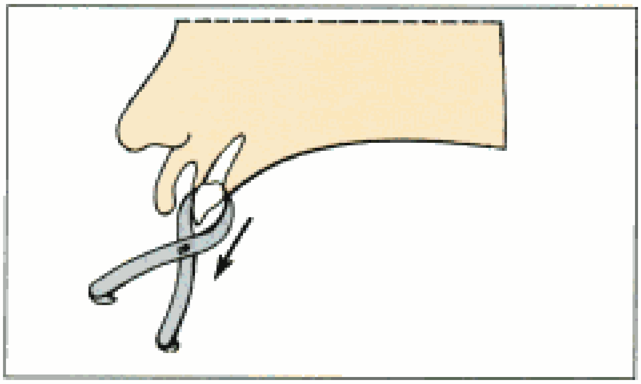


Fig. 15.12a: Extraction of teeth

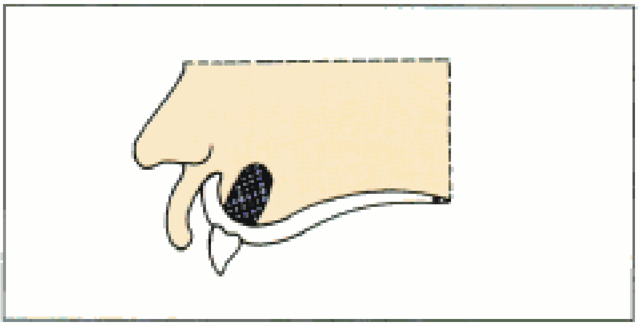


Fig. 15.12b: Insertion of the immediate denture

- For socially active people who are very self-conscious about their appearance.

Advantages

- It gives a psychological benefit to the patient. The patient does not appear edentulous at any point of time.
- Muscle tone, tongue size and vertical dimension are preserved.
- Centric jaw relation is easy to record.
- Less post-operative pain, because the extraction sockets are protected.
- Postoperative haemorrhage and infection are also prevented due to the protective action. It acts like a splint for the tissues (Fig. 15.13).
- Tooth size, shape, shade selection and arrangement are easy.
- It is easier for the patient to adapt to the permanent prosthesis.

Disadvantages

- Requires more chair time.
- More expensive.

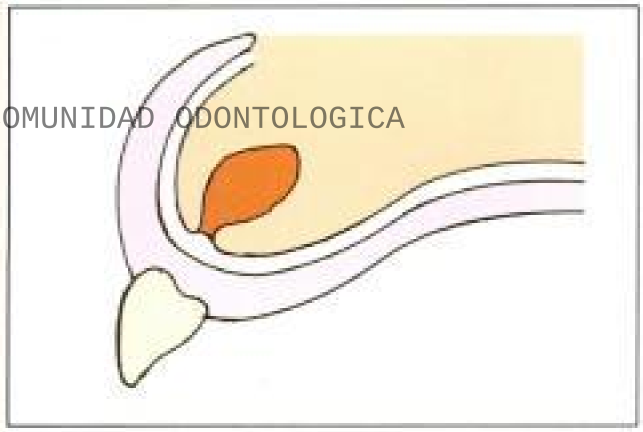


Fig. 15.13: Template/surgical splint action of the immediate denture

- Due to the different positions of the teeth centric relation and centric occlusion are difficult to record.
- Try-in procedure is not possible. Hence the dentist cannot have any idea about the outcome of the denture.
- The patient might find speech and mastication difficult for a short period of time.

Treatment Procedure

- The posterior teeth are extracted and the sockets are allowed to heal (This does not affect the aesthetics of the patient).
- An alginate impression is made with the help of a stock tray. A diagnostic cast is prepared from the impression.
- Two layers of wax are used to block out the undercuts in the dentulous areas of the cast. A custom tray is fabricated over this diagnostic cast as described in Chapter 6. The borders of the tray are trimmed 1 mm below the sulcus for border moulding (Fig. 15.14).

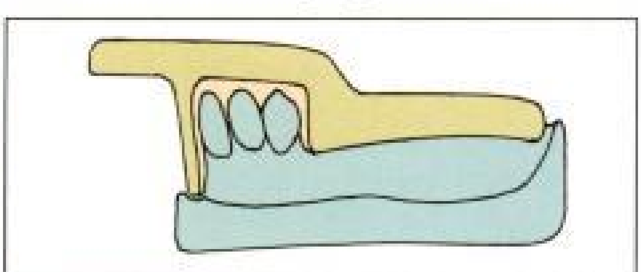
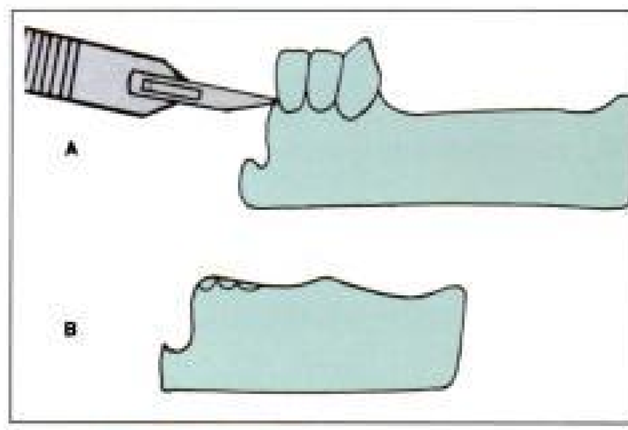


Fig. 15.14: Fabricating a temporary denture base on the diagnostic cast

- Border moulding is done using greenstick compound.
- The spacer is removed and perforations are made on the body of the tray for escape of the impression material during impression making.
- Light bodied elastomer is used as the impression material.
- Occlusal rims are fabricated over a temporary denture base covering the edentulous area.
- Posterior teeth setting and try-in are completed.
- The anterior teeth in the master cast are broken away and trimmed upto the cervical margin and smoothened. The ridge lap (cervical) portion of the artificial teeth are trimmed and arranged on a master cast (Fig. 15.15).



Figs 15.15a and b: Arbitrary trimming of the teeth to be replaced in the master cast

- Artificial teeth are arranged over the area where the teeth are to be extracted. The teeth arrangement should be in harmony with the existing teeth as well as the prosthetic teeth.
- The denture is flasked, de-waxed, packed, processed and finished.
- During the insertion appointment, the remaining anterior teeth are extracted as atraumatically as possible, preserving the soft tissues and bone. The finished denture is seated in the patient's mouth.
- If the denture does not seat properly, the tissue surface of the denture should be reduced till the denture seats properly.

- Occlusion should be refined. If the denture has poor adaptation, tissue conditioners should be used to line the tissue surface of the denture.

Patient Instructions

- The patient should be advised to wear the denture continuously for the next 48 hours.
- A soft diet is recommended.
- Cold packs can be used to reduce postextraction edema and pain.
- The patient should be recalled frequently to check for ulcers, soft tissue irritation and to reline the denture.

TOOTH-SUPPORTED OVERDENTURES

It is defined as, *"a dental prosthesis that replaces the lost or missing natural dentition and associated structures of the maxilla and/or mandible and receives partial support and stability from one or more modified natural teeth"*. It is also known as *Hybrid dentures* or tooth-supported complete dentures (Fig.15.16).

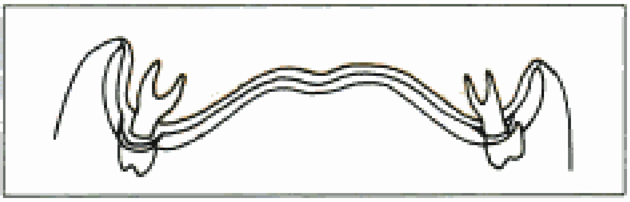


Fig. 15.16: Tooth supported overdenture

Retaining natural teeth as abutments for dentures can considerably reduce the progress of residual ridge resorption. Multiple abutments can be used for this purpose. Even abutments which are coronally modified or restored can be used. Endodontic treatment is usually done for most cases.

The stress concentration can be shared between the denture-bearing areas and the abutments. These overdentures can reduce the impact of residual ridge resorption, loss of occlusal stability, loss of aesthetics and compromised mastication.

Indications for Overdentures

- For better support and aesthetics in morphologically compromised dental arches.
- Cleft palate cases.
- Dentures for patients with maxillo-facial trauma.
- Patients with worn-out dentition
- For congenital anomalies like microdontia, amelogenesis imperfecta, dentinogenesis imperfecta and partial anodontia.
- Patients with abnormal jaw size and position where orthognathic surgery is contraindicated.

This treatment is usually indicated for:

- *Group1:* Patients with few remaining teeth that may be healthy or periodontally involved, with intact or grossly destroyed crowns.
- *Group2:* Patients with severely compromised dentition. Selective extraction should be carried out after a thorough examination of the patient.

General Considerations during Diagnosis and Treatment Planning for an Overdenture

Maintenance of Periodontal Health

Once an overdenture is planned and constructed, it is the duty of the patient to maintain his teeth free from plaque. The dentist should check for pocket formation around the abutments. Failure to do this may lead to the loss of an abutment.

Reduction in Crown-root Ratio

Reduction in crown size during abutment preparation can be beneficial for the tooth, as it reduces the crown-root ratio and decreases the leverage forces acting on the tooth.

Success of Endodontic Therapy

Endodontic therapy may be necessary for most abutment teeth because they need extensive crown reduction. A two-to-four week interval should be provided after completion of endodontic therapy in order to determine its success before starting further treatment.

Adaptation and Coverage of Denture-Bearing Area

The denture base should be well adapted to the soft tissues in order to prevent accumulation of food debris and to evenly distribute the force acting on the denture.

Design of the Denture

As the denture base for overdentures are thin, they have to be reinforced with metal. At the same time they should be easy to fabricate and maintain.

Ease of Use

The patient should be able to easily insert and remove the denture without any harm to the denture base or the abutment tooth.

Advantages of Overdentures

- Maintains the integrity of the residual ridge.
- Improves the retention and stability of the denture.
- Improved proprioception leads to better neuromuscular control. This helps in regulating the biting force over the denture.
- Psychological effect on the patient as extraction can be avoided.
- It can almost be used universally.
- Even if there is abutment failure, the abutments can be extracted and the overdenture can be relined and used as a conventional complete denture.

Disadvantages of Overdentures

- Nutritional counselling, oral hygiene measures and fluoride application should be carried out periodically.
- High incidence of caries and periodontal disease around the over denture abutments.
- Frequent reviews are needed to verify the health of the supporting tissues of the overdenture abutments.
- More expensive than conventional dentures because:
  - Endodontic therapy and coronal restorations may be needed for certain overdenture abutments.
  - Most cases need a cast metal denture base, as acrylic is weaker.
  - Additional designing and laboratory work is needed.
- Cannot be used in cases with reduced interarch space, bony undercuts adjacent to the abutments, etc.
- Improper maintenance of the overdenture may lead to periodontal breakdown of the overdenture abutments and the patient may lose all his remaining teeth.

Patient Selection

Possibility of a Fixed or Removable Partial Denture

If the periodontal condition and position of the remaining teeth favour the use of a fixed partial denture or removable partial denture, then an overdenture should not be considered for that patient.

Condition of the Abutment Teeth

The crowns of teeth should be free from caries. There should be sufficient width of attached gingiva around the abutments. The abutment should be free from any periodontal disease.

Age of the Patient

Overdentures are always recommended for young patients because they have a favourable psychological effect.

Abutment Teeth Selection

As the outcome of the treatment does not depend on the number of teeth retained, the dentist must evaluate the cost of treatment. That is he can preserve the ideal teeth and extract the remaining to reduce the cost of the prosthesis. The factors to be considered are:

Periodontal Status

- Periodontally-compromised teeth with horizontal bone loss have a better prognosis than the ones with vertical bone loss.
- A favourable crown-root ratio should be present in cases with slight tooth mobility. (Refer abutment selection in fixed partial dentures)

- A circumferential band of attached gingiva is an absolute necessity for an overdenture abutment.

Abutment Location

- Cuspids and bicuspids are frequently selected as overdenture abutments.
- As the anterior alveolar ridge resorbs easily under stress, anterior teeth are not usually selected.
- Maxillary incisors can be used as overdenture abutments, if the mandibular arch is intact.
- At least one tooth should be retained in a quadrant to maintain the health of the oral tissues.
- The number and location of the abutment teeth and the status of the opposing one should be evaluated during treatment planning.

Endodontic and Prosthodontic Status

- Usually anterior teeth (canines and premolars) are preferred as overdenture abutments as they are easier to prepare and economical too.
- When there is pulpal recession or calcifications alongwith extensive tooth wear, endodontic therapy can be avoided.

Basic Principles to be Followed

- The abutment teeth should be surrounded with healthy periodontal tissue.
- Maximum reduction of the coronal portion should be done to attain a better crown-root ratio and avoid interference during placement of artificial teeth. Endodontic therapy may be done if needed.
- A simple tooth preparation without any internal attachments can be done in a single visit. This can be done for elderly patients and medicallycompromised patients. It is less expensive than copings.
- Treatment should be accompanied with fluoride gel application and other oral hygiene measures.
- Gold copings or crowns and sleeve coping retainers can be given for grossly destructed abutments after assessing the patient's susceptibility to caries.
  Gold coping can be prepared with posts and retentive pins after evaluating on the amount of tooth structure above the gingival attachment.
- Attachments may be added to the cast copings for additional retention. These attachments may be resilient or non-resilient types.
- These additional components complicate the design and increase the cost of treatment.

Oral Hygiene Status

- The patient should be motivated to maintain adequate oral hygiene, as poor oral hygiene can lead to the loss of the abutment.
- Regular reviews should be done to evaluate the oral hygiene and the oral health maintenance measures should be revised if needed.
- Regular fluoride gel application is mandatory.

Types of Overdentures

There are two types of tooth supported overdentures namely:

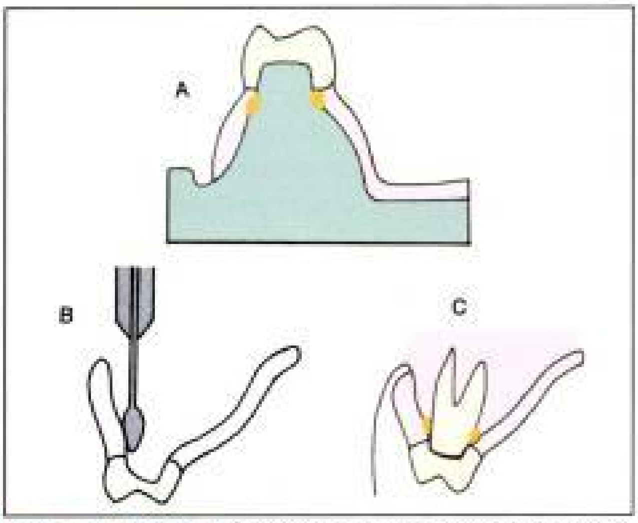
- Tooth supported conventional complete overdenture.
- Tooth supported immediate insertion complete overdenture.

Clinical Procedure for Tooth Supported Conventional Complete Overdenture

An outline of the clinical procedures has been enumerated here:

- Surgical removal of teeth with hopeless prognosis.
- Periodontal treatment of the patient.
- Endodontic treatment of abutment teeth.
- Crown reduction of the abutment.
- Fluoride application over the prepared teeth.
- Copings are fabricated and cemented if needed.
- Impressions are made and the denture fabrication is similar to a conventional complete denture.
- On the tissue surface of the fabricated denture, the areas adjoining the gingival margins have

to be trimmed/relieved in order to avoid impingement. This area is later lined with resilient liner to close the dead space between the gingiva and the denture (Fig. 15.17).



Figs 15.17a to c: (a) Gingival margin of overdenture (b) Trimming the gingival margin of the overdenture. (c) Placement of a resilient liner on the gingival region of the overdenture

Clinical Procedure for Tooth Supported Immediate Insertion Complete Overdenture

The procedure is similar to a conventional immediate denture except for the following steps:

- The crowns of the teeth to be used as abutments are reduced to the desired form in the master cast. The teeth to be extracted are trimmed upto the gingival margin in the master cast.
- The overdenture is fabricated over this master cast.
- Endodontic treatment of the abutment teeth is done a few days prior to the insertion.
- The crown reduction of the abutment teeth is done during the insertion appointment. Crown reduction is guided by the preparation done in the master cast.
- The teeth planned for extraction are removed atraumatically and the immediate overdenture is inserted.

IMPLANT-SUPPORTED OVERDENTURES

Implants are the latest trend in prosthodontia these days. Implants are used as a part of removable and fixed partial dentures. They play an important role in complete dentures too.

Some patients will not be able to wear their dentures irrespective of its perfect contour. These patients are termed as "Mal-adaptive". The implant-supported denture can be designed for these patients (Fig. 15.18).

(For further details- refer Implants Chapter 39)

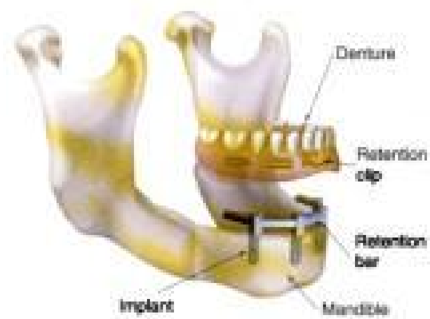


Fig. 15.18: Implant supported overdenture

OBTURATORS

It is defined as *"A prosthesis used to close a congenital or acquired opening in the palate"* – GPT.

Obturators can be used to close the defect as well as to serve as a complete denture. Designs of this type are used in edentulous patients who have undergone surgeries for malignancies in the jaw or patients who have lost their teeth and supporting bone during surgery.

(For further details-refer Maxillofacial Prosthetics Chapter 37)

Section Two

Removable Partial Denture (RPD)

- Introduction and Classification
- Diagnosis, Treatment Planning and Mouth Preparation
- Removable Partial Denture Design
- Prosthetic Mouth Preparation
- Secondary Impression and Master Cast for RPD
- Fabrication of a Removable Partial Denture
- Types of Removable Partial Dentures
- Correction of Removable Partial Dentures

Chapter 16
Introduction and Classification

- Common Terminologies Used in Removable Partial Denture
- Indications for Removable Partial Dentures
- Classification of Partially Edentulous Arches
- Steps in the Fabrication of a Removable Partial Denture
- Parts of a Removable Partial Denture

16

Introduction and Classification

Removable prosthodontics is defined as, *"The replacement of missing teeth and supporting tissues with a prosthesis designed to be removed by the wearer"* - GPT.

It can be broadly classified as

- Removable complete denture prosthodontics
- Removable partial denture prosthodontics
  - — Extra coronal
  - — Intra coronal.

In this section, we will study in detail about removable partial dentures. Extracoronal partial dentures use external attachments, which encircle the existing teeth for retention and stability. Intracoronal partial dentures use internal retentive components, which get locked within the tooth to produce retention and support.

COMMON TERMINOLOGIES USED IN REMOVABLE PARTIAL DENTURE

One must know the meaning of the following terms for a better understanding of the future sections.

Appliance

It is a device worn by a patient in the course of treatment.

e.g., Orthodontic appliance
Surgical splint
Space maintainer

Abutment

It is defined as, *"A tooth, a portion of a tooth, or that portion of a dental implant that serves to support and/or retain a prosthesis"*.

Retainer

The fixation device or any form of attachment applied directly to an abutment tooth and used for the fixation of a prosthesis is called a retainer e.g., clasps.

Extracoronal Partial Denture

The retention of this prosthesis depends on the exact parallelism of the two retentive units. Here, the retentive components of the denture do not invade the abutment tooth structure.

Tooth Supported Removable Partial Denture

A partial denture that receives support from natural teeth at each end of the edentulous space or spaces.

Tooth-tissue Supported Removable Partial Denture

The denture base that extends anteriorly or posteriorly and is supported by teeth at one end and tissue on the other end. They are also called *Distal extension partial dentures.*

Distal Extension Denture Base

The denture base that extends posteriorly without posterior support from natural teeth. They are tooth tissue supported partial dentures.

Temporary Removable Partial Denture

They are used in patient where tissue changes are expected, where a permanent prosthesis cannot be fabricated till the tissues stabilize. They should never be used as a permanent or prolonged form of treatment because of the danger of destroying the remaining oral tissues.

Interim Denture

It is a temporary partial denture used for a short period to fulfil aesthetics, mastication or convenience until a more definitive form of treatment can be rendered.

Transitional Denture

May be used when loss of additional teeth is inevitable but immediate extraction is not advisable or desirable. Artificial teeth may be added to the transitional denture as and when the natural teeth are extracted.

Treatment Denture

It is used as a carrier for treatment material. It is used when the soft tissues have been abused by ill-fitting prosthetic devices. It may also be used after surgery to protect a surgical site or to reposition soft tissue.

Centric Relation

It is the most posterior relation of mandible to the maxilla at the established vertical dimension from which lateral movements could be made (Refer Chapter 9).

Eccentric Relation

Relationships of the mandible to the maxilla other than centric relation that occur in horizontal plane.

Centric Occlusion

It is the maximum intercuspation between the upper and lower teeth. The latest terminology for centric occlusion is *inter-cuspal position* (ICP) or maximal intercuspal position.

INDICATIONS FOR REMOVABLE PARTIAL DENTURES

The following statement should be considered before planning any treatment for a patient. *Muller De Van* (1952) stated, "*the preservation of that which remains is of utmost importance and not the meticulous replacement of that which has been lost.*"

Length of Edentulous Span

Removable partial dentures are preferred for longer edentulous arches. Unlike fixed partial dentures, removable partial dentures can take support from the tissues all along the ridge. Similarly the removable partial dentures also helps to distribute forces around the ridge evenly (Fig. 16.1).

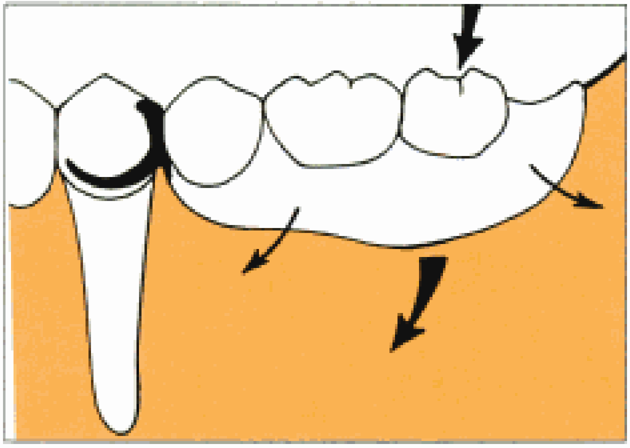


Fig. 16.1: Removable partial dentures are preferred for long span edentulous spaces because the denture base aids to evenly distribute forces all along the edentulous portion of the ridge

Fixed partial dentures are avoided in cases with long span edentulous arches because they produce excessive force on the abutment teeth. Ante's law determines if a fixed prosthesis can be used or not.

"*Ante's Law*": The pericemental surface area of the abutment teeth to be used for a fixed partial denture must be equal to or exceed the pericemental surface area of the teeth being replaced (Fig. 16.2). The GPT definition of the Ante's law for removable and fixed partial dentures is explained in Chapter 26.

Age

In patients under the age of 17 years, a fixed partial denture is contraindicated because they

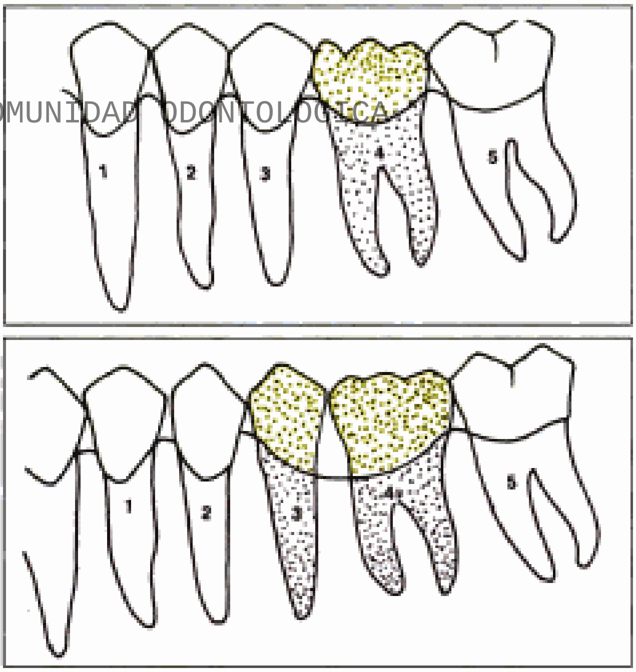


Fig. 16.2: According to the Ante's law, the combined pericemental surface area of 3 and 5 should be equal to or greater than that of 4. If both 3 and 4 are missing, the combined pericemental surface area of 2 and 5 should be equal to the combined pericemental surface area of 3 and 4. If not the prosthesis will fail. For such cases the Ante's law can be fulfilled by taking additional support for 1 so that 1 + 2 + 5 = 3 + 4

have large dental pulps and lack sufficient clinical crown height. (In a fixed prosthesis, the abutment teeth are reduced so that the prosthesis can be fabricated like a cap over the abutment to obtain support. Hence, we require sufficient height of the clinical crown for reduction). In old age, the reduced life expectancy and frequently failing health contraindicate the use of expensive fixed partial dentures.

Abutment Tooth

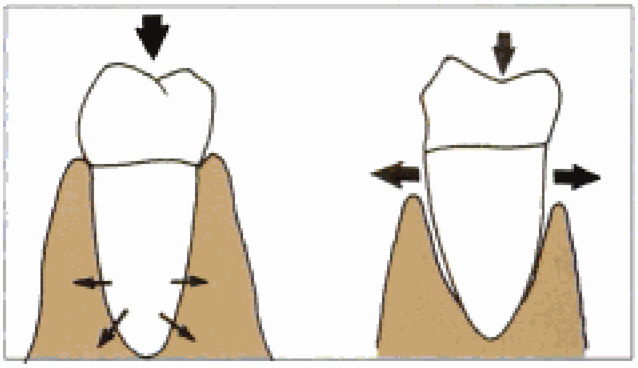
Fixed partial dentures can be used only if there is a posterior tooth for support. When there is no tooth posterior to the edentulous space to act as an abutment, a removable partial denture is preferred. Exceptions: Cantilever fixed partial denture (here, the fixed partial denture is prepared projecting posteriorly like a cantilever from the abutment. But they are avoided nowadays.

Periodontal Support of Remaining Teeth

The periodontal membrane is the structure which transfers all the load from the teeth to the underlying bone. When the periodontal support of the remaining teeth is poor, a fixed partial denture is contraindicated and a removable partial denture is preferred, because, it requires less support from the abutment teeth. removable partial dentures also act like splints to support the remaining teeth (Fig. 16.3).

Cross-arch Stabilization

When the remaining teeth have to be stabilized against lateral and anterior-posterior forces, a removable partial denture is indicated. A fixed partial denture will provide only antero-posterior



Figs 16.3a and b: (a) Sound tooth will distribute the forces acting on it to the supporting alveolar bone (b) A periodontally weak tooth will not successfully transmit the forces to the alveolar bone

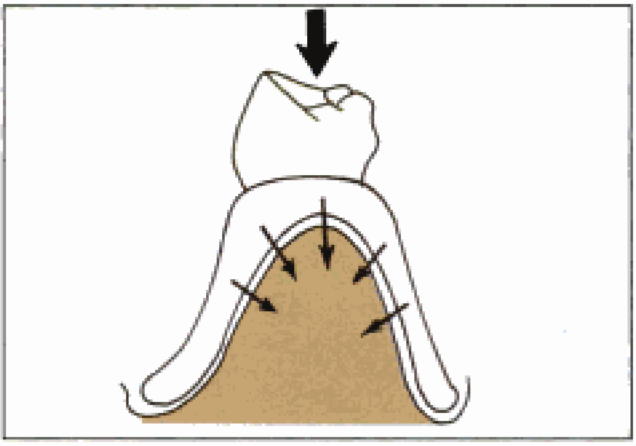


Fig. 16.3c: A removable partial denture base will concentrate it's load to the tissue relieving the abutment from excessive stress

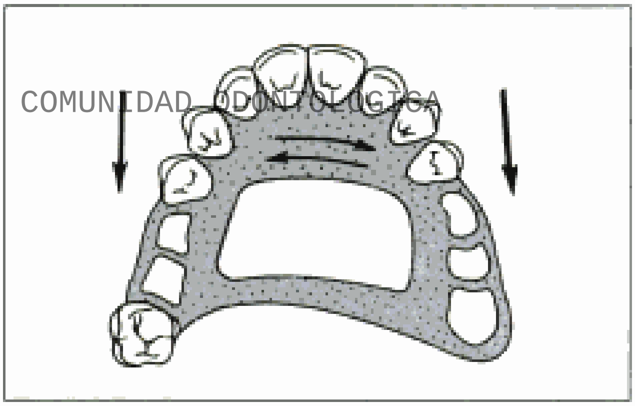


Fig. 16.4: The RPD framework helps to provide stability against levering forces acting on one side of the denture. This ability is termed cross-arch stabilization

stabilization and limited lateral or bucccolingual stabilization. In removable partial dentures, the major connectors help to provide cross arch stabilization. The forces acting on one side of the arch are stabilized distributed by the denture base on the opposite side (Fig. 16.4).

Excessive Bone Loss

When there is trauma or excessive residual ridge resorption (bone loss), it is difficult to place the artificial teeth of a fixed partial denture in an ideal buccolingual position. In a removable partial denture, the artificial tooth can be positioned as per the operators preference and the denture base can be fabricated to provide the required support and aesthetics. The denture base also provides good lip and cheek support such that it re-establishes the normal facial contours.

Aesthetics

Removable partial dentures provide better aesthetics because the denture base gives the appearance of a natural tooth arising from the gingiva. Partial denture teeth have more life like appearance than pontics that appear dull and flat. Denture teeth may be arranged more easily to satisfy phonetic and aesthetic requirements (Fig. 16.5).

Immediate Teeth Replacement after Extraction

It is not successful in the case of a fixed partial denture because, further ridge resorption will occur and produce an unaesthetic appearance. In

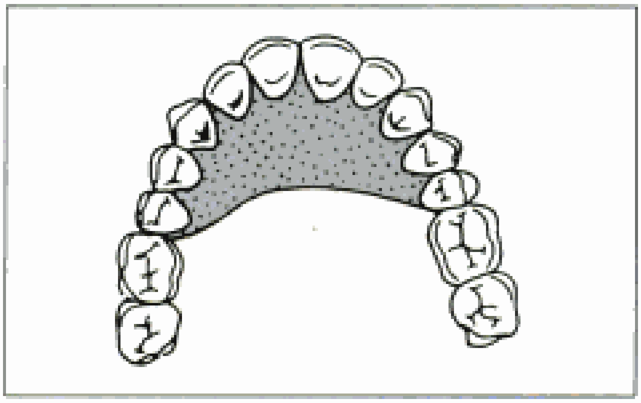


Fig. 16.5a: The denture base aids to allow flexibility teeth arrangement

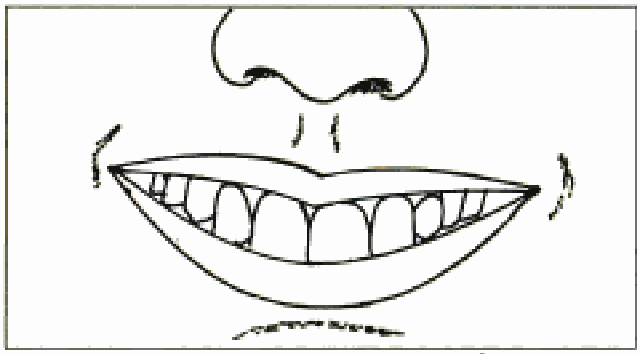


Fig. 16.5b: The resin base extending between the artificial teeth helps to block out dead spaces occurring near the gingival embrasures of the artificial teeth (a common problem in fixed partial dentures)

case of a removable partial denture, relining can be done as resorption occurs.

Emotional Problems

In cases with physical and emotional problems, expensive and tedious dental procedures required for the fabrication of a fixed partial denture are best avoided. The appointment for a removable partial denture is shorter and less demanding to the patient.

Patient Desires

Patients sometimes insist on a removable prosthesis in place of a fixed prosthesis due to the following reasons

- To avoid operative procedures on sound healthy teeth
- For economic reasons.

Removable Partial Denture is Generally Preferred in the Following Clinical Conditions

- When more than two posterior teeth or four anterior teeth are missing.
- If the canine and two of its adjacent teeth are missing. (e.g. central incisor, lateral incisor, canine), (lateral incisor, canine, premolar) etc.
- When there is no distal abutment tooth. Even single cantilever is not generally preferred.
- Presence of multiple edentulous spaces.
- If the teeth adjacent to edentulous spaces are tipped, they cannot be used as an abutment for a fixed prosthesis.
- If periodontally weakened teeth are present near the edentulous spaces.
- Teeth with short clinical crowns (unsuitable for fixed partial denture).
- Insufficient number of abutments.
- Severe loss of tissue on the edentulous space.
- Old patients.

Removable Partial Denture is Generally Avoided in the Following Cases

- Patients with a large tongue which tends to push the denture away.
- Patient attitude: Mentally retarded patients cannot maintain a removable prosthesis.
- Poor oral hygiene: In such cases, any prosthesis is better avoided.

CLASSIFICATION OF PARTIALLY EDENTULOUS ARCHES

Need for Classification

Classification of a partially edentulous arch should be done for the following reasons:

- To formulate a good treatment plan.
- To anticipate the difficulties commonly to occur for that particular design.
- To communicate with a professional about a case.
- To design the denture according to the occlusal load usually expected for a particular group.

Requirements of a Classification

A classification must satisfy the following norms

- Allow visualization of the type of partially edentulous arch that is being considered.
- Allow differentiation between tooth-supported and tooth-tissue supported partial dentures
- Serve as a guide to the type of design to be used
- Be universally accepted.

There are many classifications available for classifying edentulous arches. The most common ones are:

1. Cummer's Classification

This is the first professionally recognised classification. It was introduced by Cummer in 1920. According to him, partial dentures can be classified into four types based on the position of the direct retainers:

- Diagonal: Two direct retainers are diagonally opposite to one another (Fig. 16.6).

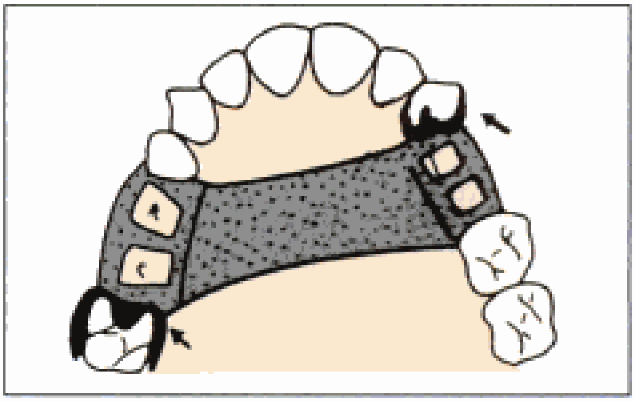


Fig. 16.6: Cummer's diagonally retained removable partial denture

- Diametric: Two direct retainers are diametrically opposite to one another (Fig. 16.7).
- Unilateral: Two or more direct retainers present on the same side (Fig. 16.8).
- Multilateral: Three (rarely four) direct retainers in a triangular (rarely quadrangular) relationship (Fig. 16.9).

He sited the various possible saddle positions in his paper "A little excursion in partial denture mathematics".

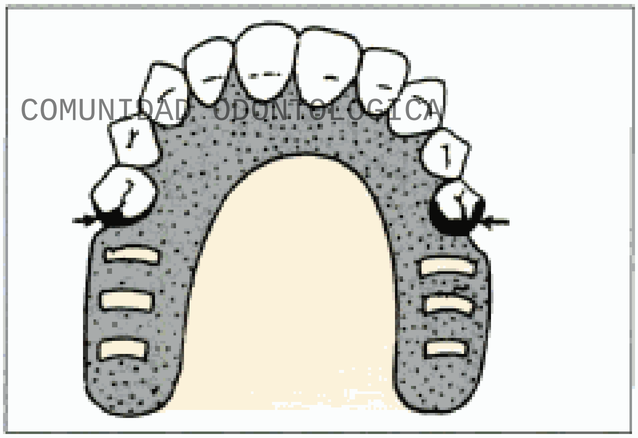


Fig. 16.7: Cummer's diametric removable partial denture

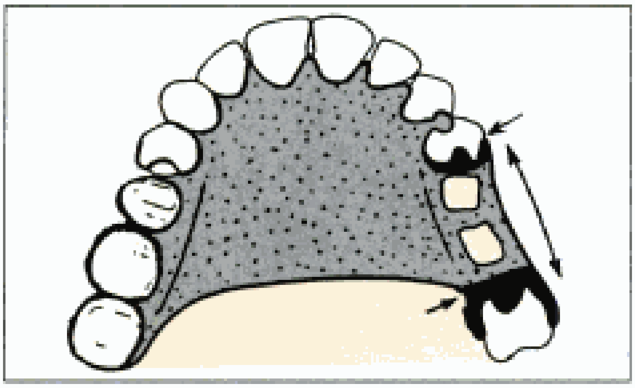


Fig. 16.8: Cummer's unilateral removable partial denture

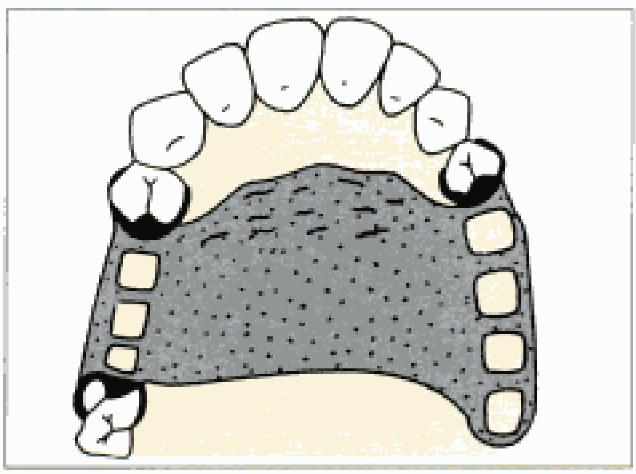


Fig. 16.9a: Cummer's multilateral triangular removable partial denture

2. Kennedy's Classification

Dr. Edward Kennedy of New York proposed this classification in 1923. This is the most popular classification. Unlike Cummer, Kennedy classi-

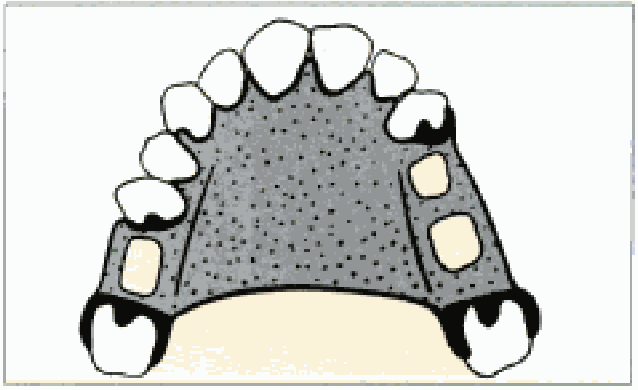


Fig. 16.9b: Cummer's multilateral quadrangular removable partial denture

fied partially edentulous arches and not the denture.

The classification is positional or anatomical and conveys a picture of certain teeth and their relationships, but gives little information about the teeth present and their positional relationships.

- Class I: Bilateral edentulous areas located posterior to the remaining natural teeth i.e., there are two edentulous spaces located in the posterior region without any teeth posterior to it (Fig. 16.10).

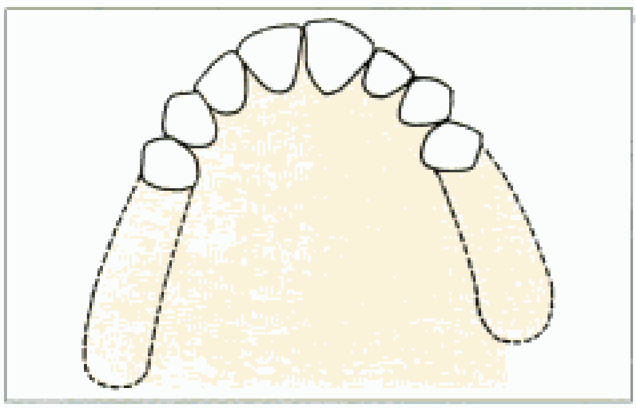


Fig. 16.10: Kennedy's class I partially edentulous condition

- Class II: Unilateral edentulous area located posterior to the remaining natural teeth, i.e. there is a single edentulous space located in the posterior region without any teeth posterior to it (Fig. 16.11).
- Class III: Unilateral edentulous area with natural teeth anterior and posterior to it, i.e. this indicates a single edentulous area which

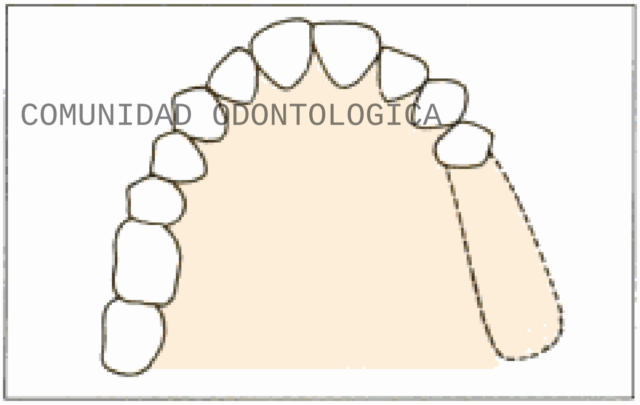


Fig. 16.11: Kennedy's class II partially edentulous condition

does not cross the midline of the arch, with teeth present on both sides (anterior and posterior) of it (Fig. 16.12).

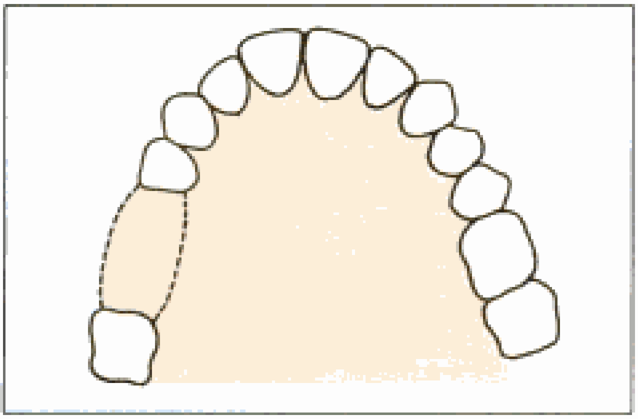


Fig. 16.12: Kennedy's class III partially edentulous condition

- Class IV: Single, bilateral edentulous area located anterior to the remaining natural teeth. This is a single edentulous area, which crosses the midline of the arch, with remaining teeth present only posterior to it (Fig. 16.13).

Applegate's Modification (1960)

Applegate modified the above classification based on the condition of the abutment to include two more additional groups:

- Class V: Edentulous area bounded anteriorly and posteriorly by natural teeth but in which the anterior abutment (e.g. lateral incisor) is not suitable for support. It is basically a class

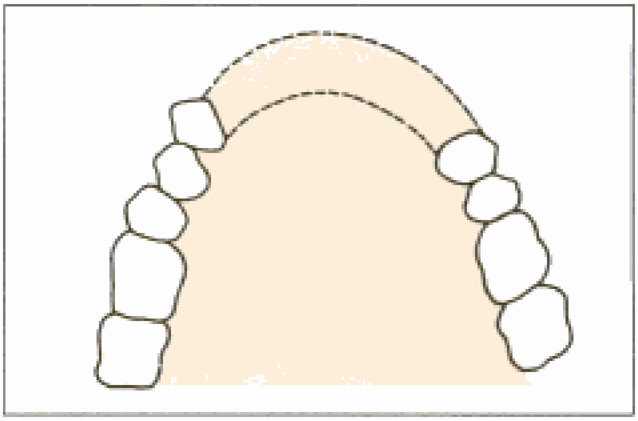


Fig. 16.13: Kennedy's class IV partially edentulous condition

III situation where the anterior abutment cannot be used for any support. Hence, it cannot be treated like a conventional class III edentulous space (Fig. 16.14).

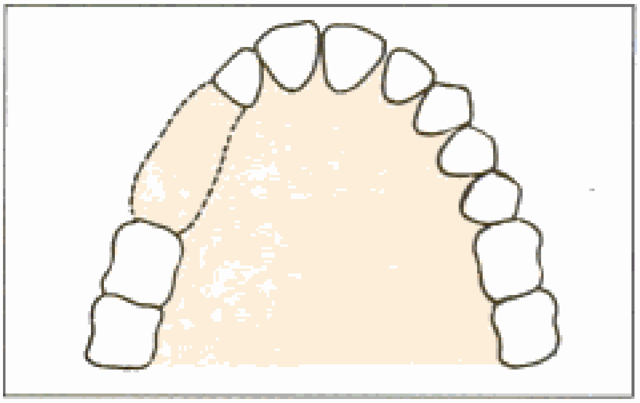


Fig. 16.14: Kennedy Applegate's class V partially edentulous condition

- Class VI: Edentulous area in which the teeth adjacent to the space are capable of total support of the required prosthesis. This denture hardly requires any tissue support. Most of the removable partial dentures are tooth tissue supported. Hence, this condition is classified as a separate group (Fig. 16.15).

Applegate's Rules

The following rules should be considered to classify partially edentulous arches based on Kennedy's classification. During the initial examination of the patient, if it is diagnosed that

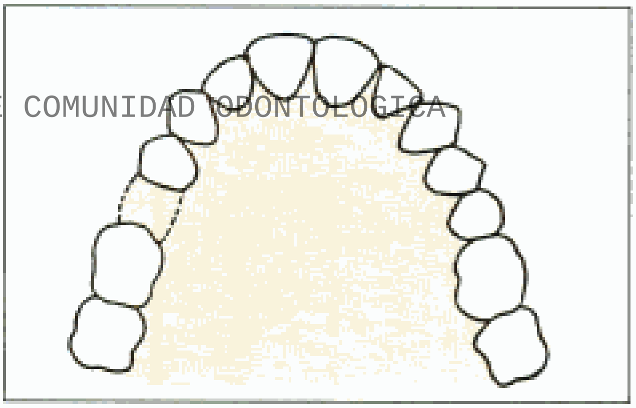


Fig. 16.15: Kennedy-Applegate's class VI partially edentulous condition

any teeth require extraction, it should be done prior to classification.

Rule One. Classification should follow rather than precede extractions that might alter the original classification.

Rule Two. If the third molar is missing and not to be replaced, it is not considered in the classification.

Rule Three. If the third molar is present and is to be used as an abutment, it is considered in the classification.

Rule Four. If the second molar is missing and is not to be replaced, it is not considered in the classification.

Rule Five. The most posterior edentulous area or areas always determine the classification.

Rule Six. Edentulous areas other than those, which determine the classification, are referred to as modification spaces and are designated by their number.

Rule Seven. The extent of the modification is not considered, only the number of additional edentulous areas, i.e. the number of teeth missing in the modification spaces is **not** considered only the number of additional edentulous spaces are considered.

Rule Eight. There can be no modification areas in class IV. Because any additional edentulous space will definitely be posterior to it and will determine the classification.

Points to remember:

Class I arches are most common and class IV are least common.

Class I and class II, long span class III and IV partial dentures are tooth-tissue supported prostheses.

Short span class III and IV are tooth supported partial dentures.

Terkla and Laney's Modification (1963)

They combined Kennedy's classification and Swenson's classification (discussed later). They changed all the modifications. They named a Kennedy's class 2 (unilateral class 1) as a Swenson Class 1 and a Kennedy's class 1 (bilateral free-end) as a Swenson class 2. The modifications were basic, hence, it almost resulted in a new classification.

3. Bailyn's Classification

Proposed by Bailyn, it was the first classification to give importance to support of partial dentures by remaining tissues. He used descriptive letters like A and P.

- A: Anterior restorations, where there are saddle areas anterior to the first bicuspid (premolar).
- P: Posterior restorations, where there are saddle areas posterior to the canine.

Further they are sub-classified as follows:

- Class 1: Bounded saddle (not more than three teeth missing).
- Class 2: Free end saddle (there is no distal abutment tooth).
- Class 3: Bounded saddle (more than three teeth missing).

Class 1 is tooth supported, class 2 and 3 are tooth-tissue supported. In cases where anterior and posterior teeth are missing, the class of anterior and posterior teeth are mentioned separately, e.g: A1P1, A2 P1, A1P3 etc (Figs 16.16a to g).

4. Neurohr's Classification

Proposed in 1939, is also based on the support derived. It is not commonly used due to its unnecessary complexity. Many of his denture

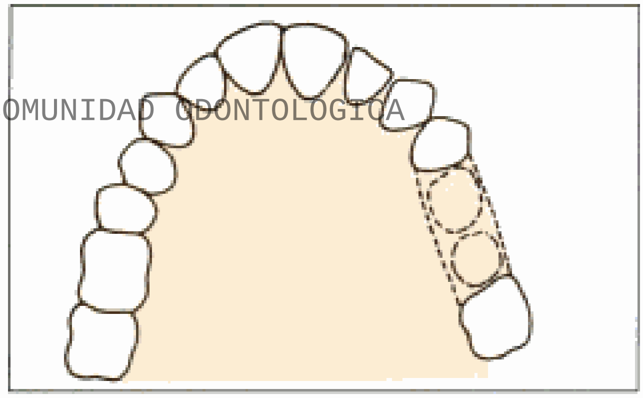


Fig. 16.16a: Bailyn' P1 partially edentulous condition

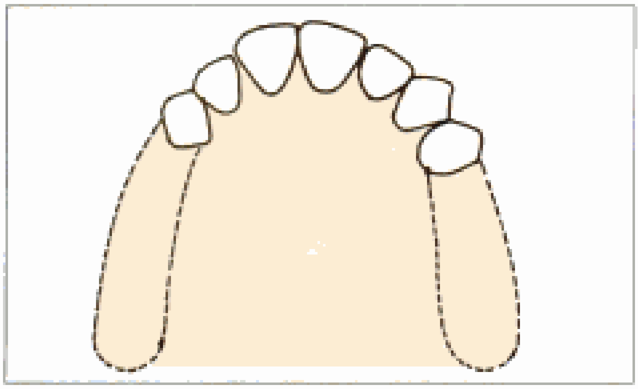


Fig. 16.16b: Bailyn's P2 partially edentulous condition

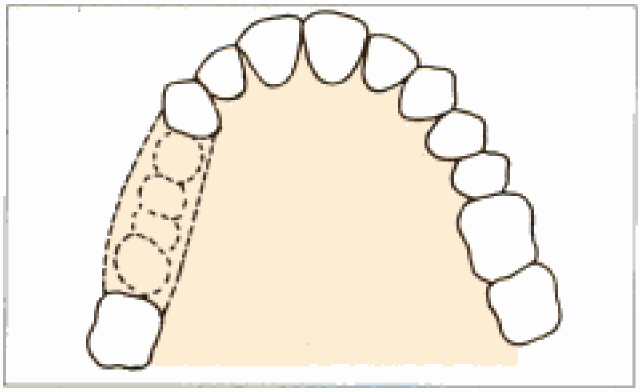


Fig. 16.16c: Bailyn's P3 partially edentulous condition

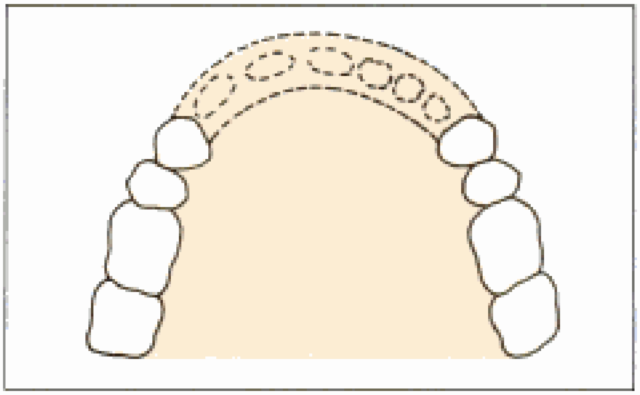


Fig. 16.16d: Bailyn's A3 partially edentulous condition

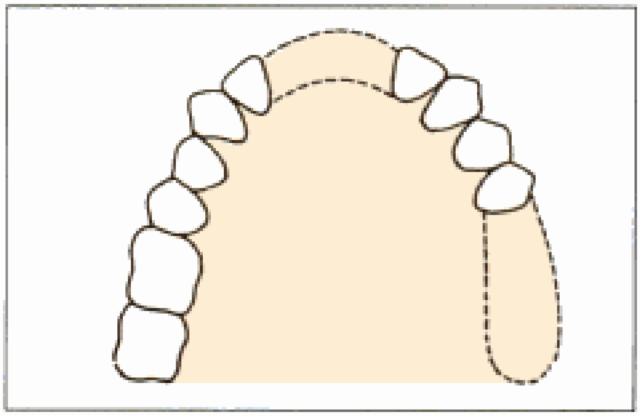


Fig. 16.16e: Bailyn's A1P2 partially edentulous condition

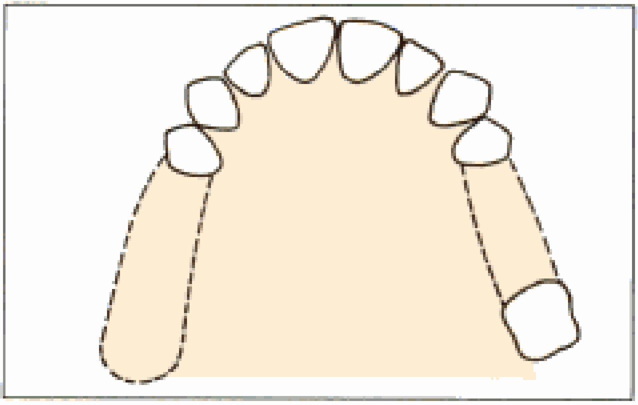


Fig. 16.16f: Bailyn's P1P2 partially edentulous condition

designs did not match his principles of classification. According to this classification.

Class I: Tooth-bearing

A unilateral or bilateral case falls into the above classification when there are teeth posterior to all spans, and when there are no more than four teeth missing in any space. There are two possible variations in this class.

- *Variation 1:* Missing posteriors predominate.
  a. Posteriors missing, anteriors in place (Fig. 16.17).
  b. Posteriors missing, some anteriors missing (Fig. 16.18).

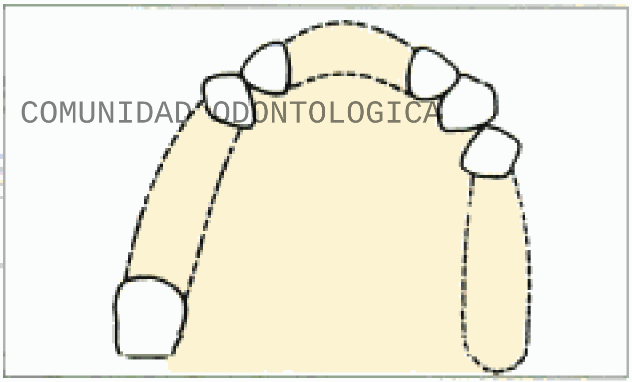


Fig. 16.16g: Bailyn's A1P2P3 partially edentulous condition

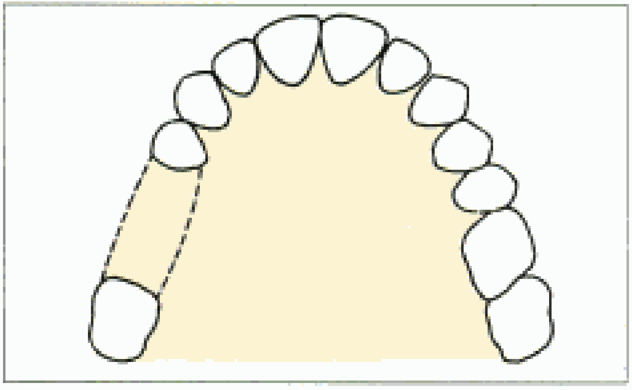


Fig. 16.17: Class I variation 1a Neurohr's the partially edentulous condition

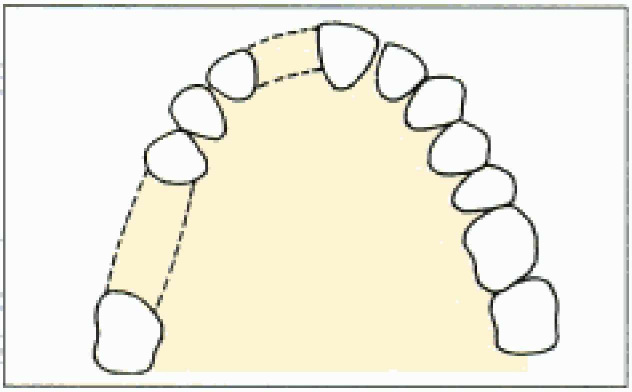


Fig. 16.18: Neurohr's class 1 variation 1b partially edentulous condition

- *Variation 2:* Missing anteriors predominate.
  a. Anteriors missing, posteriors present (Fig. 16.19).
  b. Anteriors missing, some posteriors missing (Fig. 16.20).

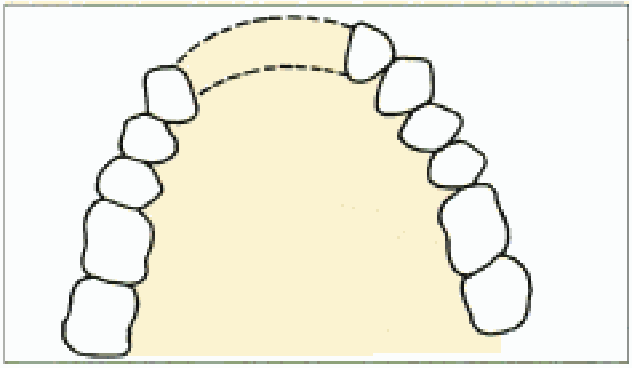


Fig. 16.19: Neurohr's class I variation 2a partially edentulous condition

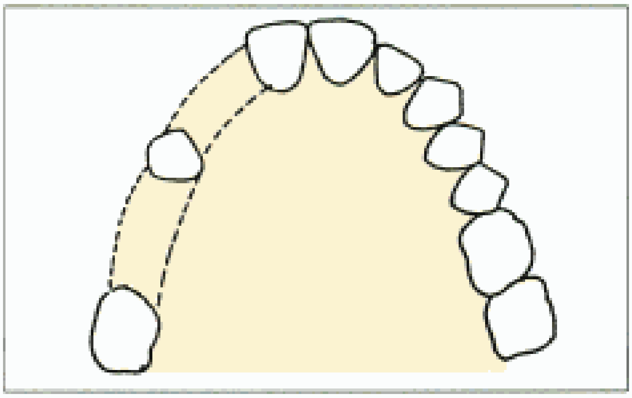


Fig. 16.20: Neurohr's class I variation 2b partially edentulous condition

Class II: Tooth-and-tissue-bearing

A unilateral or bilateral case comes under the above classification when there are no teeth posterior to one or more spans, or when there are more than four teeth (which include a canine) in one or more spans. Class 2 is further sub-divided into divisions with variations under each.

Division 1: When there are no teeth posterior to one or more spans:

- *Variation 1:* Missing posteriors predominate.
  a. Posteriors missing, anteriors in place (Fig. 16.21).
  b. Posteriors missing, some anteriors missing (Fig. 16.22).
- *Variation 2:* Missing anteriors predominate.
  a. None (Fig. 16.23).
  b. Anteriors missing, some posteriors missing (Fig. 16.24).

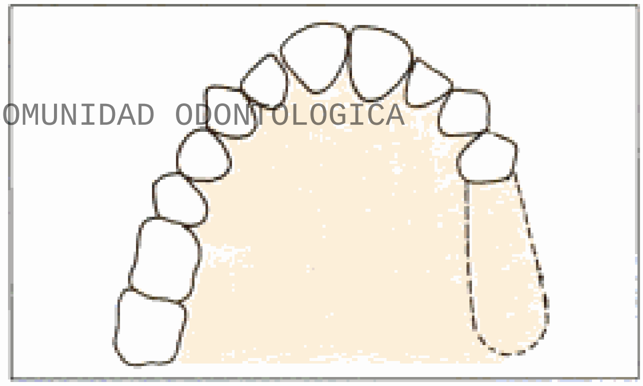


Fig. 16.21: Neurohr's class II division 1 variation 1a partially edentulous condition

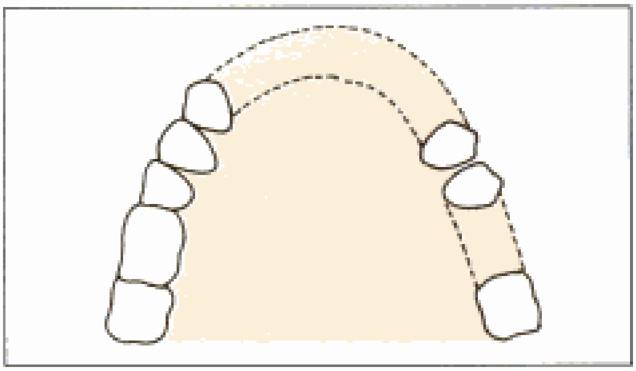


Fig. 16.24: Neurohr's class II division 1 variation 2b partially edentulous condition

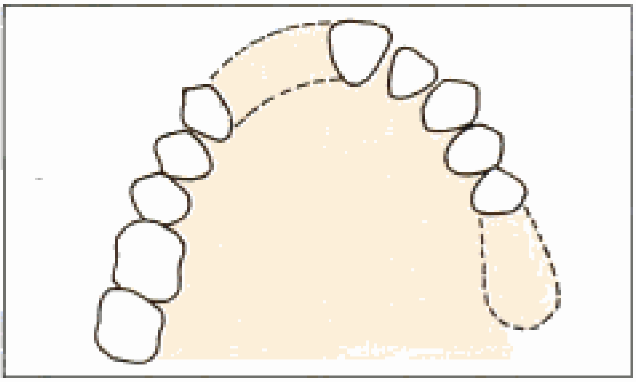


Fig. 16.22: Neurohr's class II division I variation 1b partially edentulous condition

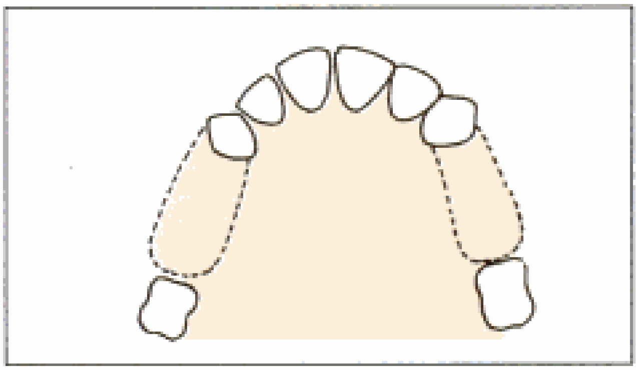


Fig. 16.25: Neurohr's class II division 2 variation 1a partially edentulous condition

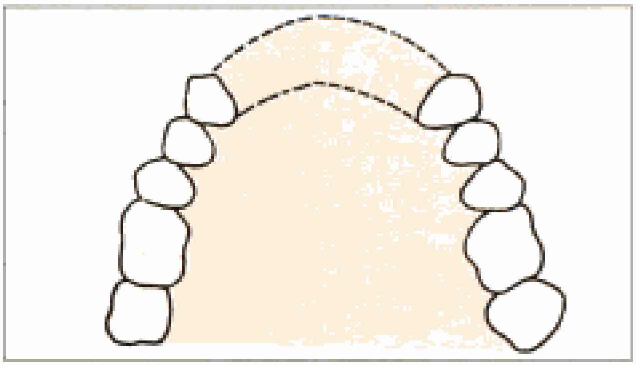


Fig. 16.23: Neurohr's class II division 1 variation 2a partially edentulous condition

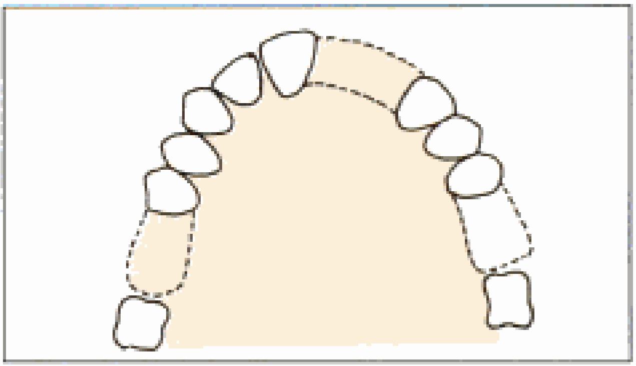


Fig. 16.26: Neurohr's class II division 2 variation 1b partially edentulous condition

Division 2: When there are teeth posterior in all spans, but when there are more than four teeth (including a canine) in any one or more spans.

- *Variation 1:* Missing posteriors predominate.
  a. None (Fig. 16.25).
  b. Posteriors missing, some anteriors missing (Fig. 16.26).
- *Variation 2:* Missing anteriors predominate.
  a. Anteriors missing, posteriors in place (bilaterals only) (Fig. 16.27).
  b. Anteriors missing, some posteriors missing (Fig. 16.28).

Class 3: Tissue-bearing complete dentures (Fig. 16.29).

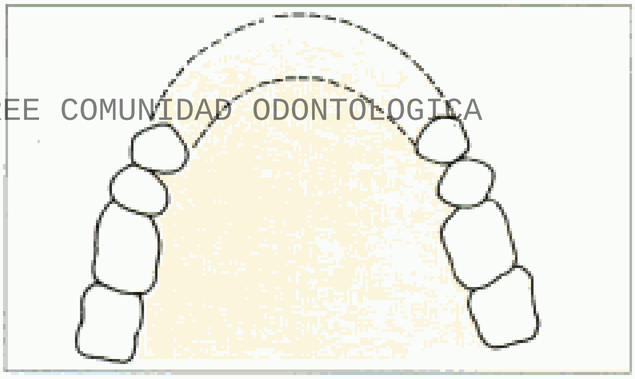


Fig. 16.27: Neurohr's class II division 2 variation 2a partially edentulous condition

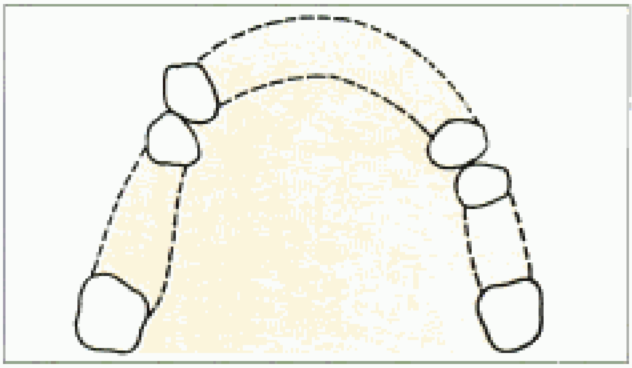


Fig. 16.28: Neurohr's class II division 2 variation 2b partially edentulous condition

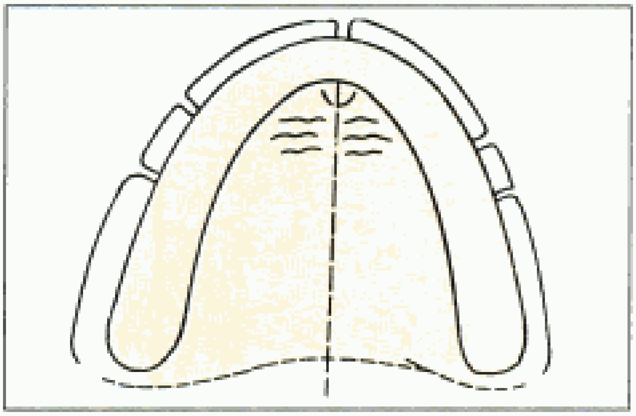


Fig. 16.29: Neurohr's class III completely edentulous condition

5. Mauk's Classification

Proposed by Mauk in 1942, it is based on number, length and position of the edentulous spaces and the number and position of the remaining teeth. According to this classification:

- Class I: Bilateral space with no teeth posterior to it (Fig. 16.30).

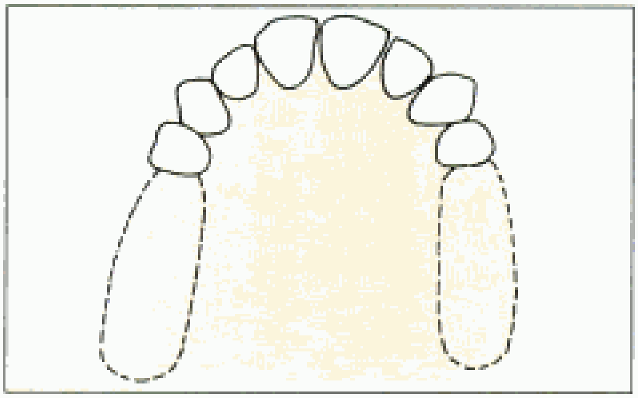


Fig. 16.30: Mauk's class I partially edentulous condition

- Class II: Bilateral space with teeth present posterior to one space (Fig. 16.31).

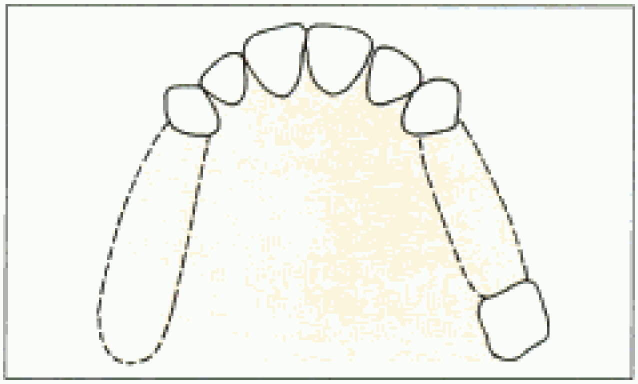


Fig. 16.31: Mauk's class II partially edentulous condition

- Class III: Bilateral space with teeth present posterior to both spaces (Fig. 16.32).

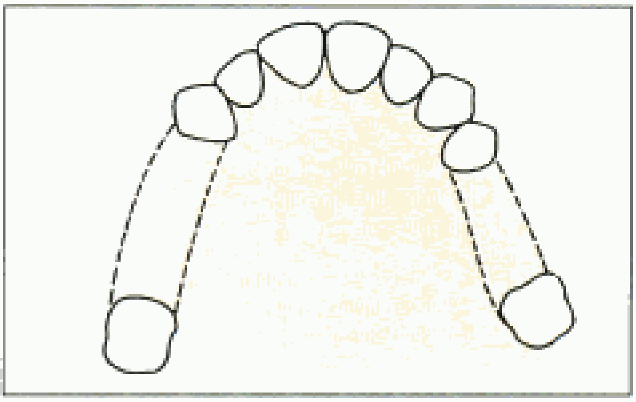


Fig. 16.32: Mauk's class III partially edentulous condition

- Class IV: Unilateral space with no teeth posterior to it. The opposing arch is unbroken (Fig. 16.33).

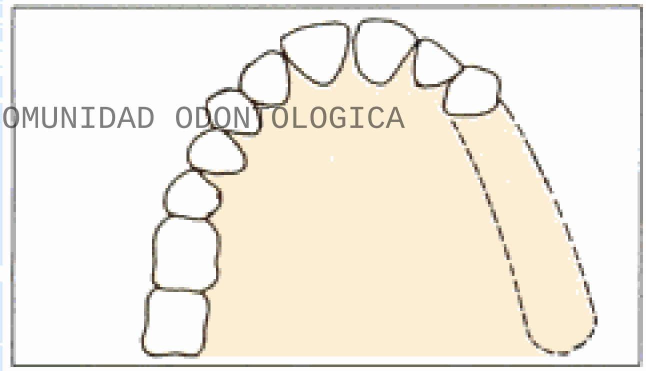


Fig. 16.33: Mauk's class IV partially edentulous condition

- Class V: Anterior space with unbroken posterior arches on both sides (Fig. 16.34).

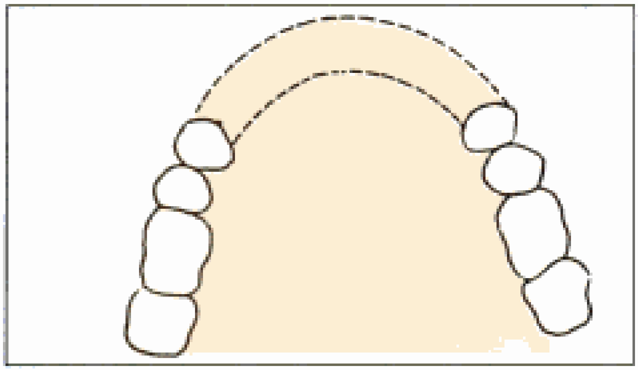


Fig. 16.34: Mauk's class V partially edentulous condition

- Class VI: Irregular spaces around the arch. The remaining teeth are single or in small groups (Fig. 16.35).

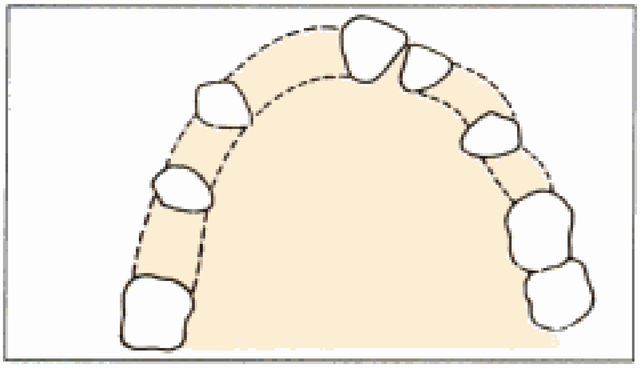


Fig. 16.35: Mauk's class VI partially edentulous condition

6. Wild's Classification

Proposed a simple yet self-explanatory classification. It is not very well-known in English dental literature.

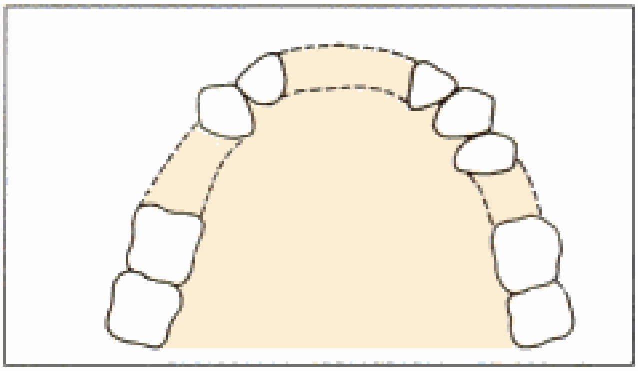


Fig. 16.36

- Class I: Interruption of the dental arch (i.e. bounded) (Fig. 16.36).
- Class II: Shortening of the dental arch (i.e. free-end) (Fig. 16.37).
- Class III: Combination of 1 and 2 (Fig. 16.38).

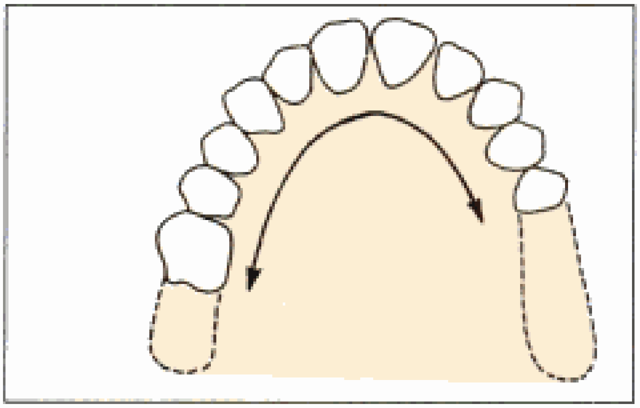


Fig. 16.37

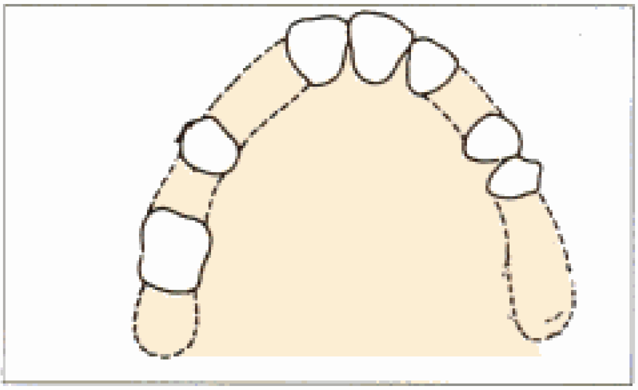


Fig. 16.38

7. Godfrey's Classification

Proposed in 1951, it is based on the location and size of edentulous spaces. The speciality of this classification is that the main classes have no modifications.

- Class A: Tooth-borne denture base in the anterior part of the mouth. It may be an unbroken five-tooth space, broken five-tooth space or an unbroken four-tooth space (Fig. 16.39).

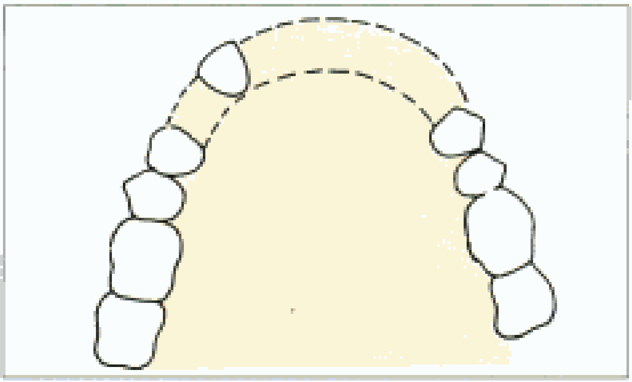


Fig. 16.39: Godfrey's class A partially edentulous condition

- Class B: Mucosa-borne denture base in the anterior region. It may be an unbroken six-tooth space, an unbroken five-tooth space, or a broken five-tooth space (Fig. 16.40).

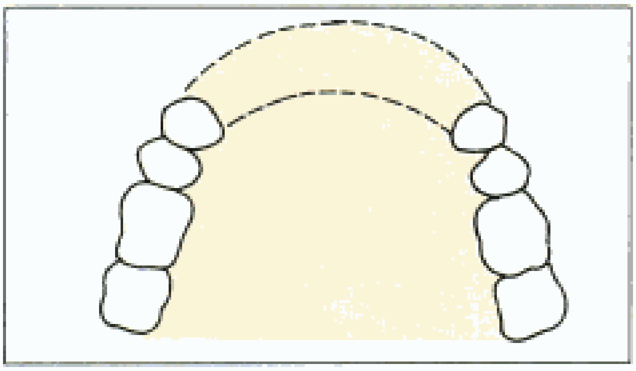


Fig. 16.40: Godfrey's class B partially edentulous condition

- Class C: Tooth-borne denture base in the posterior part of the mouth. It may be an unbroken three-tooth space, a broken three-tooth space, an unbroken two-tooth space, or a broken two-tooth space (Fig. 16.41).
- Class D: Mucosa-borne denture base in the posterior region. It may be an unbroken four-tooth, three-tooth, two-tooth, or a single-tooth space (Fig. 16.42).

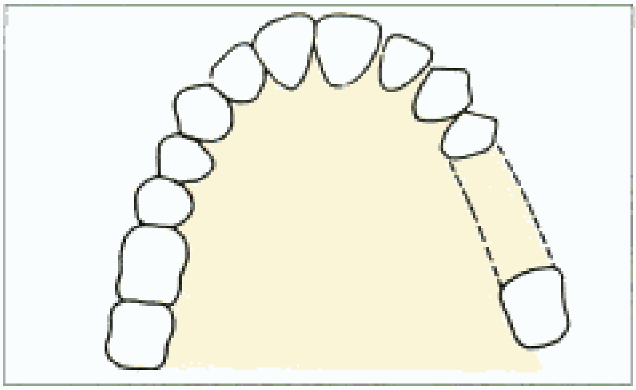


Fig. 16.41: Godfrey's class C partially edentulous condition

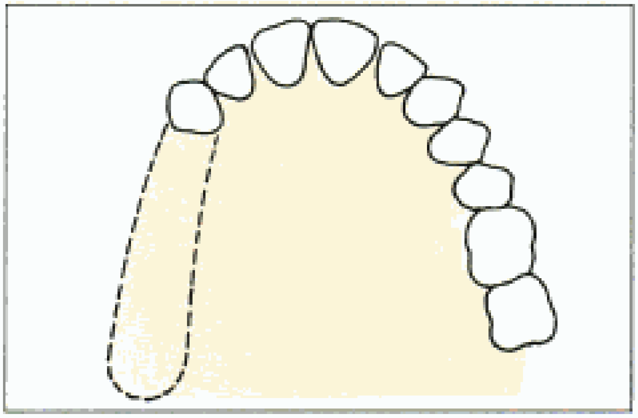


Fig. 16.42: Godfrey's class D partially edentulous condition

8. Friedman's Classification

He introduced the 'ABC' classification in 1953. According to this classification:

a. A: Anterior (Fig. 16.43).
b. B: Bounded posterior (Fig. 16.44).
c. C: Cantilever (Fig. 16.45).

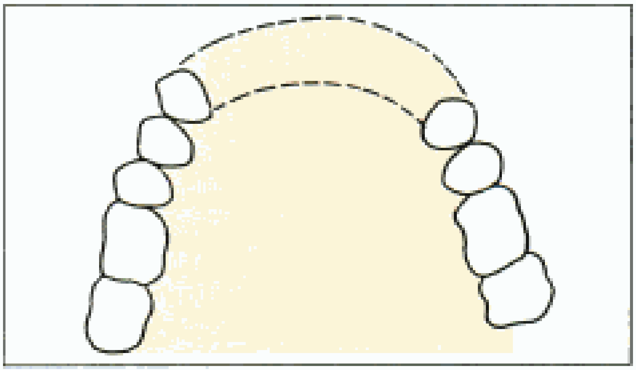


Fig. 16.43: Friedman's type A partially edentulous condition

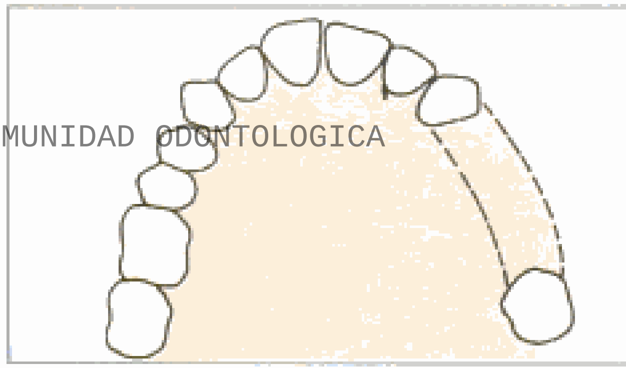


Fig. 16.44: Friedman's type B partially edentulous condition

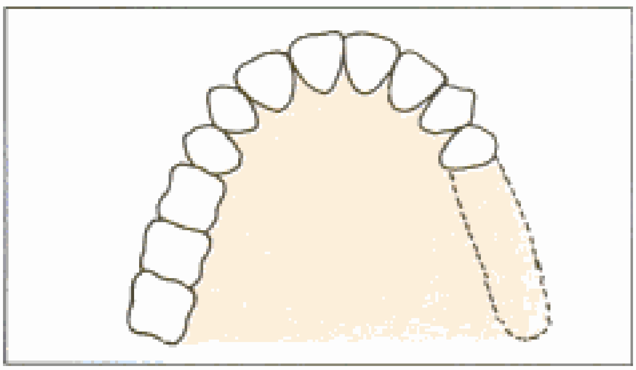


Fig. 16.45: Friedman's type C partially edentulous condition

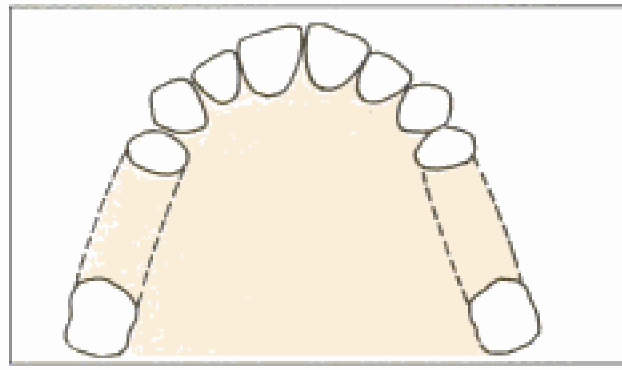


Fig. 16.46: Beckett and Wilson's class I partially edentulous condition

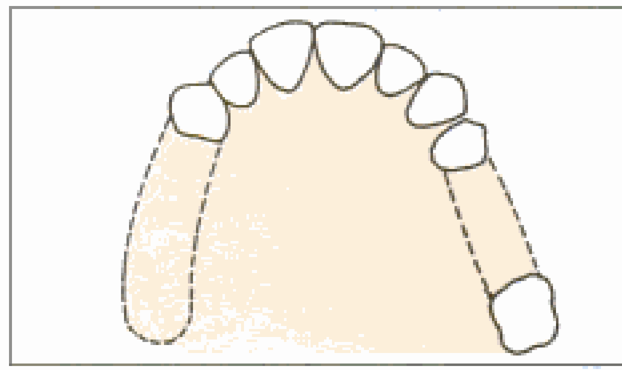


Fig. 16.47: Beckett and Wilson's class IIa partially edentulous condition

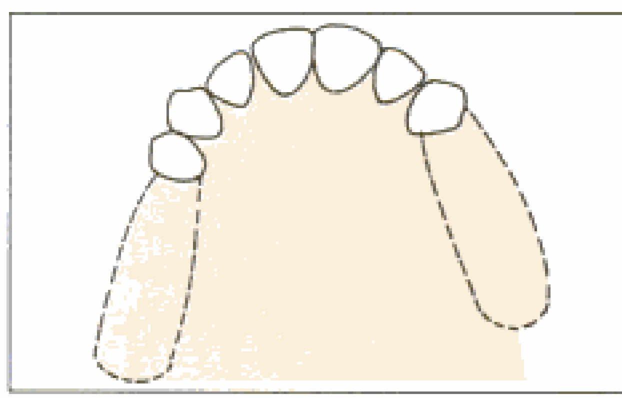


Fig. 16.48: Beckett and Wilson's class IIb partially edentulous condition

9. Beckett and Wilson's Classification

Beckett (1953) and Wilson (1957) based their ideas on Bailyn's classification (1928) and decided that the following must be considered while determining the proportionate amount of support provided by the teeth and tissue. The word tissue includes mucosa and underlying bone.

a. The quality of abutment support.
b. The magnitude of occlusal support
c. The harmony of the occlusion.
d. The quality of the mucosa and residual ridge.

They believed that every effort should be made to avoid tissue support alone.

- Class I: Bounded saddle. Abutment teeth qualified to support the denture. Mucosa is not used for support (Fig. 16.46).
- Class II: Free-End.
  a. Tooth-and-tissue-borne (Fig. 16.47).
  b. Tissue-borne (Fig. 16.48).
- Class III: Bounded saddle. Abutment teeth not so qualified to support the denture as described in class I (Fig. 16.49).

Wilson in 1957 elaborated the classification as follows:

- Mandibular Kennedy's class III should be treated as class I.

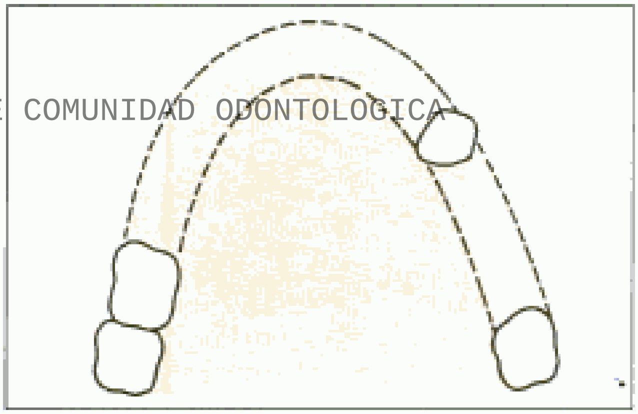


Fig. 16.49: Beckett and Wilson's class III partially edentulous condition

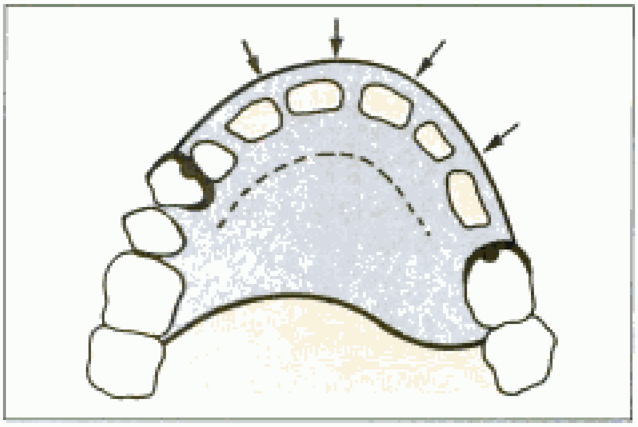


Fig. 16.51: Craddock's class II partially edentulous condition

- Maxillary Kennedy's class 3 should be treated as class 1 or 3.

10. Craddock's Classification

Craddock proposed his classification in 1954. He classified partial dentures as follows:

- Class I: Saddles supported on both sides by substantial abutment teeth (Fig. 16.50).

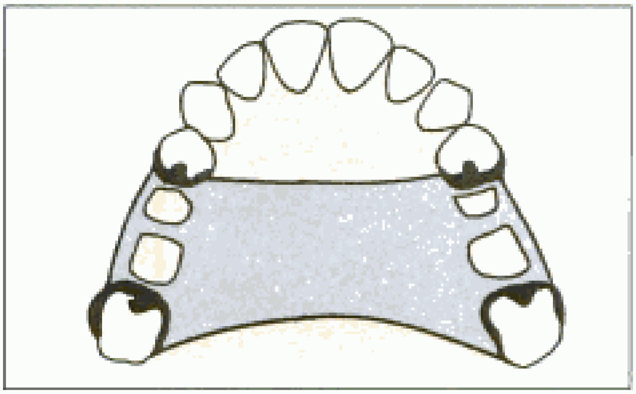


Fig. 16.50: Craddock's class I partially edentulous condition

- Class II: Vertical-biting forces applied to denture resisted entirely by soft tissue (Fig. 16.51).
- Class III: Tooth supported at only one end of the saddle (Fig. 16.52).

11. Skinner's Classification

He introduced the classification in 1959. His classification was influenced by Cummer's classification. His classification had five classes of which a few were similar to Cummer's classification. He said that about 1,31,072 combinations of partially edentulous arches are possible. His classification is based on the relation of the edentulous arches to the abutment teeth.

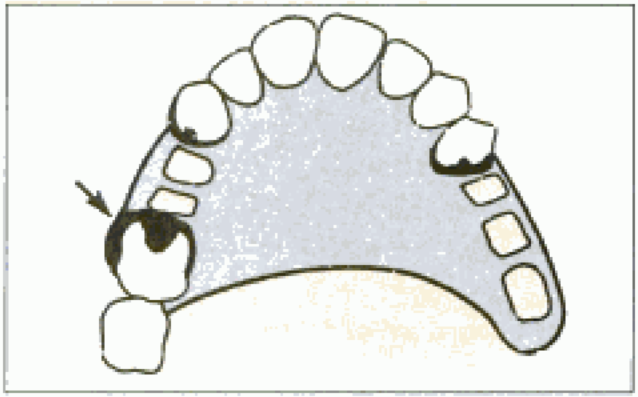


Fig. 16.52: Craddock's class III partially edentulous condition

- Class I: Abutment teeth are present anterior and posterior to the edentulous space. It may be unilateral or bilateral (Fig. 16.53).
- Class II: All the teeth are present posterior to the denture base which functions as a partial denture unit. It may be unilateral or bilateral (Fig. 16.54).
- Class III: All abutment teeth are anterior to the denture base which functions as a partial denture unit. It may be unilateral or bilateral (Fig. 16.55).
- Class IV: Denture bases are located anterior and posterior to the remaining teeth, and these may be unilateral or bilateral (Fig. 16.56).

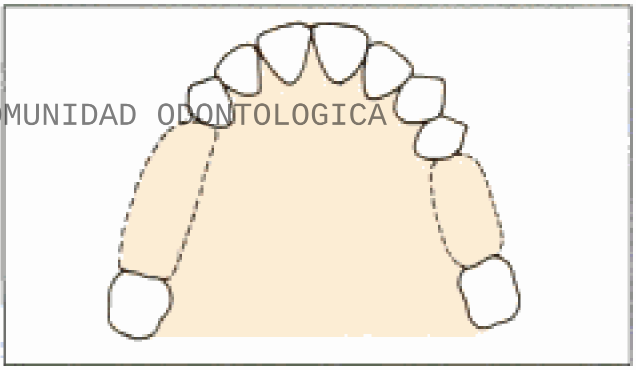


Fig. 16.53: Skinner's class I partially edentulous condition

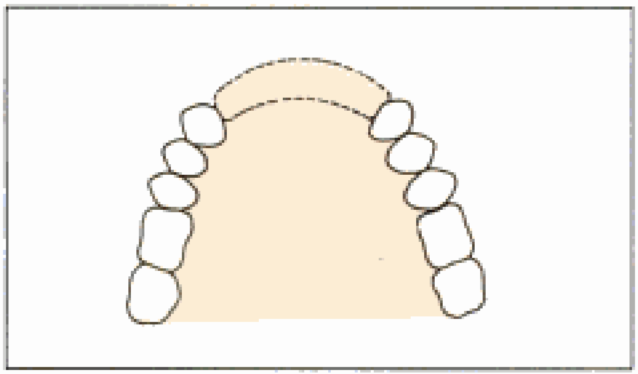


Fig. 16.54: Skinner's class II partially edentulous condition

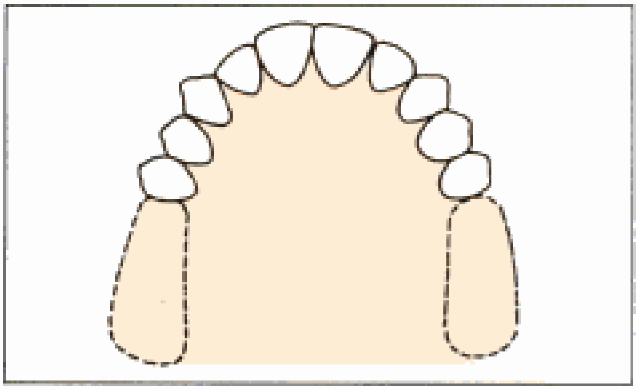


Fig. 16.55: Skinner's class III partially edentulous condition

- Class V: Abutment teeth are unilateral in relation to the denture base, and these may be unilateral or bilateral (Fig. 16.57).

12. Austin and Lidge Classification

It was proposed in 1957. They pointed out that there were 65,000 possible combinations of teeth and edentulous spaces and suggested a classification that described the position of teeth:

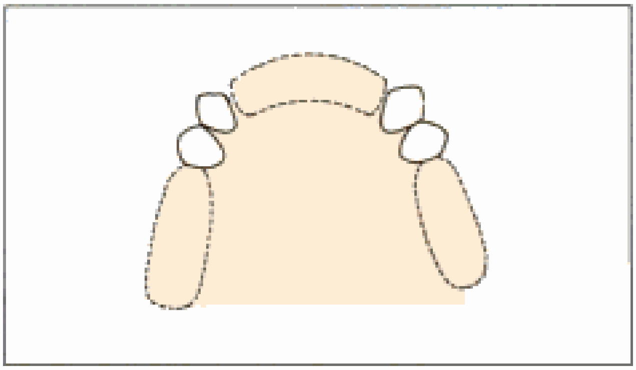


Fig. 16.56: Skinner's class IV partially edentulous condition

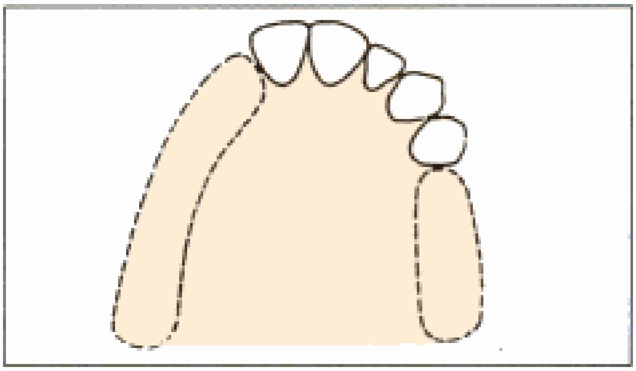


Fig. 16.57: Skinner's class V partially edentulous condition

- Class A: Missing anteriors
  - A1: Missing anteriors on one side. Unilateral construction (Fig. 16.58).

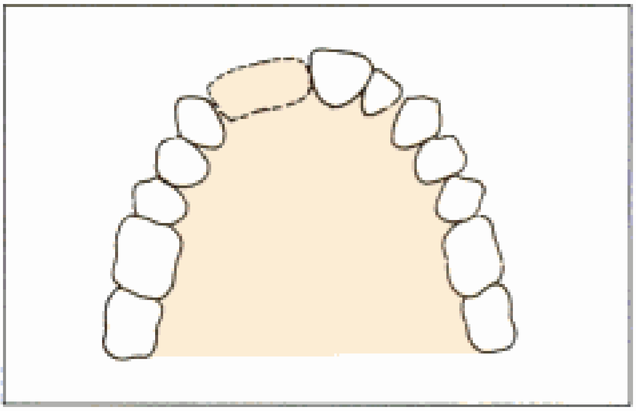


Fig. 16.58: Austin and Lidge class A1 partially edentulous condition

  - A 2: Missing anteriors on both sides (Fig. 16.59).
  - AB1: Missing anteriors with bilateral construction (Fig. 16.60).

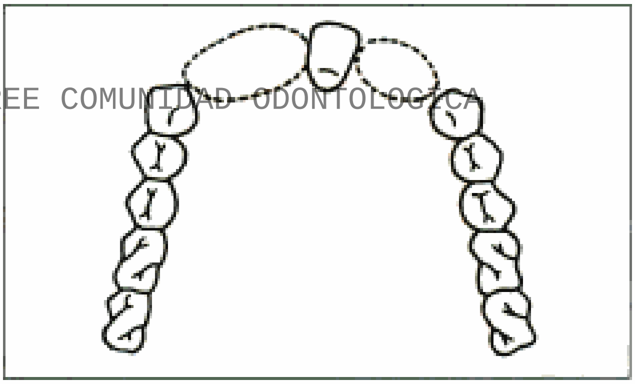


Fig. 16.59: Austin and Lidge class A2 partially edentulous condition

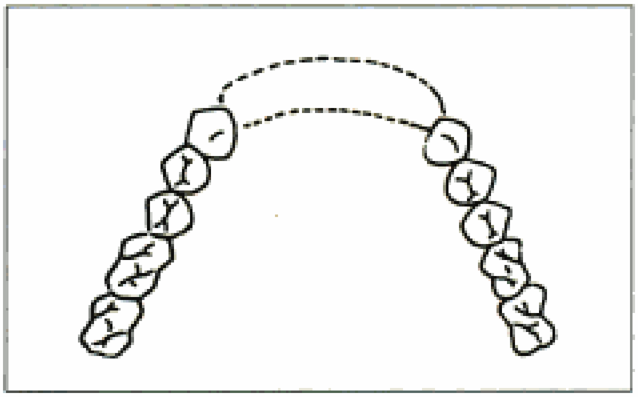


Fig. 16.60: Austin and Lidge class AB1 partially edentulous condition

- Class P: Missing posteriors.
  - P 1: Missing posteriors on one side. Unilateral construction (Fig. 16.61).
  - P 2: Missing posterior on both sides (Fig. 16.62).
  - PB1: Posteriors missing on one side with bilateral construction (Fig. 16.63).

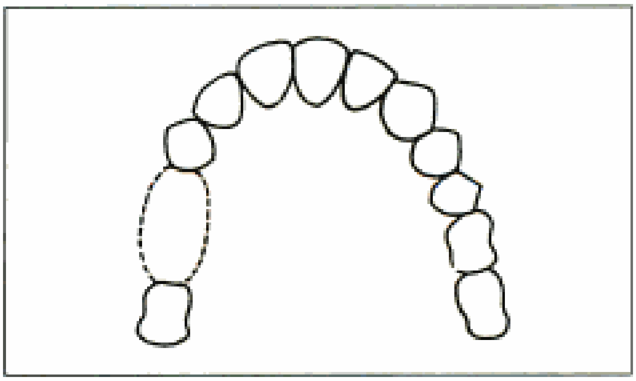


Fig. 16.61: Austin and Lidge class P1partially edentulous condition

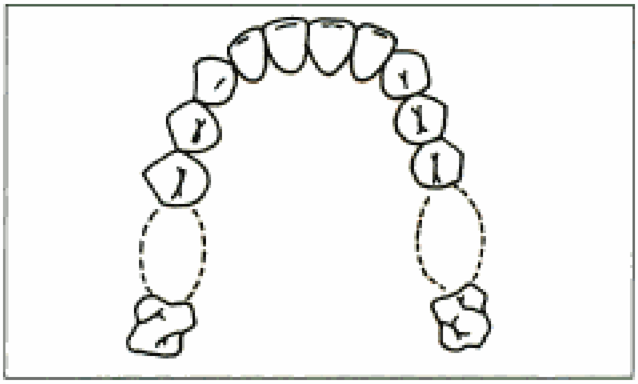


Fig. 16.62: Austin and Lidge class P2 partially edentulous condition

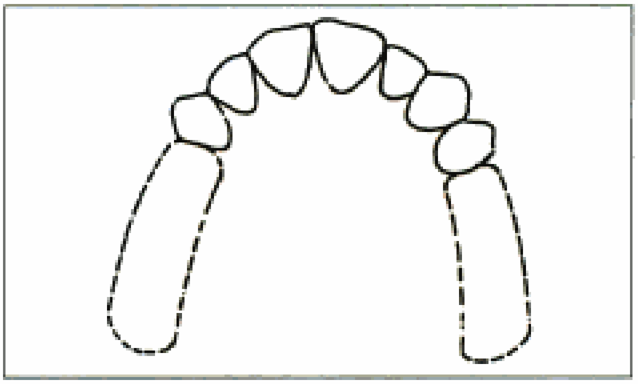


Fig. 16.63: Austin and Lidge class PB1 partially edentulous condition

- Class AP: Missing anteriors and posteriors.
  - AP 1: Missing anteriors and posteriors on one side. Unilateral construction (Fig. 16.64).
  - AP 2: Missing anteriors and posteriors on both sides (Fig. 16.65).

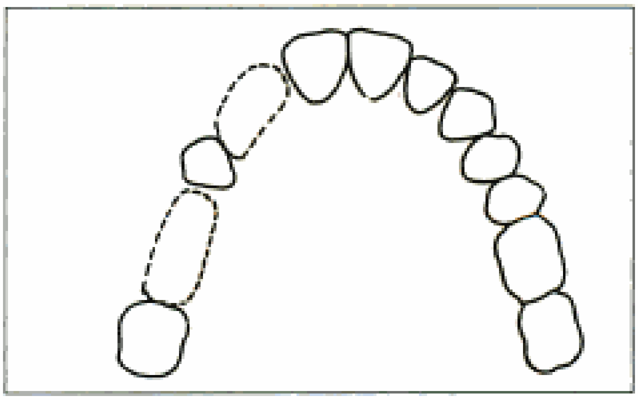


Fig. 16.64: Austin and Lidge class AP1 partially edentulous condition

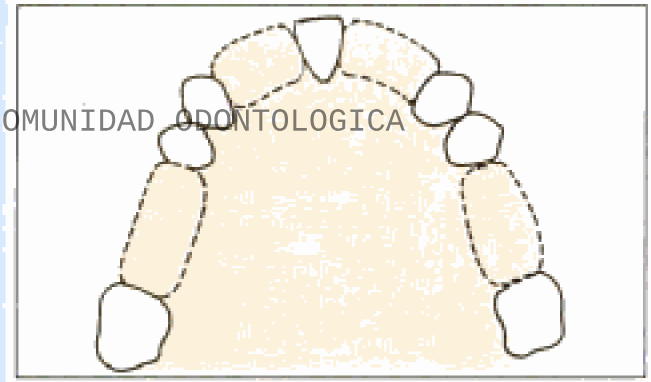


Fig. 16.65: Austin and Lidge class AP2 partially edentulous condition

– AP B1: missing anteriors and posteriors on one side with bilateral construction (Fig. 16.66).

Any combination of the above may be possible, e.g., A2P1 or A1P2.

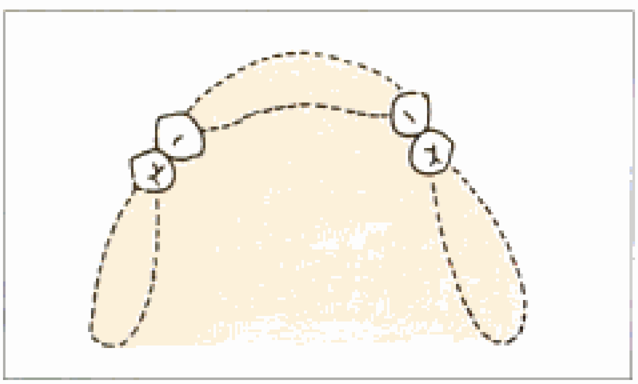


Fig. 16.66: Austin and Lidge class APB1 partially edentulous condition

13. Watt *et al* Classification

He proposed the classification in 1958. It was based on the type of support derived.

- Entirely tooth borne: The entire denture rests on the abutment teeth (Fig. 16.67).
- Entirely tissue borne: The entire denture rests on the soft tissue (Fig. 16.68).
- Partially Tooth borne and partially tissue borne: These dentures rest on both the teeth and the tissues. Generally most of the removable partial dentures come under this category (Fig. 16.69).

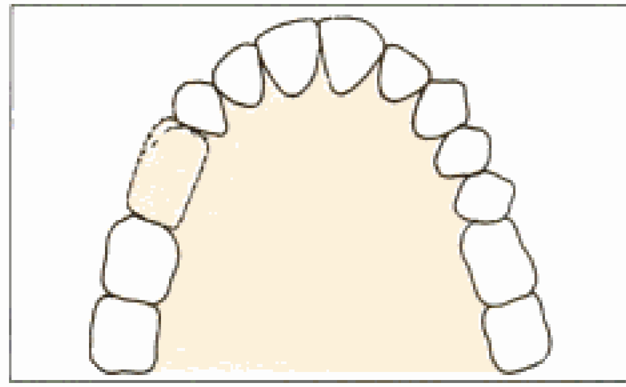


Fig. 16.67: Span of a Watt et al's entirely tooth-borne partial denture

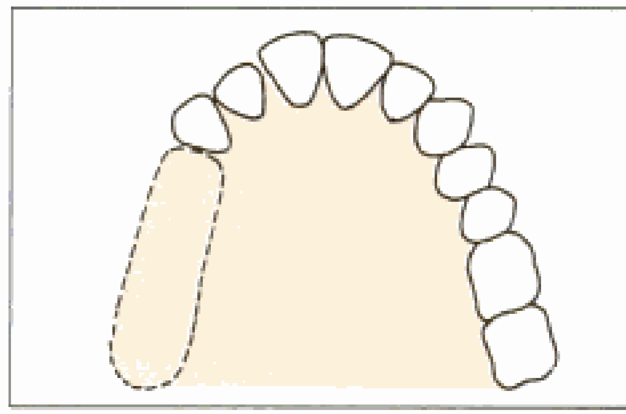


Fig. 16.68: Span of a Watt et al's entirely tissue-borne partial denture

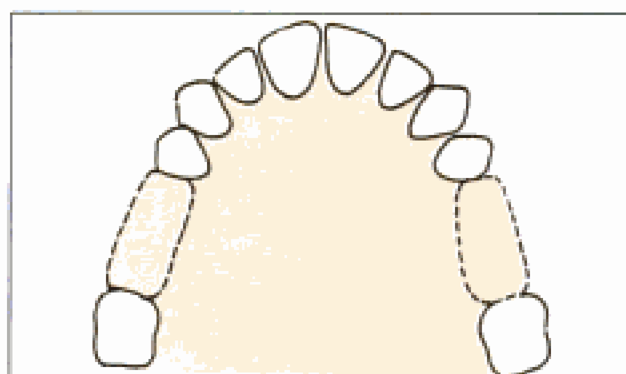


Fig. 16.69: Span of Watt et al's partially tooth and partially tissue borne partial denture

14. Applegate's Classification or Kennedy-Applegate's Classification

Applegate modified Kennedy's classification in 1960 and enumerated the following six classes:

- Class I: All remaining teeth anterior to bilateral edentulous areas (Fig. 16.70).
- Class II: Remaining teeth of either right or left side anterior to the unilateral edentulous area (unilateral free-end) (Fig. 16.71).
- Class III: The edentulous space bounded by teeth anteriorly and posteriorly (Fig. 16.72).

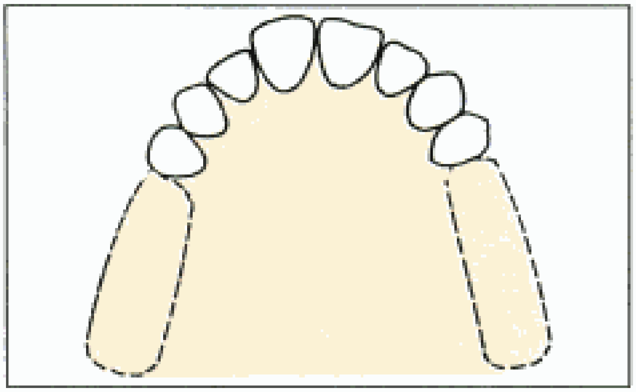


Fig. 16.70: Kennedy-Applegate's class I partially edentulous condition

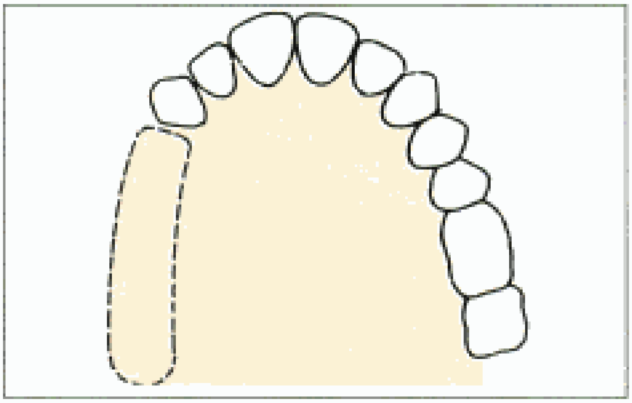


Fig. 16.71: Kennedy-Applegate's class II partially edentulous condition

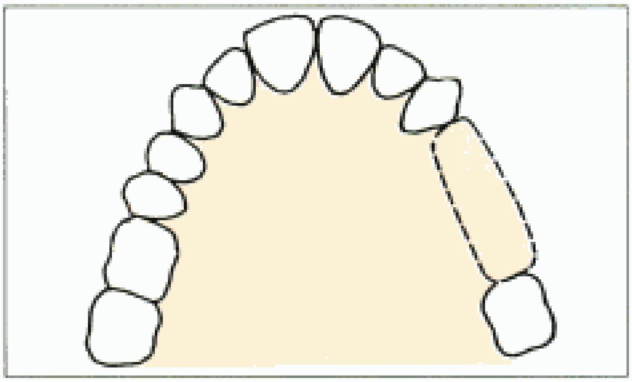


Fig. 16.72: Kennedy-Applegate's class III partially edentulous condition

- Class IV: The edentulous space anterior to the remaining natural teeth, which bound it both to the right and left of the midline (Fig. 16.73).
- Class V: A space bounded by teeth at its anterior and posterior terminals. (It differs from class 3 in that the edentulous space is long with weak anterior teeth) (Fig. 16.74).

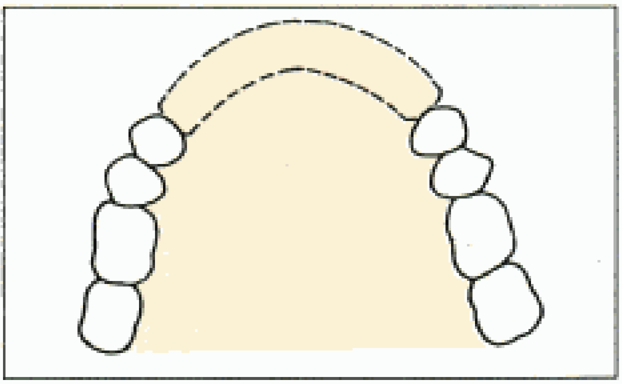


Fig. 16.73: Kennedy-Applegate's class IV partially edentulous condition

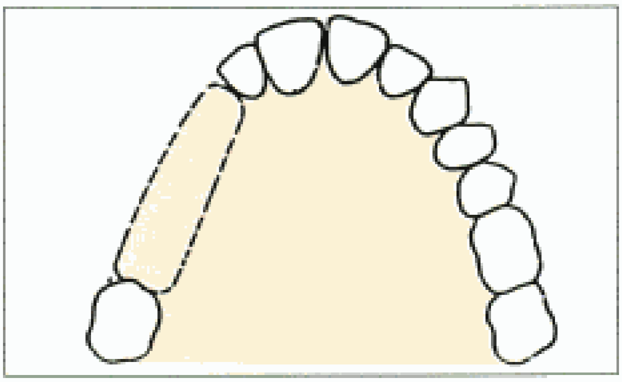


Fig. 16.74: Kennedy-Applegate's class V partially edentulous condition

- Class VI: Same as class 3 but the restoration can be fabricated to be entirely tooth borne (Fig. 16.75).

Applegate's modifications have already been mentioned along with modifications of Kennedy's classification. It has been included as a separate classification here to add a note on the modification of this classification.

Fiset's Modification

Fiset added four additional classes to Kennedy-Applegate's classification and made it a total of ten classes.

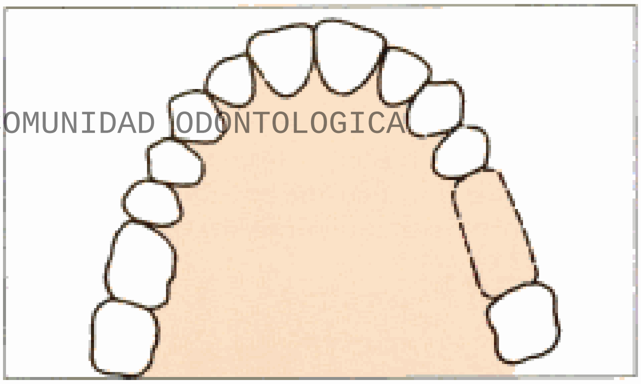


Fig. 16.75: Kennedy-Applegate's class VI partially edentulous condition

15. Swenson's Classification

It is a simple classification proposed by Swenson and Terkla in 1955. It is not widely used. It is similar to Kennedy's classification. The classes of Kennedy's classification are dramatically changed. But the modifications are more similar to Kennedy's classifications. According to this classification:

- Class I: An arch with one free end denture base (Fig. 16.76).

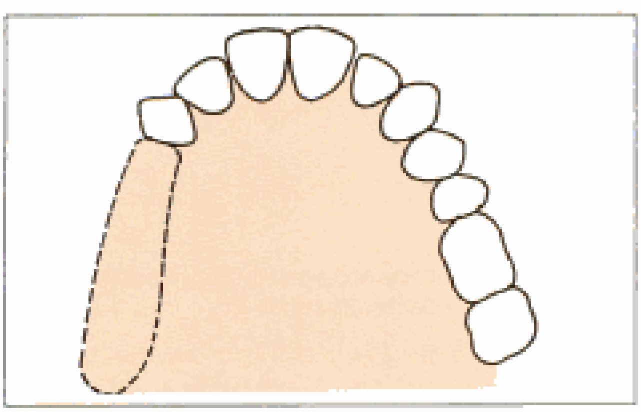


Fig. 16.76: Swenson's class I partially edentulous condition

- Class II: An arch with two free end denture bases (Fig. 16.77).
- Class III: An arch with an edentulous space posteriorly on one or both sides of the mouth but with teeth present anteriorly and posteriorly to each space (Fig. 16.78).
- Class IV: An arch with an anterior edentulous space with five or more anterior teeth missing (Fig. 16.79).

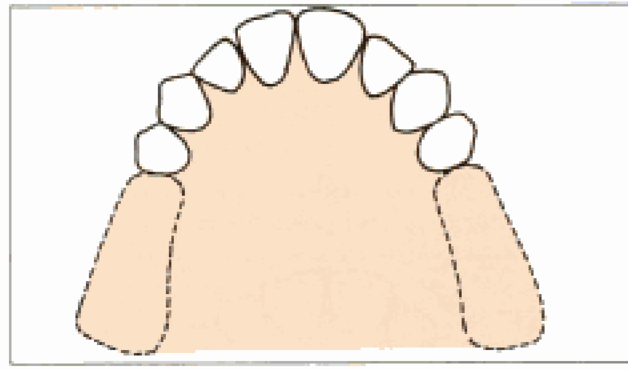


Fig. 16.77: Swenson's class II partially edentulous condition

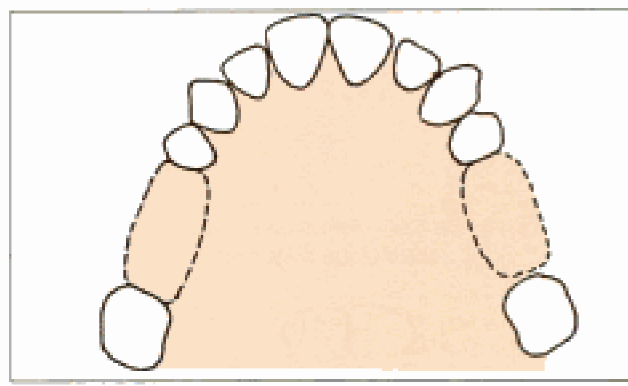


Fig. 16.78: Swenson's class III partially edentulous condition

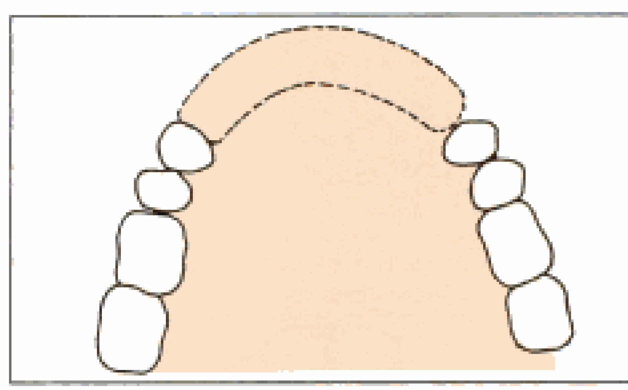


Fig. 16.79: Swenson's class IV partially edentulous condition

Subdivisions: the four major classes are subdivided without denoting which tooth is missing.

- A: Anterior (Fig. 16.80).
- P: Posterior (Fig. 16.81).
- AP: Anterior and Posterior (Fig. 16.82).

Example: Class IIA denotes a bilateral distal extension base with some anterior teeth missing.

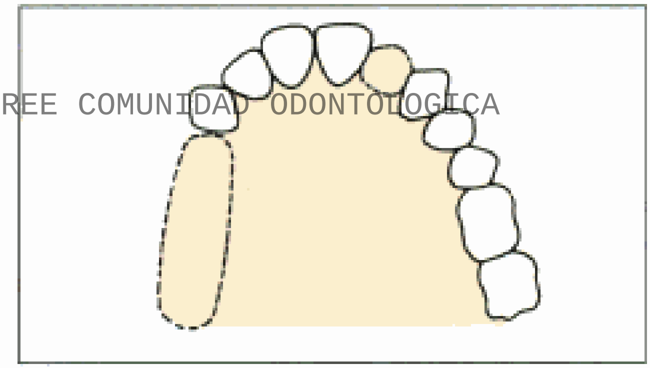


Fig. 16.80: Swenson's class IA partially edentulous condition

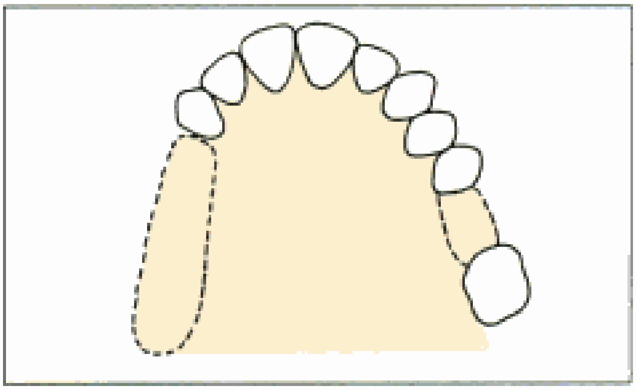


Fig. 16.81: Swenson's class IP partially edentulous condition

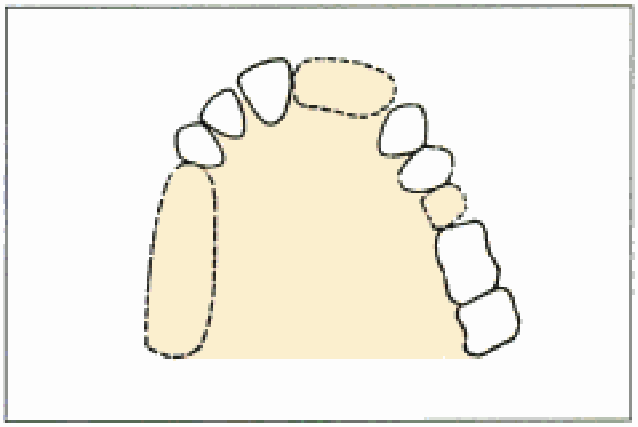


Fig. 16.82: Swenson's class IAP partially edentulous condition

16. Avant's Classification

It was proposed in 1966. The classification was based on the anterior and posterior segments of the arch. It resembled Kennedy's classification without any improvements.

17. Costa's Classification

Proposed in 1974, it was based on the anterior, lateral and terminal spaces.

18. Osborne and Lammie's Classification

It was proposed in 1974. It is similar to Watt et al's classification.

- Class I: Mucosa-borne (Fig. 16.83).
- Class II: Tooth-borne (Fig. 16.84).
- Class III: Combination of mucosa-borne and tooth-borne (Fig. 16.85).

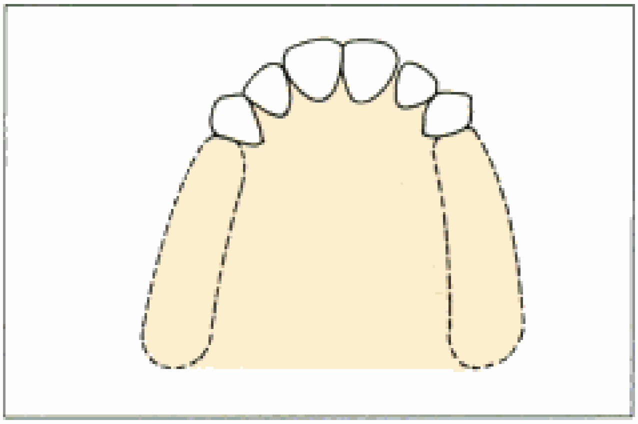


Fig. 16.83: Osborne and Lammie's span of a mucosa-borne partial denture

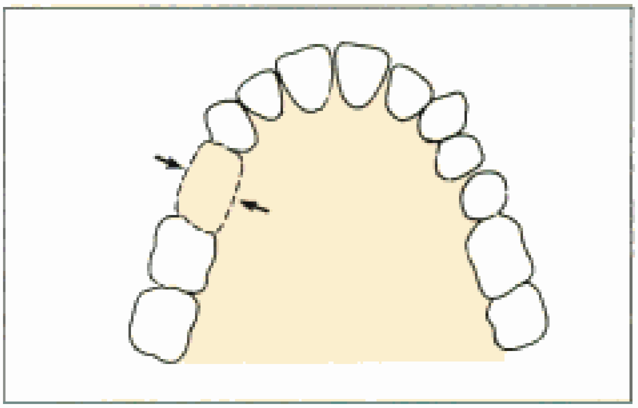


Fig. 16.84: Osborne and Lammie's span of a tooth-borne partial denture

STEPS IN THE FABRICATION OF A REMOVABLE PARTIAL DENTURE

The fabrication of a removable partial denture includes various stages enlisted below. These

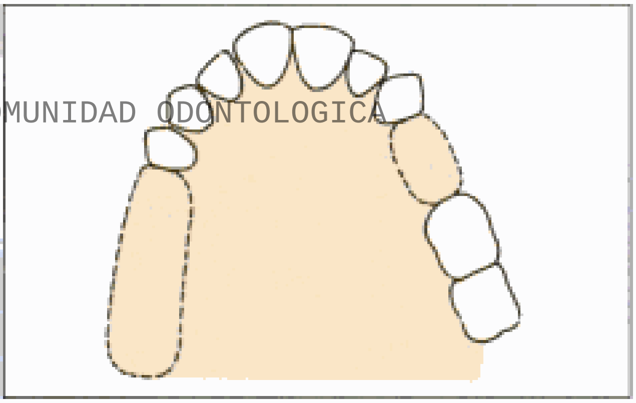


Fig. 16.85: Osborne and Lammie's span of a combination of tooth and tissue borne partial denture

stages are slightly more complex compared to those followed in a complete denture. The steps involved in the fabrication of a removable partial denture are similar to those followed in the fabrication of a complete denture except for a few additional procedures. It is *mandatory* for the first time readers to read the comprehensive explanation of these procedures to obtain an idea about a removable partial denture fabrication.

Diagnosis

Diagnosis is defined as, *"The determination of the nature of the disease"*- GPT. Here it denotes the determination of the prosthetic necessity of the patient. Diagnosis comprises of various procedures used to evaluate certain conditions in the oral cavity. The diagnostic procedures can generally be grouped into personality evaluation, clinical and laboratory evaluation. All these procedures have been described in detail in Chapter 2. The salient features in diagnosing the patient for a removable partial denture have been discussed in the next chapter.

Treatment Planning

Treatment plan is a result of evaluating the diagnostic data. The patient's oral condition is evaluated along with diagnosis. While doing so, the dentist will develop a mental picture about the type of denture that will best suit the patient. The clinician should re-evaluate the case to rule out any better treatment possibilities.

Once the type of treatment is decided, a treatment plan outline is prepared. The outline will contain details about the preprosthetic procedures required for the patient, the type of impression material to be used, the technique of impression making, the equipments preferred to carry out various recording procedures, the material to be used for preparing the frame work and the denture base, etc.

As a part of determing the treatment plan, a diagnostic cast (made of dental plaster) is made from a diagnostic impression (alginate). The diagnostic casts are mounted using a tentative jaw relation record. The inter-arch space and occlusal contacts are evaluated using the mounted diagnostic casts. The diagnostic casts may be surveyed using a surveyor to demark soft tissue undercuts, which are to be removed while carrying out other preprosthetic procedures.

Preprosthetic Procedures

They include removal of pathosis, removal of undercuts, orthodontic realignment etc. Generally the term 'preprosthetic' indicates all the non-prosthetic procedures done prior to the beginning of prosthetic treatment in order to eliminate interference and/or act as an adjunct to the success of the prosthetic treatment.

Preprosthetic procedures include extraction, periodontal treatment, orthodontic realignment of abutment teeth, conservative and/or endodontic treatment of damaged teeth.

Making the Primary Impression and Cast

Primary impression is made atleast six weeks after any preprosthetic surgical procedures. Primary impressions are made using irreversible hydrocolloid (alginate) impression material. Alginate is chosen because it is economical, elastic, and easy to manipulate.

The alginate impression is poured using dental plaster. The resulting primary cast is used to design the prosthesis.

Designing the Prosthesis

This is one of the most important phases in the construction of a removable partial denture.

Designing includes choosing the type of components for the partial denture, determining the location of various components, determining the path of insertion and choosing the type of material for each component etc. Designing can be done using an instrument called *Surveyor*.

Prosthetic Mouth Preparation

It includes preparing rest seats and guide planes. The rest seat is a depression created usually on the occlusal surface of the teeth to receive a rest (a metallic extension of the partial dentures created to transfer occlusal load to the abutment teeth). Guide planes are parallel surfaces created on the proximal surface of abutment teeth along which the certain parts of the partial denture will slide across during insertion and removal. The guide planes help to provide tensofrictional resistance/indirect retention to the proximal plate (discussed later) of the partial denture.

These preparations are created on the natural teeth after designing the prosthesis. In other words, the locations of rests and proximal plates are determined during the design procedure and the rest seats and guide planes are prepared during the prosthetic mouth preparation phase.

Secondary or Final Impression Making and Cast

The secondary impression is made after prosthetic mouth preparation. The material of choice is *alginate*. The only technical consideration being that a small quantity of alginate is applied over the occlusal surfaces prior to impression making in order to record the rest seat and guide plane preparations accurately. Special impression techniques can be employed to record distal extension cases.

The master cast is poured using dental stone. Stone is preferred due to its high strength and surface reproduction. The master cast is surveyed and the markings made on the primary cast are transferred to the master cast. The master cast is used to fabricate the prosthesis.

Fabricating the Framework

The metallic framework is fabricated by casting the wax pattern. Casting is done using a refractory cast. A refractory cast is prepared by duplicating the master cast. Undercuts and relief areas in the master cast should be blocked out before duplication. The wax pattern is prepared on the refractory cast as per the planned design. The refractory cast is invested and the wax is burnt out and the resulting mold is cast using molten metal. The material to be used to fabricate the framework is determined during the treatment-planning phase. After casting, the framework should be finished and polished.

Framework Try-in

The framework should be tried-in before fabricating the trial denture. During framework try-in, occlusal interference and fit of the framework is thoroughly examined. Indicator wax/pastes can be used for this procedure.

Fabricating the Trial Prosthesis

The framework is used as the base for the trial prosthesis. The master cast is used to fabricate the trial denture. An acrylic temporary denture base is attached to the framework over the edentulous area. The acrylic should be easily detachable during de-waxing hence, it should be fabricated such that it does not interlock with the framework.

Next the occlusal rims are fabricated over the temporary denture base. The jaw relationships are recorded. A kinematic face-bow and a fully adjustable articulator should be used for cases requiring high precision like full mouth rehabilitation *(occlusal reconstruction for patients with severe attrition or tipped teeth with loss of a proper plane of occlusion where the rehabilitated occlusion should be perfect)* and for removable partial denture's opposing fixed partial denture 's etc. Usually jaw relation and articulation are done as described in the complete denture section.

After recording the jaw relation, the master casts are articulated in an articulator *(fully adjus-*

table articulators are used only for complete occlusal rehabilitation patients). Teeth selection and arrangement is done on the occlusal rims. The trial denture is waxed up as explained for complete dentures.

Try-in of the Trial Denture

The trial denture is placed in the patient's mouth for aesthetic and functional evaluation before processing. Error correction and modifications according to the requirement of the patient is completed.

Processing the Trial Denture

After try-in, wax up, flasking de-waxing, packing, curing, finishing and polishing procedures are carried out as described in Chapter 12.

Denture Insertion

The denture is inserted and evaluated. Premature occlusal contacts and minor errors are corrected. Post-insertion instructions are given to the patient. The patient is recalled frequently to evaluate the tissue response, obtain feedback and determine periodically the success of the denture.

All the above-mentioned procedures will be explained in detail in the following chapters.

PARTS OF A REMOVABLE PARTIAL DENTURE

Before we go into the details about the removable partial denture, I wish to give a brief introduction about the various parts of a removable partial denture. A detailed description about each of these parts is discussed in chapter 18.

Various components are used in a fixed partial denture. Each one has a specific function. The design, position and location of each component vary according to individual needs. The components of a removable partial denture are:

- Major connector
- Minor connector
- Rest
- Direct retainer
- Indirect retainer
- Denture base
- Artificial tooth replacement

The first five are cast in metal and the other two may be fabricated using other materials.

Major Connector

It is defined as, *"A part of a removable partial denture which connects the components on one side of the arch to the components on the opposite side of the arch"*-GPT.

It is the largest and most important component of the removable partial denture. The major connector functions to connect all the other component parts of the prosthesis (explained later) and provide indirect retention. The types of major connectors and their design concepts have been discussed in detail in Chapter 18.

Minor Connector

It is defined as, *"The connecting link between the major connector or base of a removable partial denture and other units of the prosthesis, such as clasps, indirect retainers and occlusal rests"* - GPT.

It is the component, which connects the other components of the removable partial denture to the major connector. Minor connectors can be of four types namely:

- Minor connectors that connect the direct retainer to the major connector.
- Minor connectors that connect auxillary rests to major connectors.
- Minor connectors that connect the denture base to the major connector.
- Minor connectors that extend as the approach arm of a bar clasp.

Structural details and design concepts have been discussed in detail in Chapter 18.

Rest

It is defined as, *"A rigid extension of a fixed or removable partial denture which contacts a remaining tooth or teeth to dissipate vertical or horizontal forces"* -GPT.

Rests are metallic extensions in the denture framework that extend over the occlusal/lingual surface of the supporting teeth. The main function of a rest is to transmit the occlusal forces acting on the denture along the long axis of the abutment tooth. Since an occlusal rest extends over the occlusal surface, care should be taken to design the rest such that it does not produce any occlusal interference. A depression is created on the occlusal surface of the tooth where the rest is to be placed. This depression where the rest is fabricated to fit in is called a *rest seat*. The purpose of preparing a rest seat is to avoid occlusal interference, protect and position the rest and also direct the forces along the long axis of the abutment. The method of preparation of a rest seat is described in detail under prosthetic mouth preparation (Chapter 19). The types of rest and their design concepts are described in Chapter 18.

Direct Retainer

It is defined as, "*A clasp or attachment placed on an abutment tooth for the purpose of holding a removable denture in position*" - GPT.

A direct retainer is the part of the fixed partial denture, which helps to prevent the displacement of the denture. The direct retainer functions based on certain principles. It is the most critical component for a removable partial denture. The parts, functions, and design concepts have been discussed in detail in Chapter 18.

Attachment

It is defined as, "*A mechanical device for the fixation, retention and stabilization of a dental prosthesis*" - GPT. It is a type of direct retainer. Generally, the term 'attachment' refers to an intracoronal retainer, which extends into the abutment tooth.

Indirect Retainer

It is defined as, "*A part of a removable partial denture which assists the direct retainers in preventing displacement of distal extension denture bases by functioning through lever action on the opposite side of the fulcrum line*" - GPT.

This is not a separate component. Instead, it is a combination of the above-mentioned components, which offer indirect retention. Direct retention is the ability of the component to prevent the displacement of the denture. Indirect retention is the ability of the component to retain the denture in place. Methods of obtaining indirect retention are described in detail in Chapter 18.

The indirect retainer is a separate component in a distal extension denture base. It is a must and it assists the direct retainer to obtain retention of the denture. Mechanism is explained in Chapter 18.

Denture Base and Tooth Replacements

Denture base is the part of the denture that forms the tissue surface of the denture over the edentulous area. It is usually made of acrylic resin. It helps to distribute the forces acting on the denture over the entire residual ridge. The denture base also functions to hold the tooth replacements in position.

Tooth replacements reproduce the contour and function of the missing teeth. There are different types of tooth replacements used in a removable partial denture. They have been discussed in detail alongwith the design of an fixed partial denture (Chapter 18). The denture base should have maximum possible tissue coverage within the limiting structures. It should also have a close adaptation to the tissues.

Chapter 17
Diagnosis, Treatment Planning and Mouth Preparation

- **Clinical Diagnosis**
- **Derived Diagnosis or Post-clinical Diagnosis**
- **Treatment Planning**
- **Preprosthetic Mouth Preparation**
- **Making the Primary Cast**

17 Diagnosis, Treatment Planning and Mouth Preparation

CLINICAL DIAGNOSIS

As described in the previous chapter, diagnosis is the determination of the nature of the disease. Diagnosis can be broadly classified as *clinical diagnosis and post-clinical or derived diagnosis*. Clinical diagnosis includes personality evaluation, clinical examination and radiographic examination. Post-clinical or derived diagnosis deals with the evaluation of the patient's condition using the diagnostic data collected during clinical diagnosis.

Clinical diagnostic procedures like patient evaluation and clinical examination have been discussed in detail for complete dentures in Chapter 2. Most of the diagnostic procedures described in Chapter 2 are used in the diagnosis of a partially edentulous condition. Hence, I have skipped the detailed description of the repeating topics.

In this section, we will discuss only about the additional clinical diagnostic procedures required to diagnose a partially edentulous condition.

Clinical Evaluation of the Existing Teeth

This is very important for the success of a partial denture. The remaining teeth are the primary supporting structures for most removable partial dentures.

Evaluation of existing teeth comes under the local clinical examination stage in diagnosis. The following factors should be evaluated on the remaining natural teeth.

Periodontal Health

The periodontal condition of the existing teeth should be examined. Clinical signs of periodontal health like inflammation of the gingiva, bleeding on probing, periodontal breakdown, and mobility of the teeth etc. should be evaluated (Fig. 17.1).

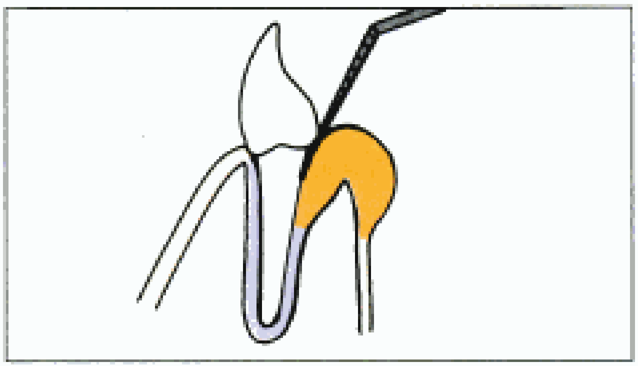
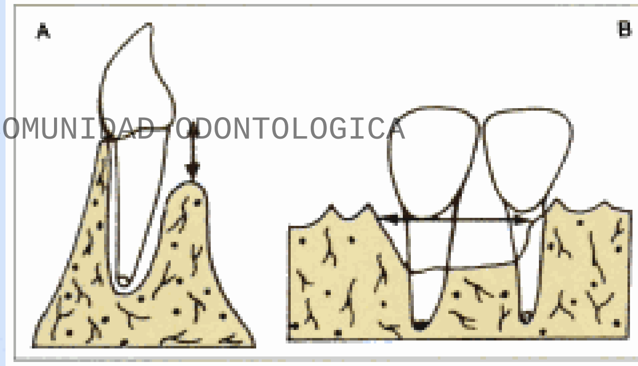


Fig. 17.1: The periodontal status can be clinically evaluated using periodontal probes

Oral hygiene is evaluated using the oral hygiene index, gingival inflammation and bleeding are evaluated using the gingival index. The periodontal breakdown and mobility of teeth are evaluated using the *Russel's index*. Mobility of teeth can be measured using instruments like *forcemeters and periodontometers*.

All these indices are diagnostic procedures carried out to collect diagnostic data, which will be analysed later to arrive at a derived diagnosis. For example, oral hygiene index is used to measure the amount of debris that is accumulated on the clinical crown based on which prosthodontic prognosis is predicted.

The periodontal health can also be determined radiographically. The amount of horizontal or vertical bone loss is measured on a radiograph. (Fig. 17.2). Radiological signs of periodontal breakdown are also included in the Russel's index.



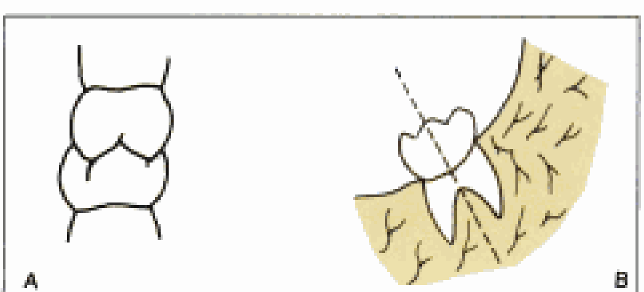
Figs17.2a and b: (a) Vertical bone loss (b) Horizontal bone loss

After evaluating the periodontal health, the clinician should decide whether to retain or extract a periodontally weak tooth. Accordingly, periodontal therapy or extraction of the tooth is carried out during the pre-prosthetic phase of treatment.

Occlusion of the Existing Teeth (Figs 17.3a to c)

The existing teeth should be examined for occlusion. The teeth should have a good cusp to fossa relationship. Improper occlusal contacts should be corrected during the preprosthetic mouth preparation phase.

Some teeth may be tilted and/or malaligned which makes them unfit to support the prosthesis. Such teeth can either be extracted if they produce severe interference to the prosthesis or orthodontically realigned so that they can be used to provide support for the prosthesis.



Figs 17.3a and b: (a) Ideal molar key of occlusion where in the mesiobuccal cusp of the maxillary first molar will rest on the mesiobuccal groove of the mandibular first molar (b) Tilted molar teeth that pose occlusal interference should be realigned or reduced or extracted

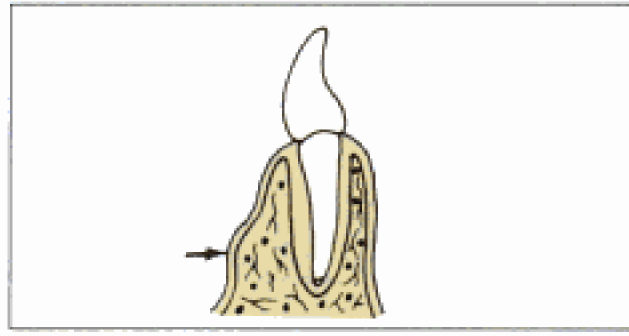


Fig. 17.3c: Buttressing bone formation due to trauma from occlusion

One other factor that should be examined under occlusion is, trauma from occlusion. Trauma due to excessive occlusal force is characterized by the presence of premature contacts (high points), mobility of teeth, and buttressing bone formation, wear facets, etc.

Conservative and Endodontic Status of the Existing Teeth

The existing teeth should be examined to rule out the presence of carious lesions like pit and fissures, deep caries, gross tooth decay etc. The depth of the lesion and the vitality of the pulp should be checked (Fig. 17.4). Appropriate treatment should be instituted during preprosthetic mouth preparation phase.

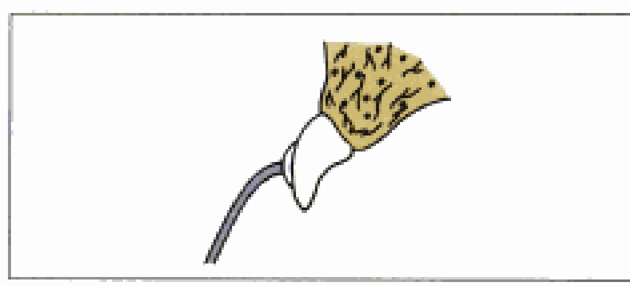


Fig. 17.4: Checking the pulp vitality using a pulp tester

The teeth should also be examined for cracks, chipped corners and fractures. If the pulp is not vital, endodontic therapy is completed during the preprosthetic mouth preparation phase.

Retained root stumps should be extracted unless a post and core preparation is decided. Post and cores can be designed to accept occlusal load from the partial denture (Fig. 17.5).

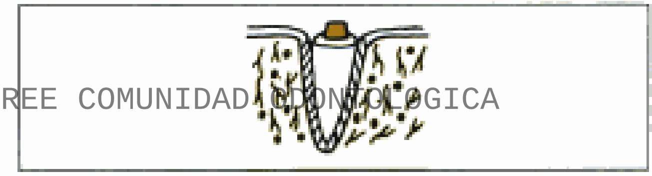
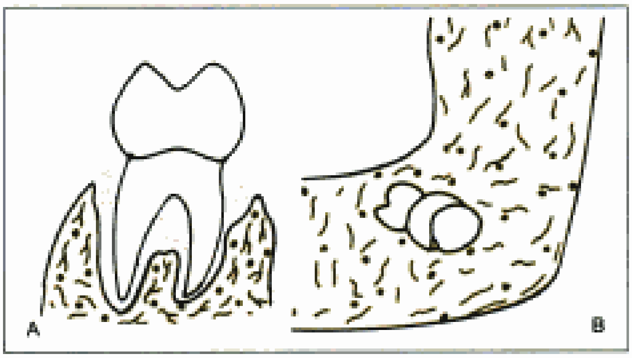


Fig. 17.5: A periodontally sound root stump can be modified with a cast post to support the prosthesis

Radiological Examination of Existing Teeth

This was explained in detail under diagnosis for a complete denture. The periodontal bone loss should be evaluated. The structure of the basal bone in the denture bearing area should be evaluated. Presence of *periapical* bone loss and furcation involvement should be examined. Last but not the least, presence of impacted teeth and submerged root stumps are also verified (Fig. 17.6).



Figs 17.6a and b: (a) Severe alveolar bone loss (b) Impacted molar tooth bud

DERIVED DIAGNOSIS OR POST-CLINICAL DIAGNOSIS

As explained, derived diagnosis is the determination of the nature of the disease by analysing the diagnostic data obtained from the patient. Generally, radiological diagnosis is considered as a derived diagnosis. But, if the radiograph is used to compare the clinical status, it is considered as an adjunct to the clinical diagnosis.

Derived diagnosis for a removable partial denture includes the evaluation of diagnostic data like diagnostic casts. The diagnostic cast is one of the most important diagnostic data from which final diagnosis is derived. The diagnostic cast also helps to develop an outline of the treatment plan. Hence, for derived diagnosis, a diagnostic cast is necessary. Other diagnostic data (used for diagnosis) include pre-extraction records, like, radiographs, photographs, diagnostic casts made by the previous clinician etc.

In this section, we will discuss in detail about the evaluation of a diagnostic cast.

Derived Diagnosis Using a Diagnostic Cast

We all know that a diagnostic cast is obtained from a diagnostic impression. Hence, before we discuss about evaluating a diagnostic cast, let us take a look at how a diagnostic cast is prepared.

Making the Diagnostic Impression

Diagnostic impressions for removable partial dentures are made using irreversible hydrocolloid (alginate). An impression is defined, as "*An imprint or negative likeness of the teeth and/ or edentulous areas where the teeth have been removed, made in a plastic material which becomes relatively hard or set while in contact with these tissues. Impressions may be made of full complement of teeth, of areas where some teeth have been removed, or in mouths from which all teeth have been removed.*"-GPT

A primary or preliminary impression is defined as "*An impression made for the purpose of diagnosis or for the construction of a tray*" - GPT.

This impression is made using a stock tray. The most commonly used impression materials for making the preliminary impression are

- Irreversible hydrocolloids (alginate)
- Reversible hydrocolloid (agar)
- Elastomeric impression materials (for cases with deep undercuts).

Impression trays An impression tray is defined as "*A device used to carry, confine and control the impression material while making an impression*"-GPT.

Impression trays are of two types, namely, prefabricated stock trays or custom made special trays. Prefabricated stock trays are used for diagnostic and preliminary impressions. Impression trays may also be classified as perforated and non-perforated trays. Perforated trays are used to carry low viscosity impression materials. The perforations help to retain the impression material on the tray by mechanical interlocking (Fig. 17.7).

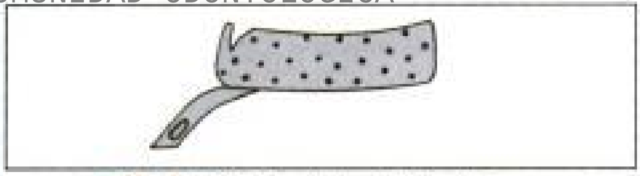


Fig. 17.7: Perforated metal stock tray

Impression material An impression material is defined as *"Any substance, or combination of substances used for making a negative reproduction or impression"*-GPT.

The material of choice for making diagnostic impression in for a removable partial denture is alginate. Alginate is preferred for its low price, ease of use, and reproduction of sufficient detail.

Composition of Alginate

Sodium or Potassium alginate (soluble alginate)	:	15%
Calcium sulphate (reactor)	:	16%
Zinc oxide (filler particle)	:	4%
Potassium titanium fluoride (accelerator)	:	3%
Diatomaceous earth (filler particle)	:	60%
Sodium phosphate (retarder)	:	2%

The soluble Sodium alginate reacts with Calcium sulphate in an aqueous solution to form insoluble Calcium alginate gel. Gelation time of commercial alginate is about 3 to 4 minutes. The water: powder ratio is 40 ml of water for 15 gm of powder.

Impression technique A stock tray of a suitable size should be selected for each patient. There should be at least 2 mm space between the tissues and the tray for the impression material to flow into.

The material is mixed in a rubber bowl using a curved spatula. 'Figure of 8' motion is used during spatulation (Fig. 17.8). This helps to breakdown the fibrous network leading to an increase the mixing time. The material is loaded onto the tray and a small amount of material is applied on to the palate. The tray is carried into the patient's mouth and seated firmly in position

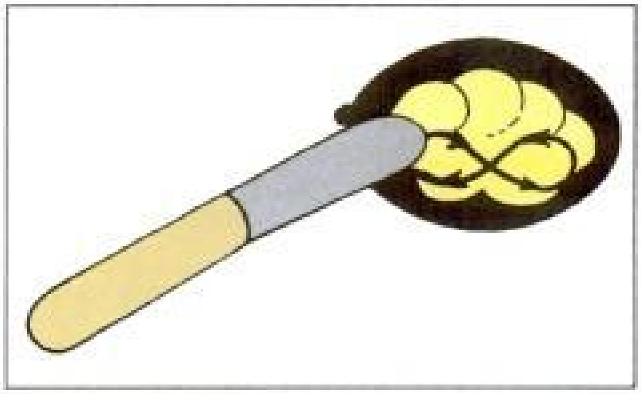


Fig. 17.8: Alginate should be mixed using figure of '8' motion

until gelation is complete. The tray is removed in a single stroke with a single path of removal. Rotating the tray during removal will cause distortion of the impression. The path of removal of the impression should be parallel to the long axis of the remaining teeth.

Inspecting the impression The impression made is inspected for air inclusions and voids. The surface is inspected to verify if all the landmarks have been recorded accurately.

Disinfecting the impression The impression is disinfected using iodophor. It should be left undisturbed for ten minutes. Two percent glutaraldehyde is also the disinfectant of choice. Glutaraldehyde has been proved to cause damage to the impression surface of elastomeric impression. Hence, it is avoided for the disinfection of elastomeric impression.

Preparing the Diagnostic Cast

Pouring the diagnostic cast It is similar to the procedure described for pouring a cast described in Chapter 3.

- The cast should be poured within 12 minutes after making the impression.
- Minimal expansion dendrite dental stone is used.
- The cast is poured with two-pour technique.
- Stone mix is made under vacuum and the first pour is made.
- The thickness of the first pour should be atleast 6 mm (Fig. 17.9).

Fig. 17.9: First pour on the diagnostic impression

- After 10 to 12 minutes, slurry water is sprayed over the first pour.
- Next the impression is inverted over a mix (platter) of stone (second pour) and the base of the cast is shaped using a plaster knife (Fig. 17.10).
- The cast is separated about 45 to 60 minutes after the initial set of the gypsum.

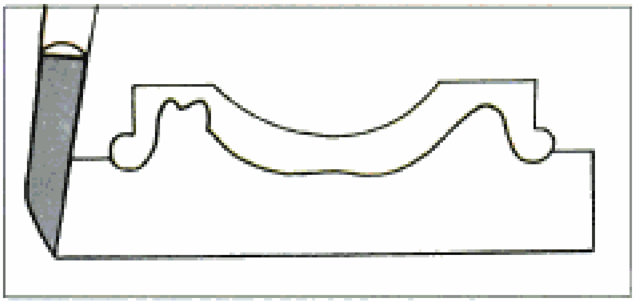


Fig. 17.10: Contouring the second pour using a plaster knife

Trimming the Diagnostic Cast

Trimming a dentulous cast is different from that described for an edentulous cast in Chapter 3.

- Minimum thickness of base (at the thinnest portion)
  - 10 mm at the center of hard palate in the maxilla (Fig. 17.11).
  - 10 mm at the depth of lingual sulcus in the mandible (Fig. 17.12).

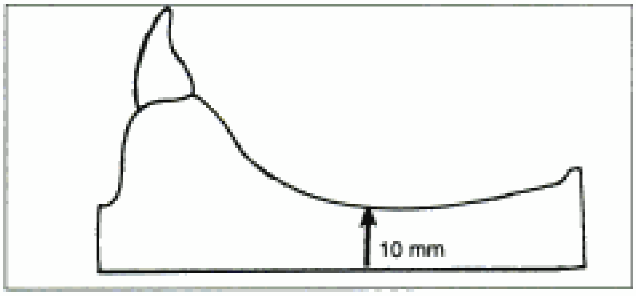


Fig. 17.11: The maxillary cast should measure atleast 10 mm in height at its thinnest portion namely the depth of the palatal vault

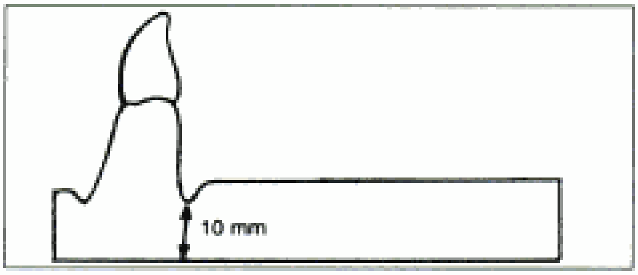


Fig. 17.12: The mandibular cast should have a minimal thickness of 10 mm from the depth of the lingual sulcus

- Posterior surface of the cast must be perpendicular to the base.
- The sides of the cast are trimmed so that they are parallel to the buccal surfaces of the teeth.
- Land area/periphery should be 3 mm wide all around the cast.
- The base of the upper cast should have seven sides (Fig. 17.13). They are:
  - Two anterior surfaces meeting at the midline.
  - Two surfaces on the sides.
  - One surface at the posterior end.
  - Two surfaces in-between the sides and the posterior end.
- The base of the lower cast will have only six sides (Fig. 17.14). It should have a single anterior curve instead of two anterior surfaces.
- The tongue space in the lower cast should be trimmed flat. The lingual sulcus, lingual frenum and sublingual fold space should be preserved.

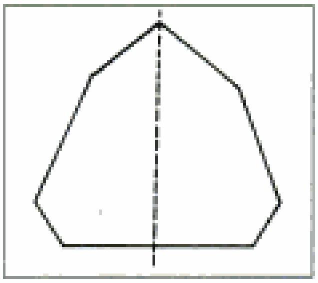


Fig. 17.13: Seven sided maxillary dentulous cast

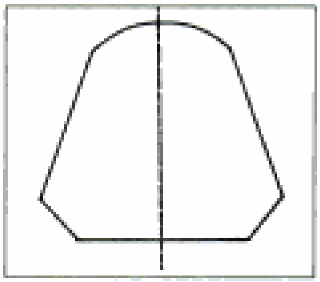


Fig. 17.14: Six sided mandibular dentulous cast

Evaluating the Diagnostic Cast

After making the diagnostic casts, they should be evaluated to determine the problems that the clinician might face during the fabrication of the denture in other words to determine the derived diagnosis.

The diagnostic casts can be evaluated using two procedures both of which are essential:

- Surveying the diagnostic cast using a surveyor.
- Mounting the diagnostic cast in an articulator.

Surveying the diagnostic cast Survey of a cast is done using an instrument called *Surveyor*. The structure, assembling and surveying procedures are described in detail in the next chapter. Here, we shall discuss about the purpose/uses of surveying a diagnostic cast:

- To locate and demark the soft tissue undercuts, and severe undercuts located on the surface of the existing teeth.
- To determine the need for preprosthetic mouth preparation and also perform mock surgeries.
- To determine the path of insertion of the denture. This also rules out the use of dentures that may require a different path of insertion.

Let me explain, consider a deep undercut on the buccal surface of the maxillary tuberosity. The denture base cannot extend to the depth of the sulcus in this area. Hence, the undercut should be eliminated. The diagnostic cast is surveyed in a surveyor which has a vertical marker, that can be used to mark the height of contour of the bone or soft tissue above the undercut. The marked height of contour should be surgically reduced to remove the undercut. The depth of the undercut can be measured from the height of contour using an undercut gauge (Fig. 17.15).

The diagnostic cast can be surveyed to determine the extent of preprosthetic procedures required. The vertical marker in a surveyor can

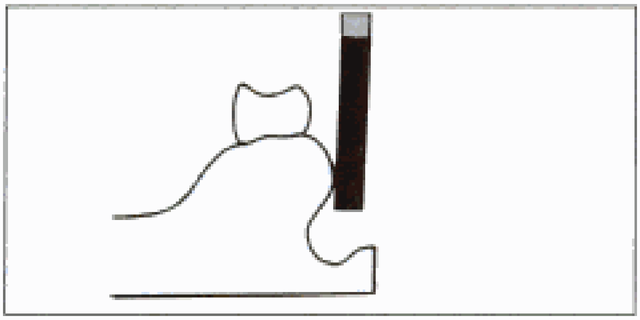


Fig. 17.15: The height of contour above an undercut can be marked on the cast using a carbon rod

be replaced with a special knife and can be used to scrape the cast till the undercut is eliminated. *This procedure of reducing the cast to evaluate the amount of surgical reduction required is known as mock surgery* (Fig. 17.16).

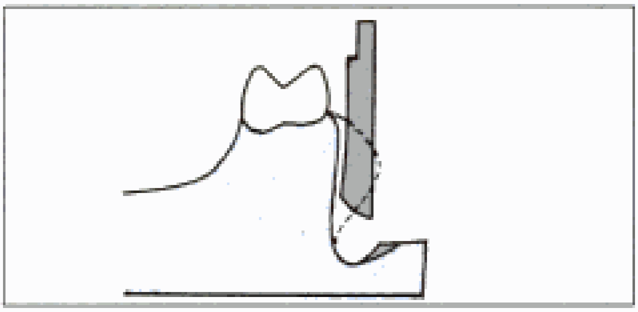
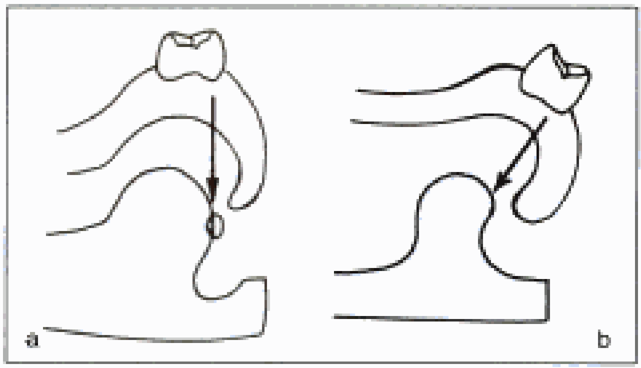


Fig. 17.16: Mock preparation done to evaluate the need for preprosthetic surgery

Some cases will have unilateral undercuts (undercut on one side of the alveolar slope alone). Altering the path of insertion will help to seat the denture in such cases. The path of insertion can be changed to a maximum 10°. The diagnostic cast should be surveyed to determine if the path of insertion which can be altered to aid in the insertion of the prosthesis (Fig. 17.17). The procedure is described in detail in the next chapter.

Hence, we understand that a diagnostic cast can be used to determine the presence and depth of an undercut. Other uses of a diagnostic cast are enumerated in Chapter 3.



Figs 17.17a and b: Altering the path of insertion to facilitate inserting a denture into an undercut

Mounting the diagnostic casts The diagnostic casts are mounted in an articulator using tentative jaw relation records (orientation, vertical and centric). The methods of recording jaw relation are similar to the procedures described in fabrication of a complete denture.

The uses of mounting diagnostic casts are:

- As an adjunct to clinical examination: Extruded teeth, overhanging tuberosities, lack of interarch space, malaligned teeth, abnormal occlusal contacts, improper restorations etc., can be examined more accurately on mounted diagnostic casts (Fig. 17.18).

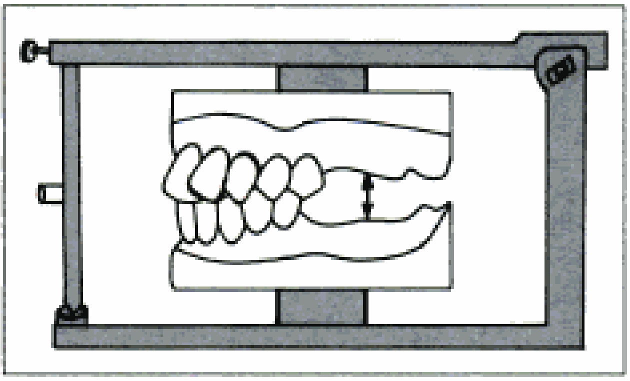


Fig. 17.18: Mounting the diagnostic casts using a tentative jaw relation record in order to evaluate the inter-arch space

- For a detailed analysis of patient's occlusion: The lingual view of the occluded teeth can be examined only on mounted casts. This helps to select and design the type of prosthesis required for a patient (Fig. 17.19).
- Patient education: They help to educate the patient about his oral condition and emphasize on the need for treatment. Diagnostic casts also help to explain the treatment plan to the patient.

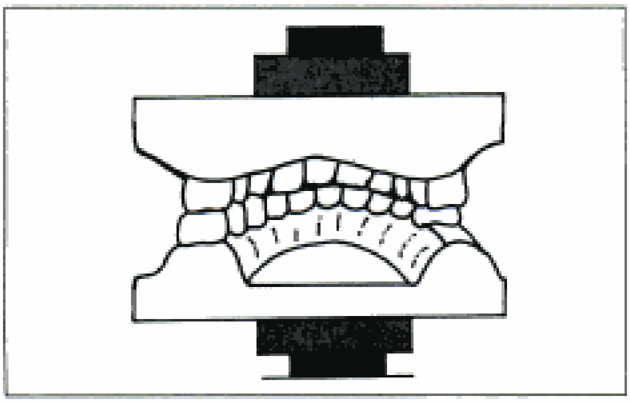


Fig. 17.19: Lingual view of occlusion can be evaluated using diagnostic data

- It is a valuable legal pre-treatment record.

Derived Diagnosis Using other Diagnostic Data

Other diagnostic data like pre-extraction radiograph and photograph give a mental picture about the previous condition of the patient. Using these records, abnormalities like malocclusion etc., can be diagnosed.

TREATMENT PLANNING

After evaluating the clinical and derived diagnosis, the mode of treatment that would best suite the patient is determined. The outline of treatment is framed before starting the treatment.

Prosthodontic treatment for partially edentulous patient's can be divided into six separate phases or stages.

Phase I

- Collection and evaluation of diagnostic data (e.g. Diagnostic impressions).
- Treatment of emergency conditions. Relief of pain and infection.
- Determining the type of prosthesis to be fabricated.
- Patient motivation.

Phase II

- Preprosthetic mouth preparation.
- Making the primary impression.
- Patient motivation

Phase III

- Designing the RPD.

Phase IV

- Prosthetic mouth preparation
- Making the final impression
- Patient motivation.

Phase V

- Fabrication of the removable partial denture.

Phase VI

- Insertion.
- Post-insertion management.
- Periodic recall and review.

While formulating a treatment plan, the dentist should decide and enlist all the procedures he/she plans to complete during each phase of treatment.

For example, some patients may not require any preprosthetic mouth preparation. In such cases, the phase II is omitted and the remaining phases of treatment are carried out. The treatment outline/plan created by the clinician should be explained to the patient. This is done to give him/her an idea about the procedures that are to be completed as a part of treatment.

Advantages of Treatment Planning

- Improves the patient's cooperation and motivation.
- Helps to communicate between two clinicians.
- Records from the previous dentist give an idea about the current status of the patient and the outcome of treatment.
- Provides treatment coordination between recall visits.
- Acts as a reminder to complete all the procedures enlisted for treatment.

PREPROSTHETIC MOUTH PREPARATION

It forms the second phase of treatment. The term mouth preparation includes all the procedures done to modify the existing oral condition of the patient to facilitate proper placement and functioning of the prosthesis.

Mouth preparation in general can be classified into preprosthetic mouth preparation and prosthetic mouth preparation. Preprosthetic mouth preparation involves the preparation of the oral cavity to remove any hindrance to prosthetic treatment (e.g. frenectomy, excision of tori etc). Prosthetic mouth preparation is done to facilitate prosthetic treatment, (e.g. preparing rest seats etc). Preprosthetic mouth preparation is done along with diagnosis and treatment planning and has been explained in detail here. Prosthetic mouth preparation is done after partial denture design and has been explained in detail in Chapter 19. Preprosthetic mouth preparation procedures are carried out in the following order:

- Relief of pain and infection.
- Oral surgical procedures.
- Conditioning of abused and irritated tissues.
- Periodontal therapy.
- Correction of occlusal plane.
- Orthodontic correction.
- Splinting weakened teeth.
- Reshaping teeth.
- Preparation of rests and guiding planes.

Relief of Pain and Infection

Pain and infection should be treated during phase I of treatment. These conditions require immediate treatment to avoid the progression of the disease. The following conditions should be treated in this phase of mouth preparation:

- Potential emergency conditions like acute pain, abscess etc.
- Carious teeth with pain and discomfort.
- Asymptomatic teeth with deep carious lesions are excavated and filled with an intermediate restorative material.
- *Gingival diseases* like *ANUG, AHGS*, gingival abscess, etc.
- *Calculus* and *plaque* accumulations should be removed and preventive dental hygiene programs should be initiated and monitored.

Oral Surgical Procedures

- These procedures should be done atleast six weeks before impression making.
- They include extraction of teeth with poor prognosis, removal of residual roots, extraction of impacted and severely malposed teeth, etc.
- Radiographs should be taken to detect cysts, tumors, exostoses, tori, hyperplasias, etc. (Fig. 17.20).
- The muscle and frenal attachments should be examined.
- The ridges should be palpated for bony spicules and knife edged ridges, which must be removed or rounded.

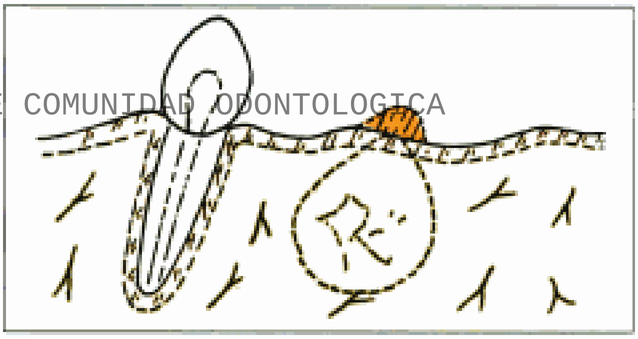


Fig. 17.20: Schematic representation of an interference produced by a cyst

- The soft tissues should be examined for pathological lesions.
- Dentofacial deformities like cleft lip, etc. which have to be corrected are treated in this phase.
- Ridge augmentation and vestibular extension procedures are done if required.

Conditioning of Abused and Irritated Tissues

Abused and irritated tissues should be treated before primary impression making because the tissue contour may change according to tissue healing. The patient should be treated for the following symptoms:

- Inflammation and irritation of the soft tissues in the denture bearing areas.
- Distortion of the normal anatomical structures like incisive papillae, rugae and the retromolar pads.
- Burning sensation in the residual ridge, tongue, cheeks and lips.

Ill-fitting dentures, nutritional deficiencies, diabetes, blood dyscrasias, etc. can produce the above-mentioned symptoms. If the symptoms are due to an ill-fitting denture, the patient should be advised to stop wearing the denture till the completion of tissue healing. Tissue conditioners may be given to provide a cushioning effect on the tissues.

A home care program, which includes a saline mouth rinse thrice a day, soft tissue massage, multivitamin tablets along with a high protein, low carbohydrate diet should be carried out.

Periodontal Therapy

It is usually performed along with the oral surgical procedures. It includes the procedures done to restore the mouth to a healthy state so that the prosthesis can function successfully. The objective of periodontal therapy is to regain the health of the periodontium of the existing teeth and maintain it. The criteria to be fulfilled for satisfying the objective of the periodontal therapy are as follows:

- Removal of the etiological factors causing periodontal disease. This includes oral prophylaxis wherein the calculi around the teeth are removed. Other procedures like root planing and curettage are done to improve the gingival health. Local irritants like overhanging restorations, food impactions should be removed.
- Elimination of periodontal pockets and gingival inflammation using flap surgery.
- Creation of normal alveolar architecture. This is done by bone resection or reconstruction.
- Establishment of functional occlusion with the help of coronoplasty.
- Oral hygiene instructions and maintenance therapy.

All these procedures should be done before primary impression making.

Correction of Occlusal Plane

The occlusal plane in partially edentulous patients is usually uneven. This is due to supra-eruption of the teeth opposing the edentulous space, mesial migration and tipping of the teeth adjacent to the edentulous spaces.

Common Problems Faced During Treatment Planning

- Supra-erupted maxillary molars bring down the tuberosity along with them. In these cases it is difficult to establish a flat occlusal plane. Hence, surgery may be required to remove the bony prominence. Frequently, surgical intervention is hampered due to the extension of the maxillary air sinus into the tuberosity. In these cases, the partial denture should be designed such that it does not extend across the areas of interference (17.21).
- Supra-erupted teeth should be reduced to re-establish an occlusal plane. If there is excessive supra-eruption, extraction or overdenture preparation is preferred (Fig. 17.22).

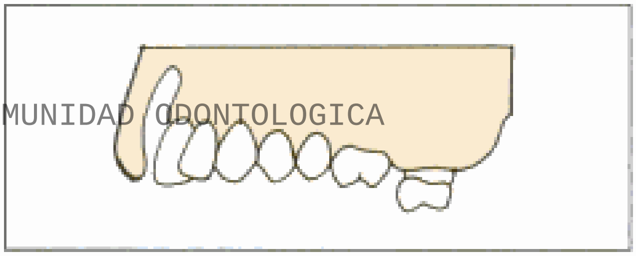


Fig. 17.21: Supraeruption of maxillary molar may bring the maxillary tuberosity down along with it

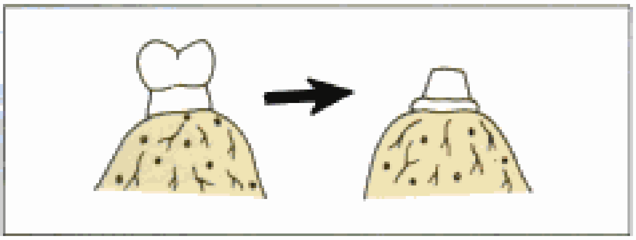


Fig. 17.22: An excessively supra-erupted tooth can be converted into an overdenture abutment

- Orthodontic treatment of submerged teeth is done.
- Mesially tipped teeth can be orthodontically uprighted or prepared to fabricate an onlay that suits the occlusal plane.

Methods of Correcting Undesirable Occlusal Plane

Enameloplasty (Fig. 17.23)

It is defined as the procedure of re-contouring a portion of the enamel to obtain a desired morphology. A **brief** outline of the procedure is given below:

- A tapered diamond cylinder stone in a high-speed handpiece with air-water spray is used for this procedure.
- Usually the procedure is confined to the enamel except in older patients where sufficient secondary dentin is present.
- In cases with buccally tilted and extruded maxillary molars, the palatal cusps will lie below the occlusal plane. In these cases reduction of palatal cusps alone will provide relief from occlusal interference.
- The occlusal anatomy should be preserved while reducing the cusp heights.
- Accessory grooves and sluiceways and functional cusps should be restored after reduction.
- The reduced enamel must be polished using carborundum containing rubber wheels or points.
- Fluoride application is done after the procedure, using soft plastic mouth guards.

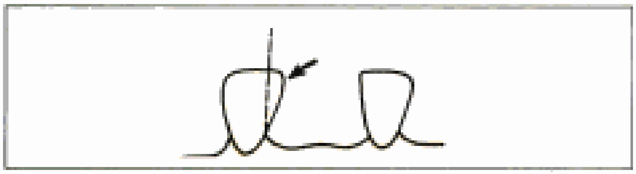


Fig. 17.23a: Enameloplasty of the incisors may be required to eliminate interferences to the prosthesis

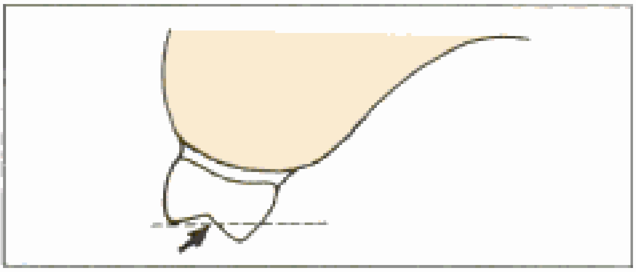


Fig. 17.23b: Reduction of the palatal cusps of buccally everted maxillary molars may be required to establish the occlusal plane

Onlay

An onlay is defined as a restoration, which covers more than two cusps of a tooth. Before placement of an onlay, the tooth should be reduced sufficiently so that the occlusal plane can be re-established by the onlay (Fig. 17.24).

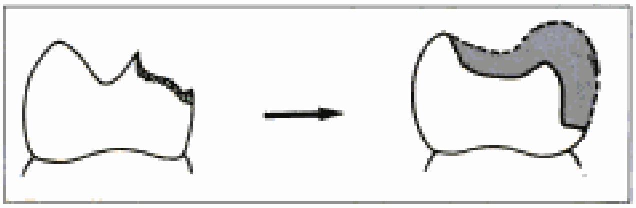


Fig. 17.24: Onlay

Teeth to be covered by an onlay should be free of pits and fissures. If present, they should be eliminated. Onlays are usually prepared using chrome alloy or gold.

If a tooth bearing an onlay is to be used as a primary abutment, the retentive tip of the retentive arm of the clasp should not engage the undercut of the onlay but should engage the undercut of the enamel (Fig. 17.25). If this design is not possible, a full veneer crown is prepared instead

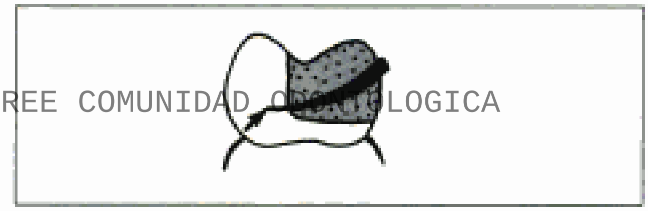


Fig. 17.25: The tip of the retentive arm should only engage the undercut on sound tooh and **never** on the onlay

of an onlay. Sometimes, the onlay can be modified to act as a retainer (Onlay clasp).

Indications

- Supra-erupted teeth.
- Severely attrited teeth.
- Teeth with inadequate crown height.
- Grossly decayed abutment teeth.

Advantages

- Minimal tooth preparation is required, compared to that of a full veneer crown.
- Only occlusal reduction is done. Hence, the natural contours of facial and lingual tooth surfaces can be maintained.

Disadvantages

- Unaesthetic due to metal display.
- Less retentive.
- A chrome alloy onlay will produce attrition of the opposing tooth. To prevent this, acrylic resin is used to cover the occlusal surface of the chrome alloy onlay. This will reduce the wear of the opposing tooth, but it should be remembered that acrylic by itself has poor wear resistance. The acrylic is retained to the metal by means of retentive metal beads on the onlay surface.

Crowns

A full veneer crown is given in cases, which require a change in the occlusal plane along with the following requirements:

- Additional change in the height of contour.
- Additional retentive undercuts.
- Additional guiding planes.

The diagnostic cast is mounted on a surveyor and the amount of tooth reduction necessary is measured. The clinician has to decide if the tooth should be endodontically treated or not, prior to tooth preparation.

Endodontic Treatment with Crown or Coping

Sometimes it is essential to retain some teeth in the arch that are vital to the design of a removable partial denture. Examples:

- Retaining a 2nd or 3rd molar is useful to provide support to the denture and prevent it from becoming a distal extension condition (Fig. 17.26a).

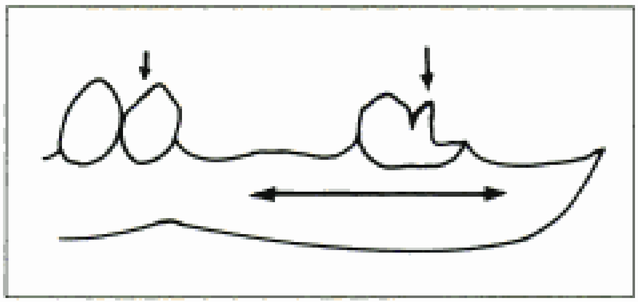


Fig. 17.26a: Saving a mutilated posterior tooth can aid to prevent the formation of distal extension denture bases which have poor prognosis

- Retaining a tooth in the centre of a long anterior edentulous span helps to improve the stability, retention and ultimately the success of the denture (Fig. 17.26b).

These teeth can be used as an abutment to prevent vertical displacement of the denture base. They are usually supra-erupted. If the tooth is supra-erupted and a sufficient interarch space is present, a crown can be prepared without endodontic treatment.

But if the tooth is supra-erupted and the interarch space is reduced, the tooth is treated endo-

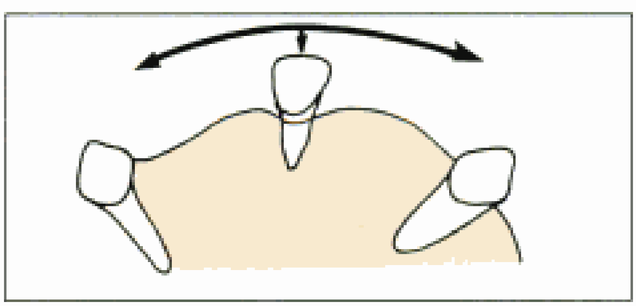


Fig. 17.26b: Retaining intermediary teeth can aid to prevent the formation of long span edentulous spaces

dontically, the clinical crown is reduced to about 2 to 3 mm above the proximal gingival margin and a coping is constructed over it (Fig. 17.27). This coping protects the overdenture abutment and at the same time helps to prevent excessive vertical movement of the denture base.

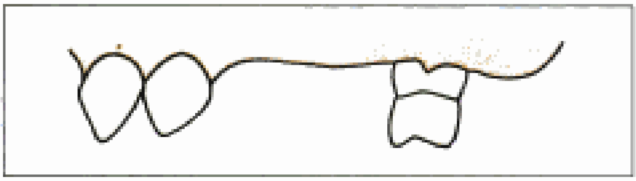


Fig. 17.27: Supraerupted molars can be converted into overdenture abutments to establish the occlusal plane

Extraction

It is indicated for the following cases:
- Where certain teeth can complicate/compromise the success of treatment.
- Orthodontic treatment cannot correct malalignment.
- When teeth interfere with the placement of a major connector.

Surgery

Surgical re-positioning of the jaws or their segments is done to correct malalignment of teeth. They include:
- Vertical osteotomy of the mandible to correct mandibular prognathism.
- Repositioning of the entire maxilla.
- Maxillary segmental osteotomy is done for superior repositioning of the maxilla to increase the inter-arch space.

Correction of Malalignment

Malaligned teeth should be rectified prior to treatment. Malalignment produces the following challenges to treatment:
- Poor oral hygiene.
- Inadequate access. Especially access to the proximal surface of crowded teeth.
- Difficulty in establishing guide planes.
- Difficulty in determining a unique path of insertion.

Orthodontic Realignment

- It is the treatment of choice for the correction of malalignment.
- It is not possible in cases with inadequate anchorage.

Enameloplasty

As described before, this method should be given primary consideration. It helps to correct minor difference in the alignment of the teeth. But the amount of correction obtained is limited.

Facial and lingual surfaces of the teeth can be reduced to accommodate seating of the major connector and allow better placement of clasps and lingual plates.

Crowns

- Full veneer or partial veneer crowns can be used to modify the axial inclination.
- They are commonly used for buccally or lingually tipped teeth.
- Grossly destructed teeth can be endodontically treated, and restored with a post core and crown.
- The crown should not be excessively inclined away from the long axis of the tooth to avoid action of deleterious forces. In other words, they cannot be used to correct severe malalignment.

Provision of Support for Weakened Teeth

Some teeth are bound to have reduced alveolar bone support in a partially edentulous condition. Additional support for these teeth is obtained by
- Removable splinting.
- Fixed splinting.
- Overdenture abutments.

Removable Splinting

Splinting of abutments is defined as *"The joining of two or more teeth into a rigid unit by means of fixed restorations"*-GPT.

A *Splint* is defined as *"a prosthesis which maintains a hard and/or soft tissue in a predetermined position"*-GPT.
- Splinting can be removable or fixed. It may be made of rigid (wood, metal, plaster) or flexible (fabrics, or adhesive tape) materials. It is used

to protect, immobilize, support, brace or restrict motion in a part.

- Removable splinting will either decrease the mobility or atleast prevent the increase in mobility of the teeth.
- Splinting helps to retain the teeth and maintain the continuity of the arch, as extraction can lead to the incorporation of additional modification spaces into the design of the RPD.

Fixed Splinting

It has better prognosis than a removable splint, as the patient's cooperation is not needed for the success of treatment.

Indications

For teeth that do not provide adequate amount of support for the RPD.

Contra-indications

Splinting with a strong tooth should not be done for the following conditions, as it may weaken the strong tooth.

- Teeth with more than 50 percent loss of bone support.
- Teeth with less than 1:1 crown root ratio.
- Splinting is avoided in cases where the teeth cannot be immobilized.

Procedure

- Two adjacent teeth are splinted together by soldering full crown or partial coverage crowns.
- Pin retained restorations can also be used for splinting.
- Splinting can provide anteroposterior stabilization but not lateral or buccolingual stabilization.
- For lateral stabilization, the splinting should extend till the canine to involve the turn of the arch. This turn in the arch will provide lateral as well as anteroposterior stabilization.
- The major connectors of partial dentures also help to provide lateral stabilization for the splinted teeth.

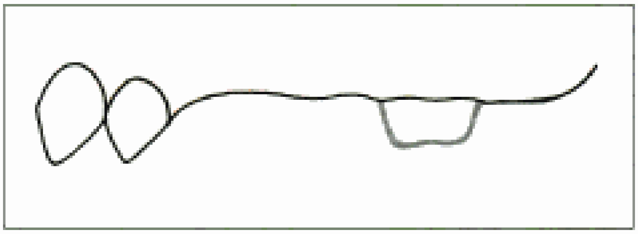


Fig. 17.28: Overdenture abutment with a protective coping

Overdenture Abutments

A crucially positioned tooth which has lost more than 50 percent of bone support can be converted into an overdenture abutment. This will help in preventing tissueward displacement of the denture.

For example, a periodontally weakened tooth distal to an edentulous space should be converted into an overdenture abutment instead of extraction to avoid the formation of a distal extension case because a Class III case has a better denture performance and patient acceptance. Metal copings are provided over the overdenture abutment for additional protection (Fig. 17.28).

MAKING THE PRIMARY CAST

After completing all the preprosthetic procedures, the RPD is designed. A primary cast is required to design the RPD. If the patient does not require any preprosthetic procedures, the diagnostic cast is directly used as the primary cast to design the RPD.

The primary cast is poured from a primary impression. Primary impression is made using alginate and the primary cast is poured using dental plaster. The primary impression should be made atleast six weeks after the completion of any surgical preprosthetic procedure. This time period is to ensure complete healing of the surgical wounds.

The procedure and technique used to make and pour an impression are similar to the one described for a diagnostic impression.

Chapter 18
Removable Partial Denture Design

- **Surveying**
- **Determining the Path of Insertion and Guiding Planes**
- **Designing the Component Parts of a RPD**
- **Principles of a Removable Partial Denture**
- **Principles of Design/ or Philosophy of Design**
- **Essentials of Design**
- **Laboratory Design Procedure**

18

Removable Partial Denture Design

Denture design is defined as "*A planned visualization of the form and extent of a dental prosthesis arrived at after a study of all factors involved*" - GPT.

Designing a removable partial denture comes under phase III of treatment planning. After completing phase II (preprosthetic mouth preparation) a primary cast is made and the RPD is designed using this cast.

Designing a RPD includes determining the path of insertion of the denture and also the location, position and type of components to be used in the prosthesis. A RPD is designed using an instrument known as surveyor. As the name suggests, this instrument surveys or studies the contours and morphology of the supporting tissues replicated on a cast.

The primary cast is mounted on a surveyor and surveyed. According to the contours of the tissues in the cast, the RPD is designed. The determined design of the prosthesis is outlined on the primary cast. A thorough knowledge about surveying is essential for one to understand the designing procedure of a removable partial denture.

SURVEYING

It is the first step in the design of a RPD. The term 'survey' is defined as a procedure done, "*To examine as to condition, value, or situation; to appraise*" or "*To determine the form and position of a given entity by means of taking linear and angular measurements*" or "*To inspect or scrutinize*" or "*The procedure of locating or delineating the contour and position of the abutment teeth and associated structures before designing a removable partial denture*"—GPT-1. The fourth definition is the most relevant one to this topic.

Surveying is defined as, "*An analysis and comparison of the prominence of intraoral contours associated with the fabrication of a prosthesis*" - GPT.

As mentioned before, surveying is done using a surveyor. Before we go into the surveying procedure, let us read about the surveyor.

Surveyor

A surveyor is defined as "*An instrument used in the construction of a removable partial denture to locate and delineate the contours and relative positions of abutment teeth and associated structures*" -GPT.

The surveyor is a parallelometer; an instrument used to determine the relative parallelism of surfaces of teeth or other areas on a cast. Dr. A.J. Fortunati (1918) was the first person to use a surveyor.

Objectives of Surveying

- To design a RPD such that it's rigid and flexible components are appropriately positioned to obtain good retention and bracing.
- To determine the path of insertion of a prosthesis such that there is no interference to insertion along this path.
- To mark the height of contour of the area (hard or soft tissues) above the undercut.
- To mark the survey lines. (height of contour of a tooth)
- To mark the undesirable undercuts into which the prosthesis should not extend.

Types of Surveyors

The surveyors commonly used are:
- Ney surveyor (widely used).
- Jelenko or Will's surveyor.
- Willam's surveyor.

The structure of these surveyors is basically similar with mild differences from one another. Generally, the William's surveyor is more flexible.

Parts of a Surveyor (Fig. 18.1a)

Surveying platform It is a metal plate parallel to the floor where a cast holder can be placed. It forms the base of the surveyor onto which all the other components are attached and supported (Fig. 18.1b).

1. Cast holder or surveying table
2. Vertical arm
3. Horizontal arm
4. Surveying arm
5. Surveying tools

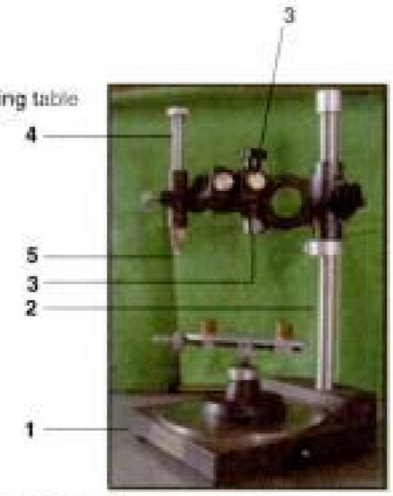


Fig. 18.1a: Parts of a surveyor

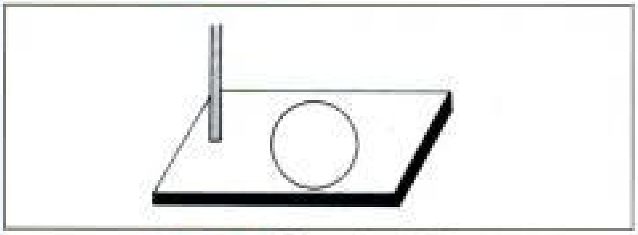


Fig. 18.1b: Surveying platform

Cast holder/surveying table It is a stand **placed** over the surveying platform. This stand has a *base* and a *table* to place a cast. The cast can be locked in any position on the table with the help of a locking device. The table is attached to the base with the help of a ball and socket joint. This joint facilitates to tilt the table.

The joint also helps to tilt/position and lock the surveying table in any required position. If there is a mild soft tissue undercut, the cast can be tilted to expose the undercut. The height of the surveying table can also be altered (Fig. 18.2).

The surveying table should not be tilted more than 10° because with the increase in tilt, the path of insertion of the denture will also change, ultimately requiring excessive mouth opening during insertion. (If a change in path of insertion is planned, the clinician should prepare the rest seats and guiding planes accordingly).

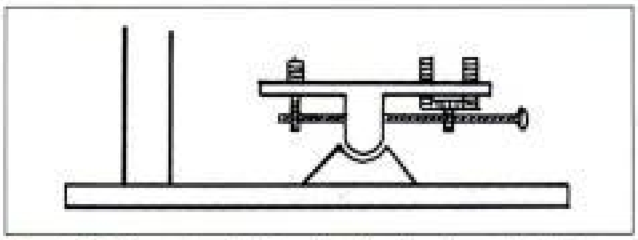


Fig. 18.2: Surveying table with a ball and socket joint and cast positioning screws. When tighined, the screws aid to lock the cast to the table. The ball and socket joint aids to tilt the platform

Vertical arm It arises vertically from the surveying platform. It supports the superstructure (horizontal arm and the surveying arm) (Fig. 18.3).

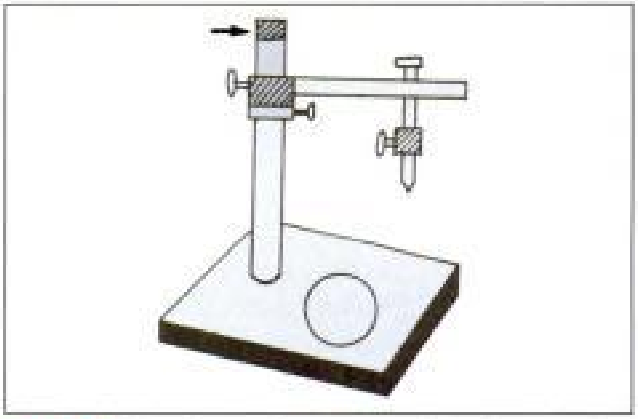


Fig. 18.3: Vertical supporting arm attached to the surveying platform. In some surveyors, the open end of the vertical arm contains a small chamber to store the surveying tools (arrow)

Horizontal arm It extends horizontally from the top of the vertical arm. It is designed to support the surveying arm at its free end. It is fixed in the Ney surveyor, whereas it can be revolved horizontally in a Jelenko surveyor (Fig. 18.4). Dr Nobel Wills introduced this feature.

Williams surveyors on the other hand had a revolving horizontal arm with a joint in the middle (Fig. 18.1a). These surveyors also had a Spring-mounted surveying arm that could be locked at any position. They have a gimbal stage table and are used to place precision attachments

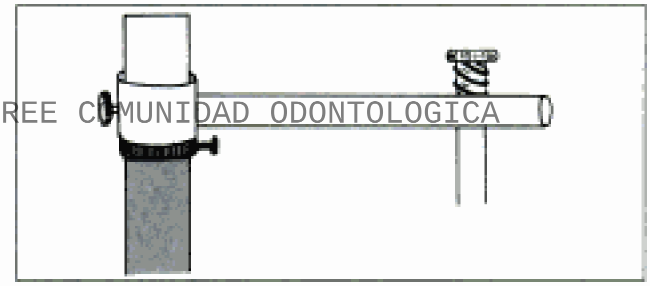


Fig. 18.4: Horizontal arm. It is fixed in a Ney surveyor whereas it revolves around the vertical arm in a Will's surveyor

Surveying arm It extends vertically from the free end of the horizontal arm. It is parallel to the vertical arm. It can move upward and downward. The lower end of this arm has a mandrel into which, tools used for surveying can be locked in. In the Jelenko surveyor the surveying arm is spring loaded. In the Ney surveyor the surveying arm is positioned by a locking device (Fig. 18.5).

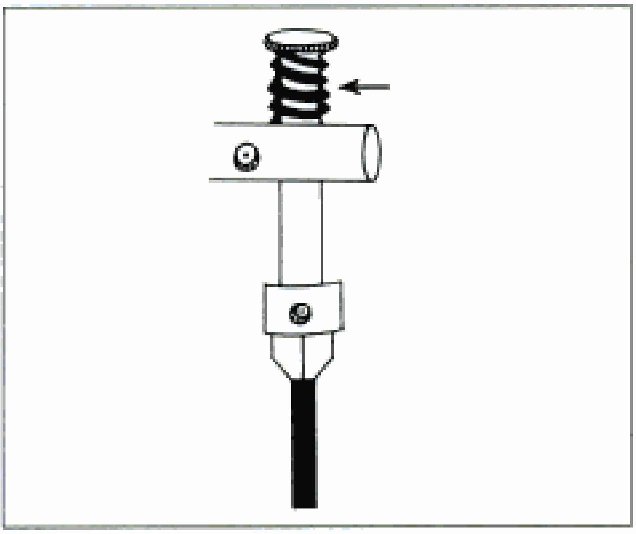


Fig. 18.5: Spring loaded surveying arm of a Will's surveyor

Surveying tools These are tools attached to the mandrel of the surveying arm and are used for surveying. They are of different types, e.g. analyzing rod, carbon marker, wax knife and undercut gauges.

Analyzing rod It acts like a tangent to the convex surface of the object being surveyed. It is more of a diagnostic survey tool. It helps to analyze the location of the height of contours, the presence and absence of favorable and unfavorable undercuts for a particular path of insertion (Fig. 18.6).

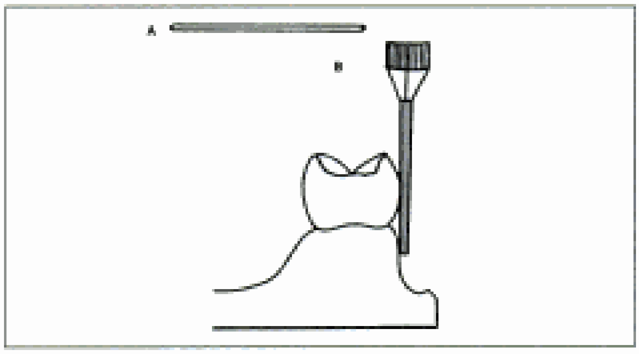


Fig. 18.6: Using an analyzing rod to analyse a cast

It is a solid cylindrical metal rod. It is the first tool to be used during surveying. It is used to determine the parallelism of the tooth surfaces before marking the survey line (discussed later). It also helps to arbitrarly determine the path of insertion.

Carbon markers They resemble the lead points commercially available for the micro-tip pencils. They are circular in cross-section in Ney Surveyors, and triangular in cross-section in Jelenko surveyors. When placed on the mandrel of the surveying arm, they can be used to draw the height of contour of the object being surveyed. Generally, they are used to draw survey lines, which denote the height of contour of the teeth (Fig. 18.7a).

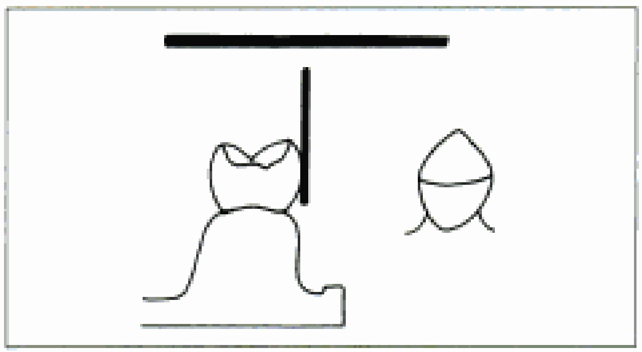


Fig. 18.7a: Marking or scribing the height of contour using a carbon marker

After analyzing the teeth with an analyzing rod, it is replaced with a carbon marker. Hence, the carbon marker will have the same relationship as the analyzing rod with the object being surveyed. After replacing the analyzing rod, the cast mounted on the surveyor is rotated against the carbon marker. This will produce a line along the most convex area of the object being surveyed (E.g. teeth). The resultant line formed by the carbon marker is known as a *survey line*.These survey lines help us in positioning the various component parts of a removable partial denture.

Undercut gauges: A gauge is a high precision instrument used to measure the linear dimension of any structure. Undercut gauges are used to measure the depth and location of the undercuts on the analyzed tooth in three dimensions. Stewart states the availability of undercut gauges in three standard sizes namely, 0.010 inch, 0.015 inch, and 0.020 inch. Mc Cracken states the availability of undercut gauges at 0.010, 0.020 and 0.030 inch. All these gauges have the same shank only the size of the tip or bead varies (Fig. 18.7b). The gauges are of standard sizes and the area of the tooth that matches the gauge is chosen as the undercut.

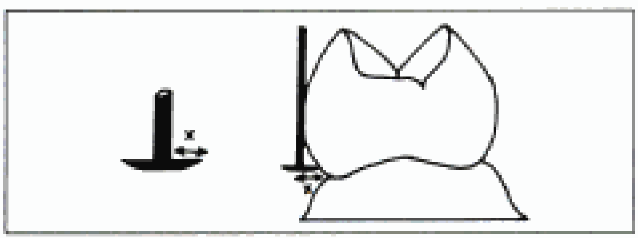


Fig. 18.7b: A Surveying undercut gauge. The distance between the periphery of the bead and the stem of the gauge gives the value of the undercut

Ney Surveyors have a circular beaded undercut gauge whereas Jelenko Surveyors, have a fan shaped bead with each wing of the fan measuring different dimensions (Fig. 18.7c).

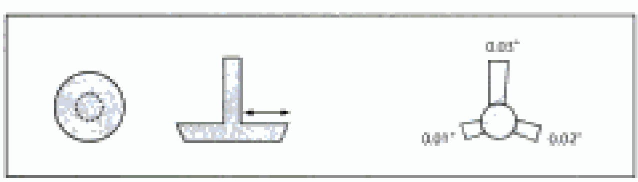


Fig. 18.7c: Ney undercut gauge (available in different sizes). Jelenko undercut gauge (single gauge can be used to locate undercuts of different sizes)

Wax knife: They can be attached to the mandrel of the surveying arm. They are used to directly trim the excess wax while surveying the wax patterns and also to eliminate and block out undesirable undercuts parallel to the path of insertion (Fig. 18.8).

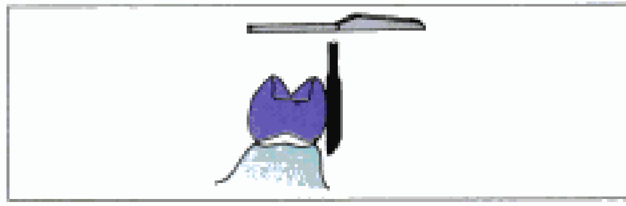
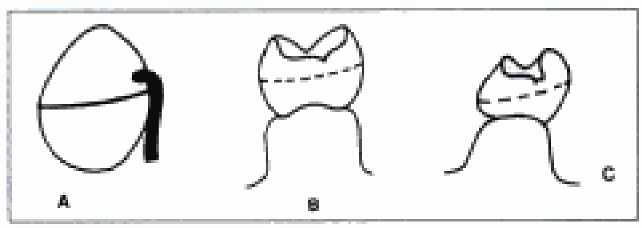


Fig. 18.8: Surveying wax knife used to contour wax patterns

Survey Lines

Survey lines are nothing but the height of contour of the abutment teeth marked by a carbon marker during surveying. A survey line is defined as "*A line drawn on a tooth or teeth of a cast by means of a surveyor for the purpose of determining the positions of the various parts of a clasp or clasps*"- GPT (Fig. 18.9).



Figs 18.9a to c: (a) Survey line, (b and c) Height of contour. It can vary according to the axial morphology of the tooth

A survey line can also be defined as "*A line produced on a cast of a tooth by a surveyor or scriber marking the greatest height of contour in relation to the chosen path of insertion of a planned restoration*"- GPT.

(Scribe: *to write, trace, or mark by making a line or lines with a pointed instrument* –GPT.)

The survey line marks the height of contour of the tooth. The height of contour is defined as "*A line encircling a tooth designating it's greatest circumference at a selected position*" - GPT (Fig. 18.9).

Blatterfein divided the buccal and lingual surfaces of the tooth adjacent to the edentulous space into two halves by a line passing through the center of these surfaces along the vertical axis of tooth.

The area closer to the edentulous space is known as *near zone* and the other, which lies away from the edentulous space, is called *far zone*

(Fig. 18.10). The proximal surface of the teeth can also be described in the same manner i.e. the proximal surface near the edentulous space is the near zone and the proximal surface away from the edentulous space is the far zone.

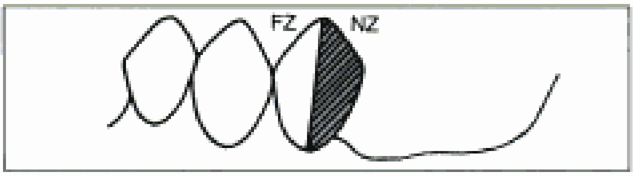


Fig. 18.10: Blatterfein's near (Nz) and far (Fz) zones

Survey lines can be classified as:

- High survey line
- Medium survey line
- Low survey line
- Diagonal survey line.

High survey line High survey line passes from the occlusal third in the near zone to the occlusal third in the far zone. When a high survey line is present, the undercut will be deep and hence a wrought wire clasp which is more flexible should be used (Fig. 18.11).

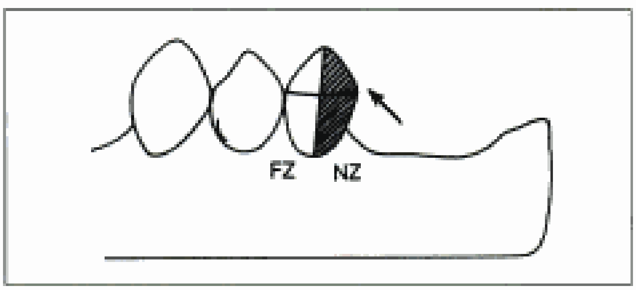


Fig. 18.11: A high survey line extending from the occlusal third of a near zone to the occlusal third of the far zone

It is commonly found in inclined teeth and in teeth with a larger occlusal diameter compared to its diameter at the cemento-enamel junction.

Medium survey line It passes from the occlusal third in the near zone to the middle third in the far zone. Either Aker's or Roach clasp is used for teeth with a medium survey line. Aker's clasp is preferable (Fig. 18.12). During survey, the cast should be tilted such that maximum number of teeth have a medium survey line.

Low survey line This survey line is closer to the cervical third of the tooth in both near and far

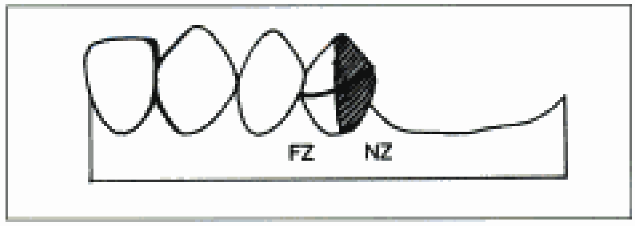


Fig. 18.12: Medium survey line extending from the occlusal third of a near zone to the middle third of the far zone

zone. A modified T-clasp is used for teeth with low survey lines (Fig. 18.13).

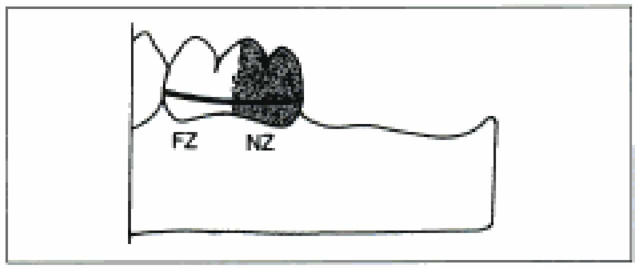


Fig. 18.13: A low survey line arising from the gingival third of the near zone to the gingival third of the far zone

It is common in teeth with marked inclination, when it is associated with a high survey line on the opposite side. The retentive clasp tip cannot be placed in such cases, because the undercut will be very close to the gingiva and difficult to maintain oral hygiene. In such cases one of the following designs can be followed.

- A bracing or reciprocal arm is placed along the low survey line and a retentive wrought wire clasp is placed to engage the undercut on the opposite side.
- Extended clasp can be used.
- Re-contouring the tooth with a crown can be done.
- A proximal undercut can be used for retention.

Diagonal survey line This survey line runs from the occlusal third of the near zone to the cervical third of the far zone. Here, a reverse circlet clasp is used (Fig. 18.14)

It is more common on the buccal surfaces of canines and premolars. It can be managed by using reverse action (hair pin) or ring type Aker's clasp (occlusally approaching), or L or T type roach clasp (gingivally approaching).

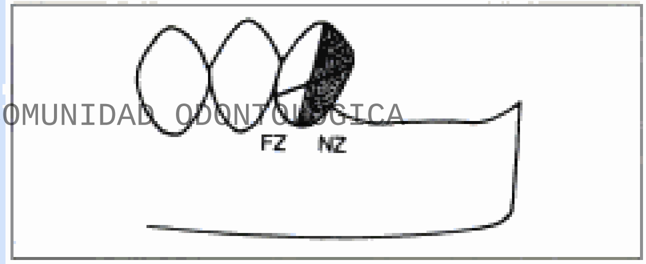


Fig. 18.14: A diagonal survey line arising from the occlusal third of the near zone to the gingival third of the far zone

Set Up for Surveying

Setup for surveying includes mounting the primary cast on a cast holder, locking it in position with "zero" degree tilt. The cast holder is placed on the surveying platform. After positioning the cast, the surveying arm is positioned in relation to the cast. the cast is analyzed after positioning the surveying arm.

Mounting the cast The primary cast should be mounted on the surveying table. The cast can be fixed tightly to the clamps on the surveying table. The cast should be mounted such that the occlusal surfaces of the remaining teeth are parallel to the base. (*The cast should never be tilted before analyzing*) (Fig. 18.15).

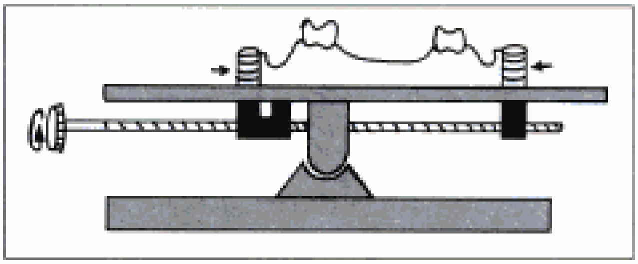


Fig. 18.15: After positioning the primary cast on the surveying table, it should be locked in place by tightening the screws

Positioning the surveying arm

- After mounting the cast, the horizontal arm is positioned in the surveyor. The horizontal arm should be vertically adjusted such that the surveying arm can contact atleast three different spaced out points on the cast (Fig. 18.16).
- Once the proper position of the horizontal arm is determined, it is locked to the vertical arm with the help of a thumbscrew. In Ney's surveyor the surveying arm should also be adjusted and locked such that it can contact atleast three different points on the cast from this plane. The horizontal arm cannot be vertically adjusted in a Ney's surveyor.

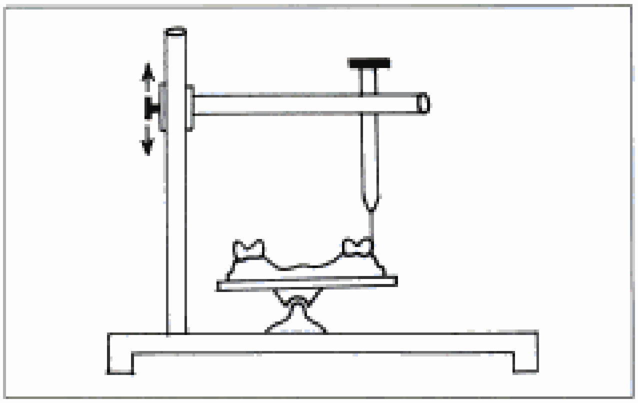


Fig. 18.16: The surveying arm is adjusted and locked in position such that the surveying tools extend upto the soft tissue undercuts in the cast

Analyzing the cast (Fig. 18.17a)

- The analysing rod is the first surveying tool that should be used during any survey procedure. It should be attached to mandrel of the surveying arm.
- The cast is rotated against the analyzing rod to analyse the presence of undercuts (favourable and unfavourable). At this stage, the operator will develop a mental picture about a design that would best suit the clinical condition. Favourable undercuts should be present on the abutment teeth to place the retentive components of a clasp. Unfavourable undercuts (soft tissue, bony undercuts) should be eliminated. If favourable undercuts are absent during analyzing, undercuts favourable to that path of insertion should be created. Favourable undercuts can be created by preparing crowns over the abutment teeth (the depression is prepared in the crown to act as an undercut), or by enameloplasty (the enamel is contoured using a bur-*dimpling*) or by slightly tilting the cast (not preferred- tilting the cast is done only to improve the placement of the non-retentive claps).
- Soft tissue undercuts revealed during analyzing should be removed. The removal of soft

tissue undercuts is done during preprosthetic mouth preparation (Fig. 18.17).

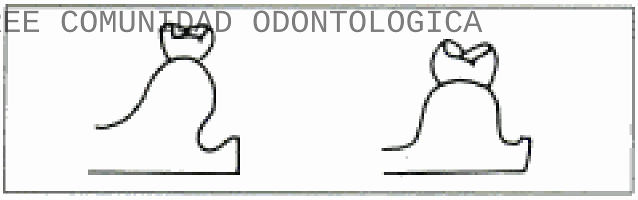


Fig. 18.17: A soft tissue undercut should be eliminated to avoid interference to the prosthesis

- If there is a deep unilateral soft tissue undercut, the cast can be tilted so that the prosthesis can be placed using a different path of insertion without interference. (*If the cast is tilted, path of insertion of the prosthesis is changed. For this path of insertion, patient may require a wide mouth opening during insertion.* (Fig. 18.18).

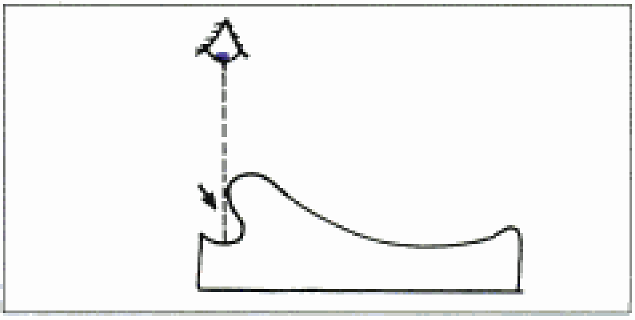


Fig. 18.18a: One should remember that any undercut is relative to the angle of view. Here we notice a soft tissue undercut when viewed vertically

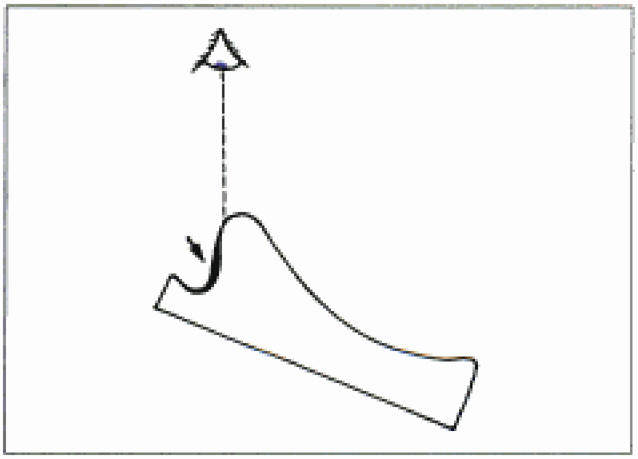


Fig. 18.18b: The same undercut is eliminated when viewed from a different angle. Hence, if we alter the path of insertion, hinderence due to unfavourable undercuts can be avoided. The same principle can be used to produce favourable undercut in order to obtain retention

- If the operator decides to tilt the cast, the surveying table is slowly tilted with the help of a thumbscrew till the undercut vanishes when viewed from above. The cast should not be tilted more than 10°. The angle of this tilt is the path of insertion. Determining the path of insertion and its significance has been discussed in detailed in the next section of this chapter.

  Survey set up is completed with analyzing the cast. After completing the set up for surveying, the cast is surveyed.

Uses of a Surveyor

1. Surveying the diagnostic and primary casts.
2. Tripoding the cast. (Recording the cast position).
3. Transferring the tripod marks to another cast.
4. Surveying the master cast.
5. Contouring crowns and cast restorations.
6. Placing internal attachments and rests.
7. Performing mouth preparation directly on the cast to determine the outcome of treatment.
8. Surveying the master cast.
9. Surveying ceramic veneers before final glazing.

1. Surveying the Diagnostic and Primary Cast

The diagnostic cast should be surveyed before treatment planning whereas, the primary cast is surveyed after completion of **preprosthetic mouth preparation**. Basically, the primary cast is surveyed to determine the required amount of **prosthetic mouth preparation**, design and mark the outline of the prosthesis (Note: *If the patient did not require any preprosthetic procedure, the diagnostic cast is directly used as the primary cast*)

Objectives of surveying the primary cast

- To determine the most accepted path of placement that has the least interference and the best aesthetics. *"Path of placement is the direction in which the restoration moves from the point of initial contact of its rigid parts with the supporting teeth to its terminal resting position, with rest seated and the denture base in contact with the tissues"*.
- To identify proximal tooth surfaces on which guiding planes can be prepared.

- To locate and measure the retentive areas in a tooth.
- To determine the soft tissue and/or bony interferences which are to be eliminated.

- To identify the height of contour.
- To identify undesirable undercuts that should be blocked out during casting.
- To record the cast position for future reference.
- To plan and determine the required mouth preparation procedures like preparing guiding planes, rest seats, etc.

Surveying the primary cast (or any cast) includes:

- Analyzing the cast
- Surveying the teeth
- Surveying the soft tissue contours on the cast.

Analyzing the cast

(Described under set up for surveying).

Surveying the teeth

The teeth are surveyed for the following reasons:

A. To determine the height of contour.
B. To determine the depth of the undercut.
C. To determine the location of undesirable undercuts.
D. To determine the parallelism of the abutments.
E. To determine the path of insertion of the denture.

A. Determining the height of contour Teeth are surveyed to determine their height of contour. Based on the height of contour, the clasp of a RPD is designed. The rigid components of the clasp should lie above the height of contour and the flexible parts of the clasp should be placed below the height of contour.

Hence, we understand that according to the height of contour, the design of the clasp will vary. The types of clasps and their indications are discussed in detail in the next section in the same chapter.

The height of contour is marked using the flat surface of a carbon marker attached to the mandrel of the surveying arm (Fig. 18.19a). This forms the survey line. If there is no height of contour and there is no undercut to place the flexible part of the clasp (Fig. 18.19b), in such cases a small depression (undercut) can be created to engage the flexible part of the clasp (dimpling - discussed later) (Fig. 18.19c). Another alternative is to re-contour the tooth with a crown (Fig. 18.19d).

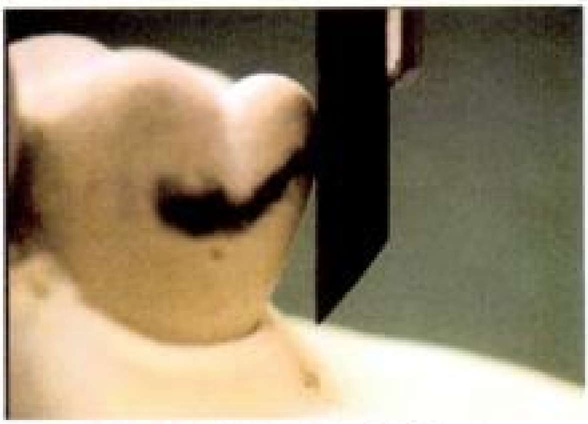
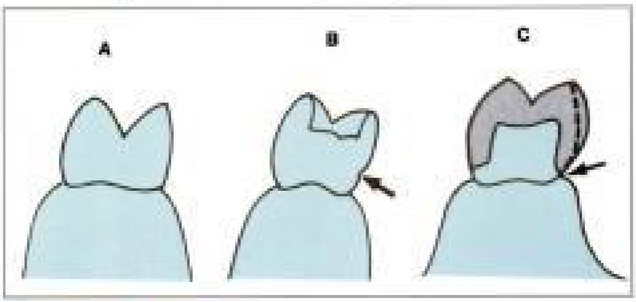


Fig. 18.19a: Marking the height of contour



Figs 18.19b to d: (b) A proximal surface without any undercuts (c) Dimpling to introduce a favourable undercut in the same (d) Recontouring the proximal surface using a crown to produce a favourable undercut

B. Determining the depth of the undercut This is done using undercut gauges (Fig. 18.20a). One should remember that the depth of the undercut is not always measured at the level of the gingival crevice, instead it is measued ast a level where the operator plans to place the retentive terminal of the retentive arm.

A more flexible material should be used to engage a deeper undercut. Hence, the alloy for the partial denture is chosen based on this measurement during this procedure.

C. Determining the location of undesirable undercuts Undesirable undercuts should be blocked out (filled) to avoid interference. Block out is done using wax or block out material. Usually block out is done in the master cast before

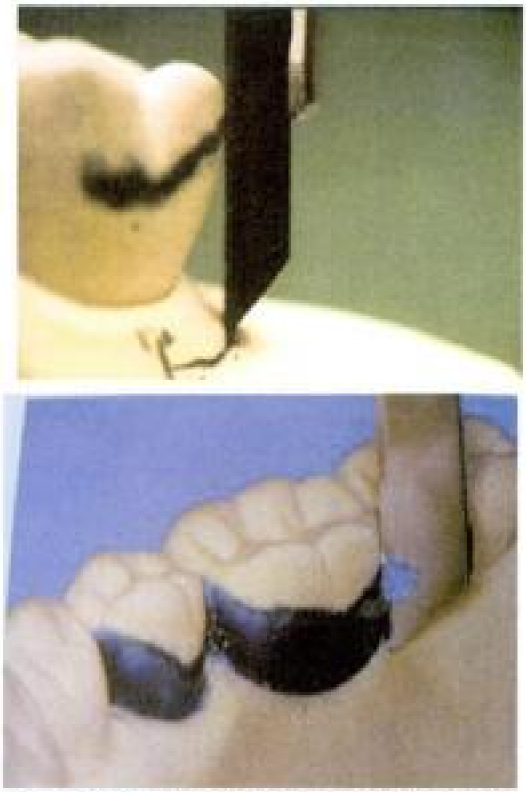
Fig. 18.20a: Determining the depth of the undercuts

duplicating it to form the refractory cast. The resulting refractory cast is used exclusively for casting the partial denture framework, and will not have all the undercuts that were blocked out in the master cast. Refer Chapter 21 for a detailed description of blockout.

Undesirable undercuts should be filled (blocked out) till the height of contour for that path of insertion (*height of contour will vary according to the path of insertion*). The excess blockout material is trimmed flush to the height of contour using a surveying wax knife (Fig. 18.20b).

D. Determining the parallelism of the abutment teeth: The parallelism of the abutment teeth to one another should also be determined. The path of insertion of a RPD is usually parallel to the long axis of the abutment teeth (Fig. 18.20c). Parallelism is essential for easy insertion and removal of the prosthesis. If it is absent, it should be established by contouring the enamel surfaces or by placing restorations on one or more teeth. The undesirable undercuts in the teeth should be identified and eliminated.

E. Determining the path of insertion of the denture: While surveying to check for the parallelism of the abutment teeth, the cast is tilted till the long axis of the abutment tooth is parallel to the vertical axis. This tilt gives the angle of path of insertion of the denture (Fig. 18.21). Tilting can be done in anterior, posterior, right or left directions. The established tilt should not exceed 10°. If the established tilt exceeds 10°, the designed RPD would require excessive mouth opening for insertion.



Figs 18.20b: Determining the area for blockout

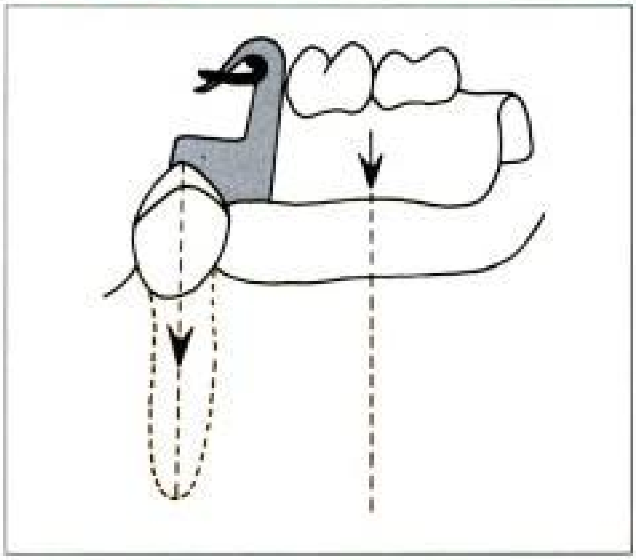


Fig. 18.20c: Vertically upright teeth serve as good abutments to transfer the masticatory forces from the denture to the supporting structures. They also produce least interference while inserting or removing a prosthesis

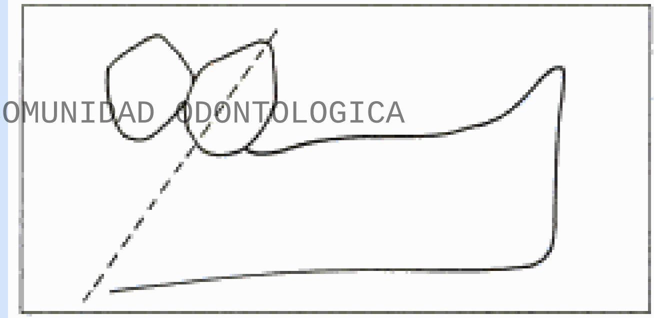


Fig. 18.21a: A distally tipped abutment will produce hinderance to a vertical path of insertion of the denture

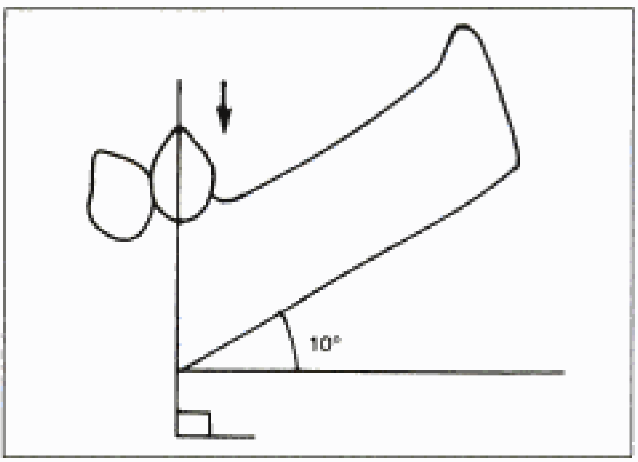


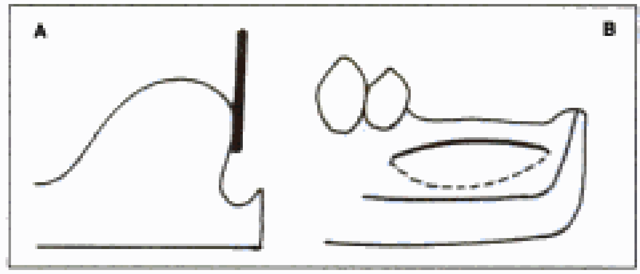
Fig. 18.21b: The interference produced by the tipped abutment can be eradicated by tilting the cast (i.e.) the cast should be tilted till the abutment teeth become vertical. Tilting the cast is essentially equivalent to opening the jaw to the same angle during insertion. Hence, it is bound to a physiological limit of 10°

Surveying the Soft Tissue Contour

Soft tissues to be covered by the prosthesis or the soft tissues that support the prosthesis should be surveyed for unfavourable undercuts (Fig. 18.22). If any form of surgery is needed to eliminate these undercuts, they are added to the treatment plan. Remember, surveying the diagnostic cast comes under the diagnostic phase of RPD treatment.

2. Tripoding the Primary Cast

The angle of path of insertion is maintained by maintaining the tilt determined for the primary cast. To achieve this degree of tilt for the master cast, tripoding the primary cast is done. If the path of insertion of the primary cast is not used for the master cast, all the prosthetic mouth preparation



Figs 18.22a and b: Scribing the cast at the height of contour of a soft tissue undercut

procedures (rest seat preparation, guide plane preparation dimpling, etc discussed later) done in relation to the path of insertion of the primary cast will become useless. Hence, it is very important for us to preserve the tilt of the primary cast. The orientation of the cast is recorded during surveying. Recording the spatial orientation of the cast is done by a procedure called *tripoding*.

Tripoding is a very simple procedure, wherein three different widely spaced out points **of a single plane** are marked on the cast (Fig. 18.23). These tripod points are reference points and should not be altered till the end of treatment.

The uses of tripoding include positioning the master cast and remounting the diagnostic casts (if needed later) on the surveying table.

Procedure

- Tripoding is done after surveying the primary cast
- The primary cast is mounted according to the determined tilt on the surveying table.

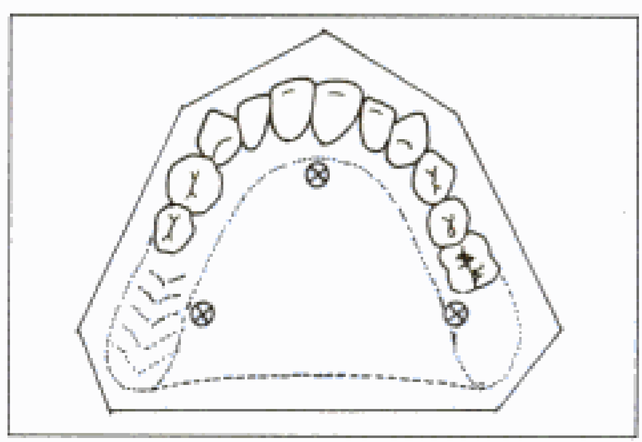


Fig. 18.23a: Tripoding the primary cast

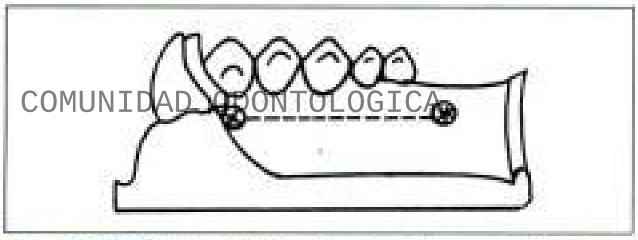


Fig. 18.23b: Notice that the tripod marks are at the same horizontal plane. Each tripod point can be accentuated by placing two intersecting lines about 4 mm length enclosed in a circle

- A carbon marker trimmed to an angle of 45° is fixed to the mandrel of the surveying arm.
- The height of the horizontal arm is adjusted such that the carbon marker touches the tissue lingual to the teeth on the cast.
- The horizontal arm is locked in that position.
- The surveying arm is moved freely. Since the horizontal arm is locked to the vertical arm, the tip of the carbon marker will lie in a single plane irrespective of the position to which the surveying arm is moved (Fig. 18.24).

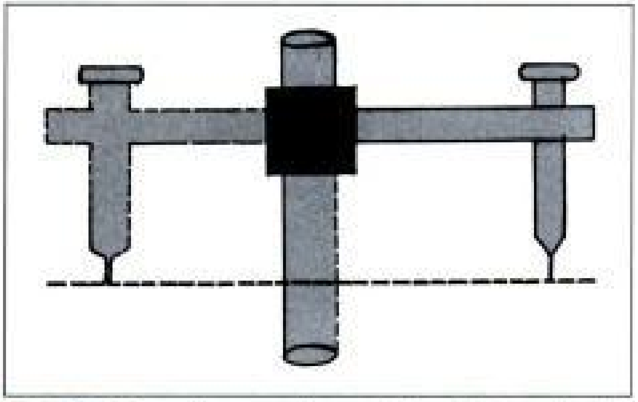


Fig. 18.24: Once the surveying arm is locked in position, its plane will not be altered when the horizontal arm is revolved

- As the surveying arm is moved, two additional points in the cast that come in contact with the carbon marker, are marked. Since carbon marker is in the same horizontal plane, all the three points marked using it will also lie in the same plane (Fig. 18.25).
- One technical consideration to be remembered is that the side and not the tip of the carbon marker should be used to mark the tripoding points. This is because if the tip is used, it may abrade and provide a faulty reading.
- As an alternative to tripoding, the orientation of the cast can also be recorded by scribing a vertical line on the base of the cast (Fig. 18.25b).

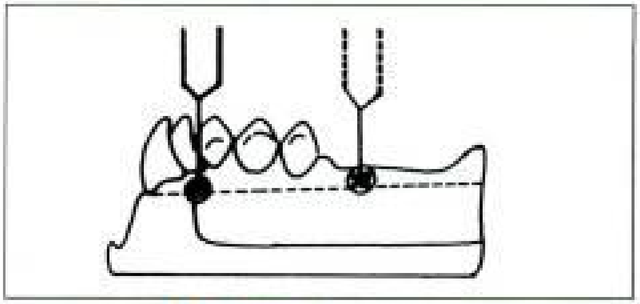


Fig. 18.25a: Tripoding a cast

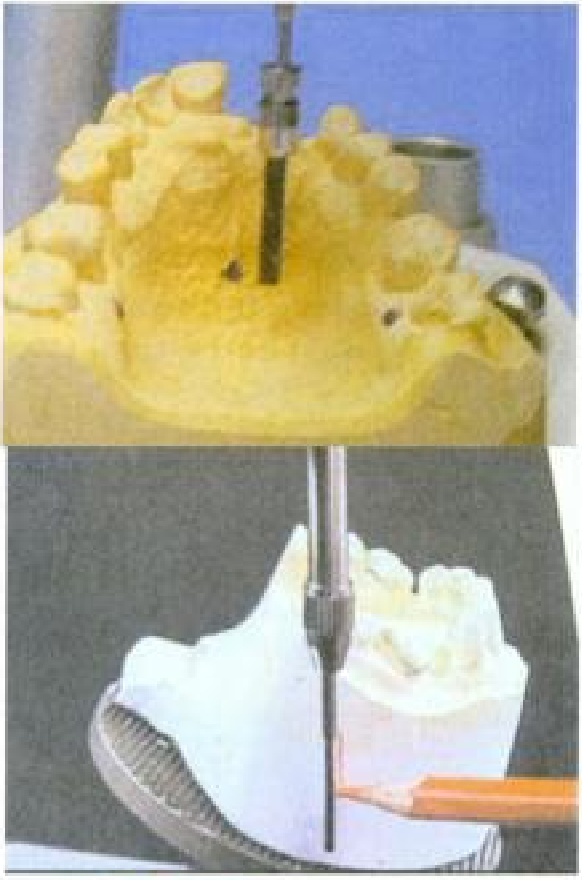


Fig. 18.25b: Tripoding the cast

3. Transferring the Tripod Marks

This procedure is done to orient the master cast using the same angulation of the primary cast.

After tripoding the primary cast, three additional reference points are marked on the cast using the same procedure described to mark the first three tripod marks. The commonly used additional reference points are:

- Distal marginal ridge of the first premolar.
- Incisal edge of lateral incisor.
- Lingual cusp tip of the first premolar on the opposite side (opposite to the side where the other two points were marked) (Fig. 18.26).

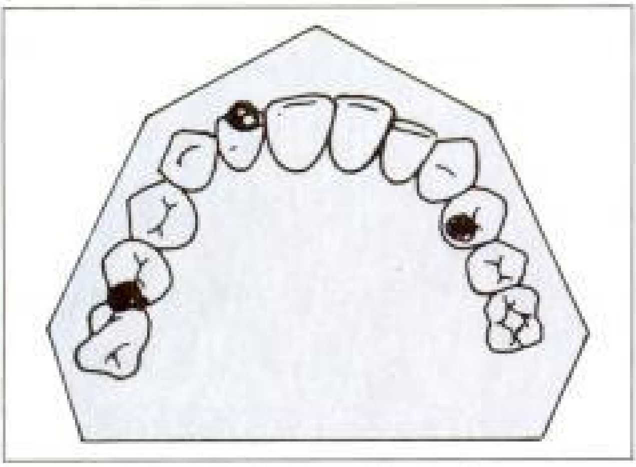


Fig. 18.26: Additional tripod points

After marking the reference points, the primary cast is removed and the master cast is placed on the surveying table. Since the additional reference points are located on distinctive anatomical landmarks, it is easy to locate them on the master cast.

The master cast is adjusted in the surveying table such that the carbon marker in the surveying arm contacts the additional reference points in the same manner as it did with the primary cast (Fig. 18.27).

4. Contouring Wax Patterns

A sharp instrument attached to the mandrel of the surveying arm can be used to contour the wax pattern (where necessary). If a cast restoration is to be prepared for an abutment tooth, the wax pattern on the cast should be mounted on the surveyor to check and modify it to obtain an ideal contour. Surveying wax knife (a surveying tool)

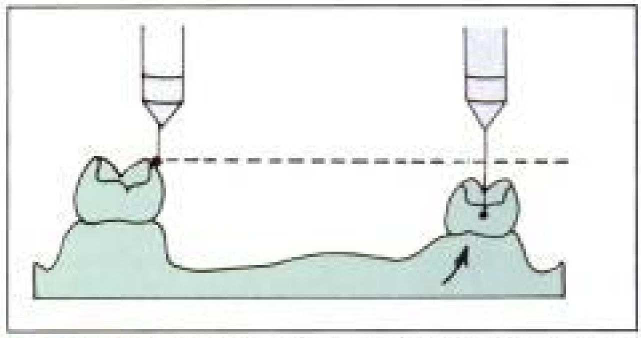


Fig. 18.27: The master cast should be repositioned and adjusted such that the areas where the tripod points were placed on the primary cast lie in the same plane. The surveying arm can be used as a guide to position the master cast

is mounted on the surveying arm to contour the wax pattern. *Guiding planes or guide planes* (proximal surface of the abutment tooth which contacts the body of the clasp during insertion and removal) on the wax pattern are prepared until they are parallel to the path of insertion (Fig. 18.28). The height of contour of the pattern may also be altered to facilitate proper positioning of the rigid and flexible parts of the clasp.

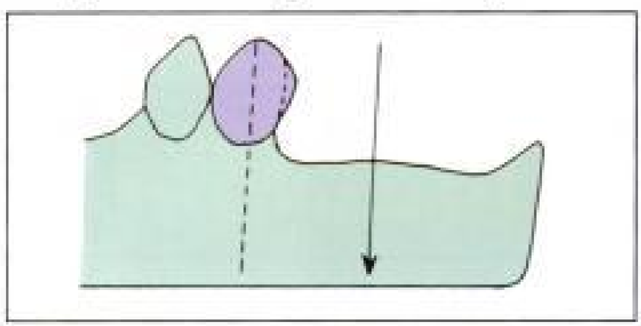


Fig. 18.28a: A wax pattern whose guiding planes should be recontoured parallel to the path of insertion (long arrow)

5. Contouring Crowns and Cast Restorations

Just as we contoured wax patterns using a sharp instrument like wax knife, crowns and cast restorations (metal) can be trimmed using rotary instruments attached to the surveyor. The working cast along with the restorations are placed on the surveyor at the established plane of orientation.

A handpiece holder is attached to the surveying arm. To this, a handpiece with a cylinder

Fig. 18.28b: Contouring wax patterns

stone is attached. The handpiece is switched on and the surveying arm with the functioning hand piece is moved slowly over the sides of the restoration to trim the excess crown material (Fig. 18.29). The material is reduced till the guide planes are parallel to the path of insertion and the height of contours of all the other surfaces of the crown or restoration are as desired.

While contouring a wax pattern for a cast restoration or a crown, care should be taken to contour them such that the favourable undercut (required to engage the clasp) should be created/ preserved. Both contouring the wax pattern and the cast restoration belong to Phase V of treatment planning.

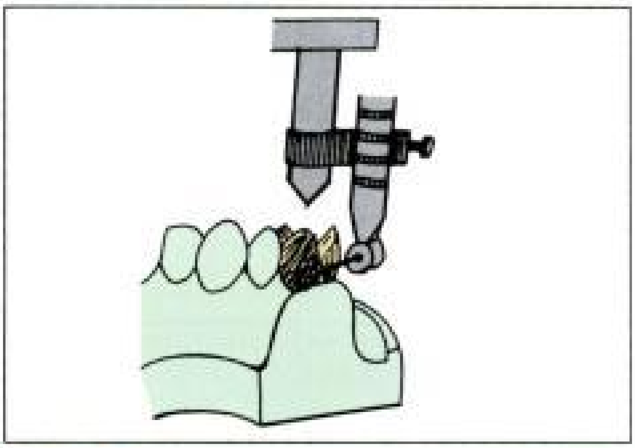


Fig. 18.29: Contouring the proximal surface of a cast restoration using a rotary instrument mounted on a surveyor

6. Placing Internal Attachments

Intracoronal retainers, occlusal rests can be created on wax patterns using a rotary handpiece (Fig. 18.30). They are later refined on the cast restorations. The intracoronal retainer is similar to a hook and a loop. The loop like structure is placed within the crown and the hook is attached to the prosthesis. During insertion, the hook gets locked into the loop to provide retention.

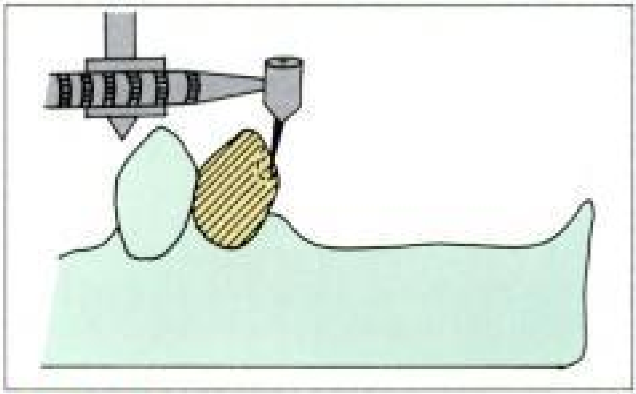


Fig. 18.30: Preparing receptacles to place the (usually) female component of an internal attachment

The basic principle on which an intracoronal retainer works is friction. The frictional resistance is produced by the parallelism of the male and female components of the retainer. This parallelism can be determined using a surveyor.

Procedure for placing an internal attachment:

- A path of insertion with least interference is determined.
- A receptacle to hold the keyway of the attachment is cut on the stone teeth of the cast. The extent of the recess is determined using radiological investigations.
- Next, a receptacle is carved in the wax pattern to receive the key of the internal attachment.
- Finally, the attachment is positioned with the receptacle with the help of a surveyor. All the attachments that belong to a single prosthesis should be parallel to one another.

7. Placing Internal Rest Seats

Internal rests are large box-shaped metallic extensions that function as intracoronal retainers.

They differ from internal attachments in that they are not pre-fabricated and the rest seat formed by the sound tooth structure functions as the key-way (Fig. 8.31a). (attachments use prefabricated metallic keyways).

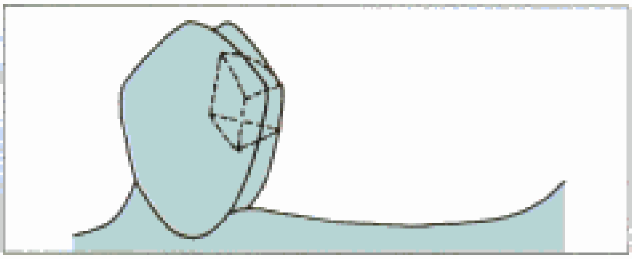


Fig. 18.31a: Internal rest seat

8. Surveying the Master Cast

The master cast is fabricated after prosthetic mouth preparation. It is surveyed to check whether the desired results have been obtained in mouth preparation. All the objectives for surveying the diagnostic cast hold good here too. Additionally, the following factors are checked during survey of the master cast:

Parallelism of the guiding plane It is measured using the paralleling tools like surveyor blade and diagnostic stylus (Fig. 18.31b). It is checked by tilting the cast laterally and antero-posteriorly.

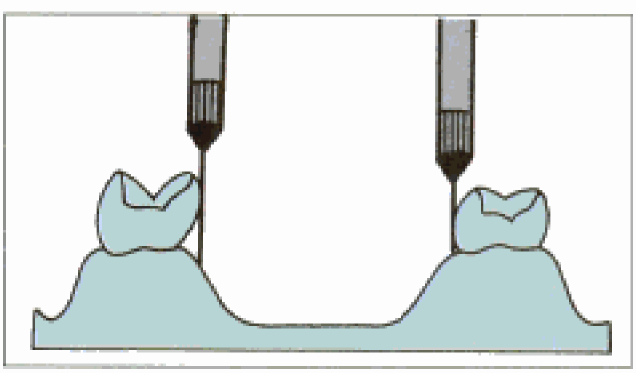


Fig. 18.31b: All guiding planes should be parallel to one another. This can be checked using a surveyor

Depth of undercuts and retention It is measured using undercut gauges mounted onto the surveying arm (Fig. 18.32).

Height of contour It is the widest circumference and is marked using a carbon marker (Figs 18.33 and 18.34).

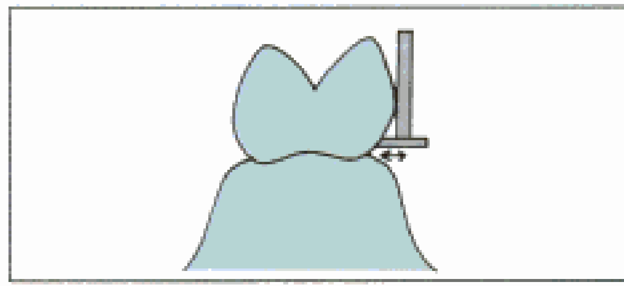


Fig. 18.32: Measuring the depth of the undercut to a particular path of insertion using an undercut gauge

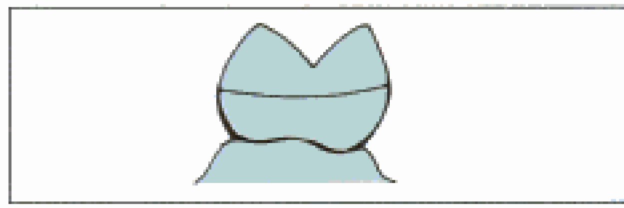


Fig. 18.33: Height of contour or survey line marked on the master cast

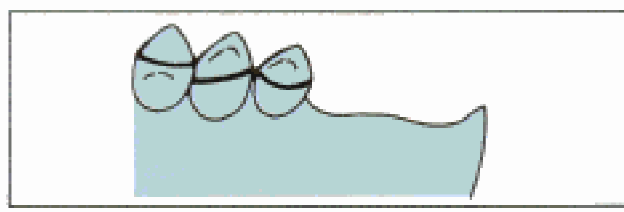


Fig. 18.34: The survey lines should be marked for each tooth individually. Notice the variations according to the morphology of each tooth

Interference Interference to insertion and removal for a particular path of insertion is checked with the help of an analyzing rod.

9. Surveying Ceramic Veneer Crowns

When a removable partial denture abutment is to be restored with a ceramic crown, the contour of the facial surface of the crown is developed in a surveyor. The ceramic restoration is placed on the cast and the height of contour is verified/modified before final glazing.

DETERMINING THE PATH OF INSERTION AND GUIDING PLANES

After surveying the primary cast, the next step in the treatment plan of a partial denture is determining the path of insertion and guiding planes.

This procedure can even be done alongwith surveying. A brief explanation about determining the path of insertion was explained under setup for surveying.

Path of Insertion

It is defined as *"the direction in which a prosthesis is placed upon and removed from the abutment teeth"* - GPT.

- The path of insertion or path of withdrawal is the angle made by the direction of the removable partial denture with the remaining teeth during insertion (Fig. 18.35).

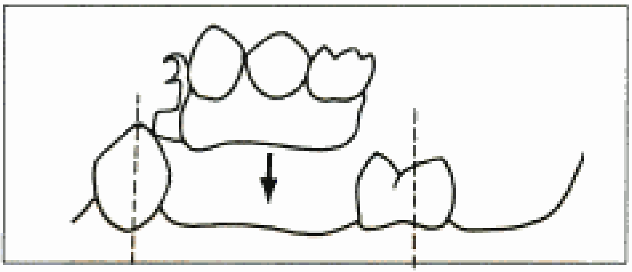


Fig. 18.35a: When all abutment teeth are vertically upright parallel to one another, they produce least hinderence to the prosthesis during insertion and removal

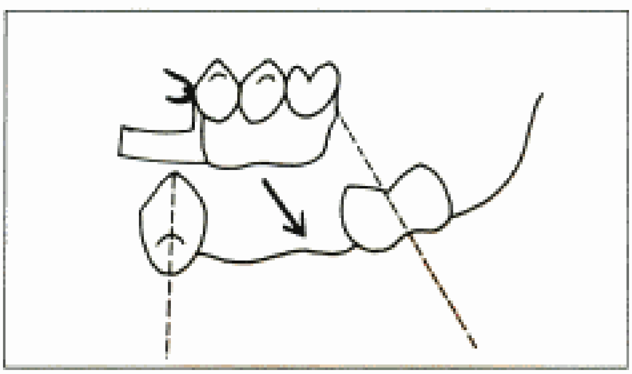


Fig. 18.35b: When abutment teeth are not parallel to one another, they produce hinderence to insertion and removal. To overcome this, one may think it's best to relieve the denture of interference to facilitate insertion and removal. This should not be done, instead the teeth should be reduced/uprighted to facilitate insertion or removal without compromising retention. If the abutment teeth are tipped but parallel to one other, the path of insertion of the denture should be altered such that it is parallel to the long axis of the remaining teeth. It should also be remembered that the denture will usually be seated in a vertical direction and the patient should open his mouth wide enough (angulate the jaw) to accommodate and seat the denture

- A simple method to establish an ideal path of insertion is to alter the tilt/angulation of the cast on the surveyor. Changing the tilt will change the guiding plane and the amount of mouth opening needed to seat a denture. Exaggerated tilts (beyond 10° to the horizontal plane) should be avoided to prevent excessive mouth opening during insertion.

Clinical Considerations

- Multiple paths of insertion are possible in a class I case. A single path of insertion is obtained by preparing additional guiding planes on the lingual surfaces of remaining teeth. Since the denture is constructed such that it is forced to contact all these guiding planes during insertion it reduces the occurrence of multiple paths of insertion (Fig. 18.36).

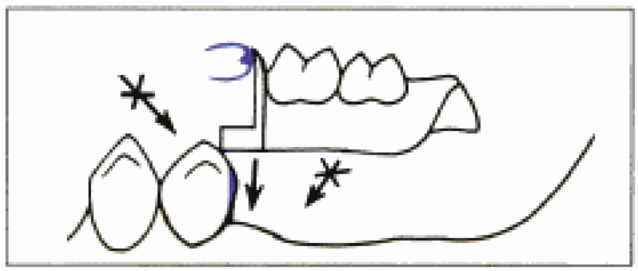


Fig. 18.36: Guide planes prepared on the proximal surface of the abutment teeth guide the denture during insertion **only** along the path of insertion. They prevent the placement of the denture along any other direction

- A class II case with modification 1 will have a single path of insertion. This is because the modification space has two guiding planes and the two sides of the arch are connected by a rigid major connector. The side having the modification space governs the path of insertion (Fig. 18.37).
- A single path of insertion is possible in a class III case wherein the edentulous space is bound by teeth anteriorly and posteriorly. The guiding planes formed on the proximal surfaces (mesial and distal) of the abutment teeth, control the path of insertion (Fig. 18.38).
- A class IV case will also usually have a single path of insertion.

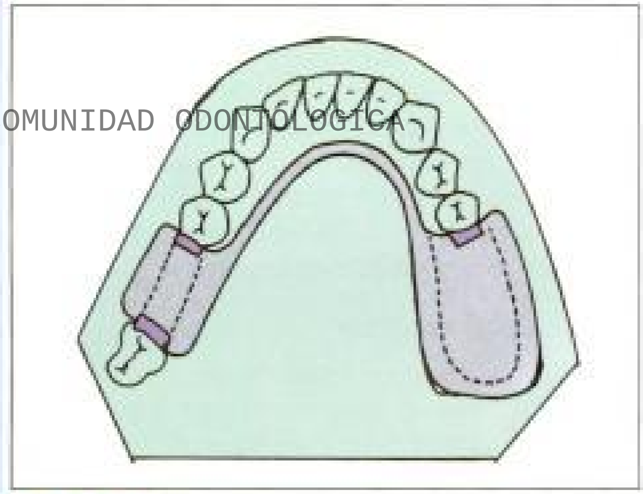


Fig. 18.37: In a Kennedy's class II case with a modification space, the guiding planes in the modification space determine the path of insertion

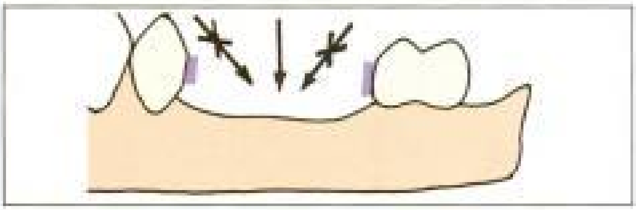


Fig. 18.38: In a Kennedy's class III case, the guiding planes of the primary abutment teeth determine the path of insertion

Factors Influencing Path of Insertion

The major factors that determine the path of insertion are:

- Retentive undercuts
- Interference
- Aesthetics
- Guiding planes.
- Denture base.
- Location of vertical minor connector
- Point of origin of the approach arm.

Retentive undercuts When the cast is placed horizontally, favourable undercuts on the abutment teeth should be identified to obtain good retention. The cast can be tilted until the height of contour lies between the gingival and middle third of the crown to obtain a good undercut (Fig. 18.39).

The advantages of having the height of contour between the gingival and middle third of the crown are:

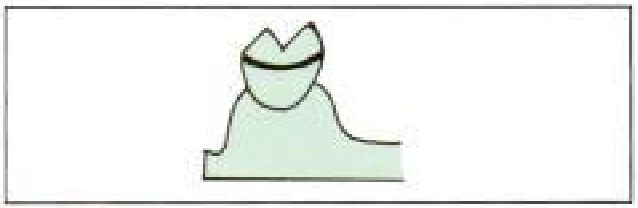


Fig. 18.39a: Height of contour located at the middle third of the tooth. This is not ideal for retention

- Aesthetic placement of the clasp.
- Reduces the rotational forces on the abutment tooth.
- Reduces the forces transferred to the abutment.

Tilting of the cast will alter the path of insertion.

Interference Certain areas of the mouth can cause interference to insertion. If surgery cannot be done to remove these interferences, the path of insertion should be altered. A few examples for structures that may produce interference are stated below.

Interferences in the mandible

- Lingual tori.
- Lingual inclination of remaining teeth.
- Bony exostoses.

Interference in the maxilla

- Torus palatinus.
- Bony exostoses.
- Buccally tipped teeth.

Aesthetics *"Aesthetics is a pleasure feeling obtained due to the visual perception of an object."* To obtain optimum aesthetics, the following procedures can be done:

- Clasp arms must be concealed. Positioning the clasp arm at a lower level will help to conceal the clasp arm. The cast should be tilted so that the height of contour is shifted to a lower level. This will alter the path of insertion (Fig. 18.39).
- A balance should be obtained between aesthetics and function.
- The artificial teeth should be placed in the same position as the natural teeth.
- In some Kennedy's class IV cases where the length of the edentulous span is decreased due to mesial migration/inclination of the

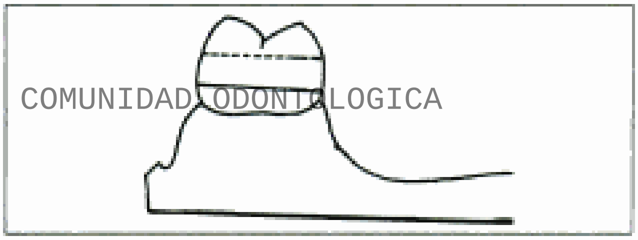


Fig. 18.39b: The tooth should be tilted or recontoured such that the height of contour lies at the junction of the middle and gingival third of the abutment tooth

remaining teeth, guide planes are prepared on the proximal surfaces of the abutment teeth to increase the length of the edentulous span. This will allow proper placement of the artificial teeth.

- Cases with mesially tilted abutments on either side of the edentulous space will have large unaesthetic undercuts with accumulation of plaque and debris. This can be eliminated either by tilting the cast posteriorly or altering the path of insertion or by selectively grinding the teeth to establish a proper guiding plane thereby eliminating the undercut (Fig. 18.40).

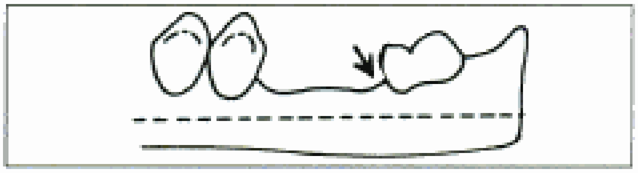


Fig. 18.40a: Tipped abutment tooth with an unfavourable undercut

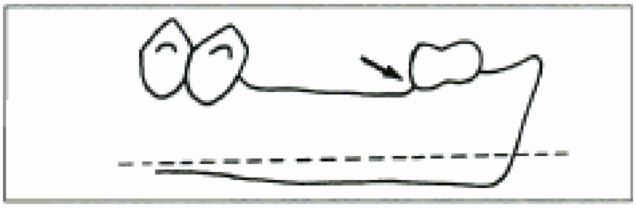


Fig. 18.40b: Enameloplasty done to eliminate unfavourable undercuts

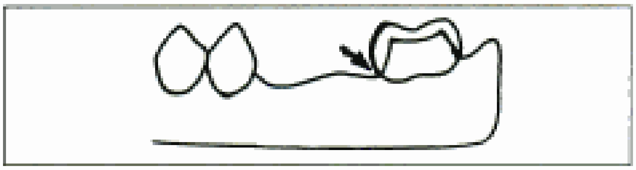


Fig. 18.40c: The proximal surface of such teeth can also be recontoured using a crown

Guiding planes The path of insertion will always be parallel to the guide plane. In other words, the guiding planes determine the path of insertion. The proximal plates on the partial denture should and will contact the guide planes during insertion. Hence, when many guide planes are used, multiple paths of insertion are avoided (Fig. 18.41). Determining the location, extent, and function of a guide plane is discussed in detail in the next section.

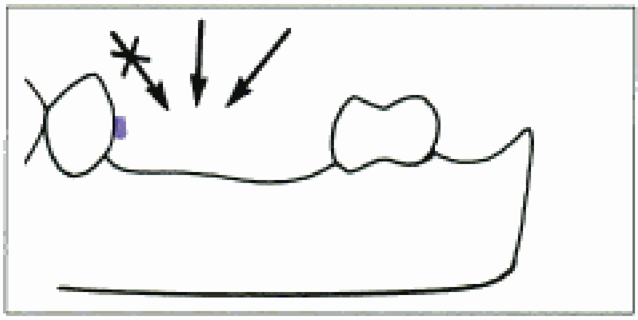


Fig. 18.41a: Since the proximal plates of the denture are forced to slide over the guiding planes during insertion, multiple guiding planes should be prepared parallel to one another, in order to avoid multiple paths of insertion. Consider a bounded saddle with three paths of insertion as shown in the diagram. Preparing a guiding plane on one side eliminates atleast one unwanted path of insertion

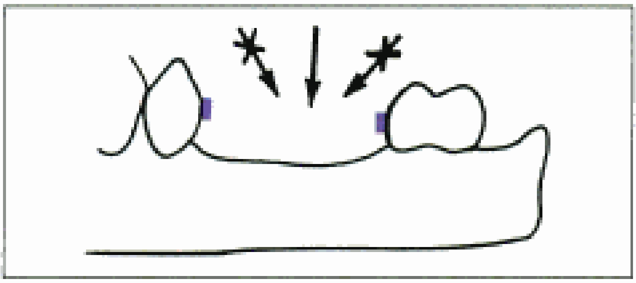


Fig. 18.41b: If guiding planes are prepared on either side of the saddle all unwanted paths of insertion are avoided

Denture base Shape and extent of the denture base determines the path of insertion. If a distal extension denture base is made to extend anteriorly on both sides it tends to embrace the abutment limiting multiple paths of insertion (Fig. 18.42).

Location of the vertical minor connector The vertical minor connector connects the auxiliary rest to the major connector. This minor connector will be parallel to the guide plane on the abut-

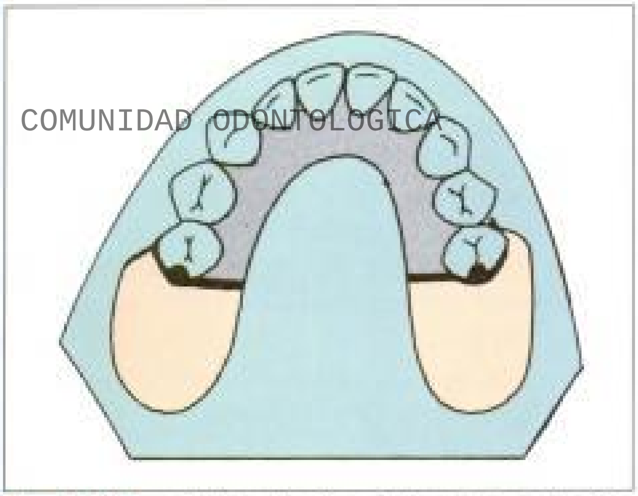


Fig. 18.42: In a distal extension denture base, extending the buccal flange of the denture base anteriorly will aid to limit multiple paths of insertion

ment. We know that the path of insertion should be parallel to the guide planes (Fig. 18.43).

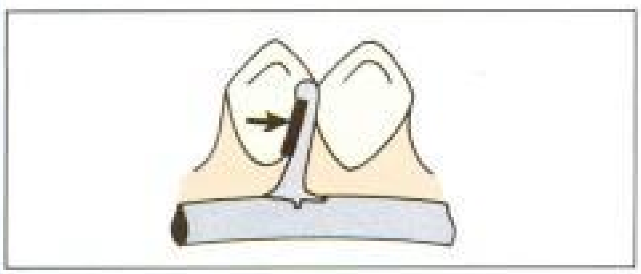


Fig. 18.43: Vertical minor connectors connecting auxilliary rests also lie close to prepared guide planes hence, they also aid to limit multiple paths of insertion

Point of origin of the approach arm of a bar clasp

A bar clasp is described in detail under designing the component parts of a removable partial denture (Fig. 18.44). From the picture, we understand that it arises from the denture base minor connector. The approach arm of the clasp then descends down and loops up to end in a 'T' shaped tip (retentive terminal). Since the approach arm of the bar clasp forms a loop, it is capable of producing interference during insertion (Fig. 18.45). Actually, the bar clasp should be designed to produce least resistance according to the path of insertion. But in some cases where the approach arm cannot be modified, the path of insertion is altered. When the path of insertion is altered, the resulting bar clasp will not provide

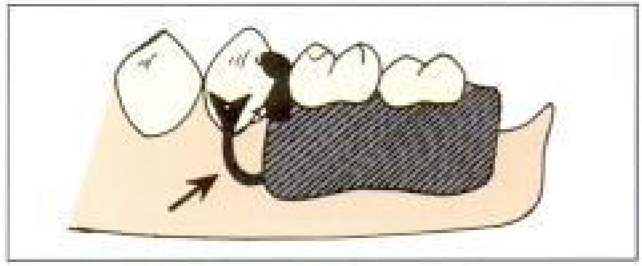


Fig. 18.44a: Approach arm of a roach or bar clasp

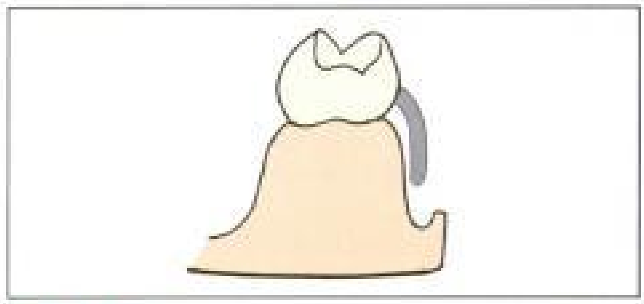


Fig. 18.44b: Coronal view of the approach arm showing it's relationship with the soft tissue

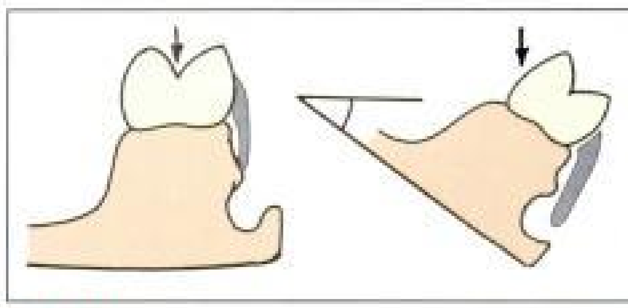


Fig. 18.45: Bar clasps cannot be placed against soft tissue undercuts. Hence altering the path of placement of the denture may avoid this interference without compromising retention. Black arrow indicates the path of insertion

retention in the vertical direction, instead it will provide resistance to removal only against the path of insertion. Other factors that control the path of insertion (e.g. guide planes) will provide resistance to vertical displacement of the denture.

Guiding Planes

Guiding planes or guide planes are defined as *"Two or more vertically parallel surfaces of abutment teeth so oriented as to direct the path of placement and removal of removable partial dentures"* -GPT.

They are prepared on the proximal and axial surfaces of primary and secondary abutment teeth. (Fig. 18.46). The minor connector that

Fig. 18.46: The proximal plate of the direct retainer should be closely associated with the guide plane of the primary abutment

connects the auxiliary rest to the major connector should lie within the embrasure and adapt closely to the tooth that supports the auxiliary rest. The surface of the minor connector that contacts the secondary abutment is known as a *proximal plate of the minor connector* (Fig. 18.47). Similarly the body of a clasp (discussed later) will lie very close to the proximal surface of the abutment tooth. The surface of the body of the clasp or direct retainer is known as the *proximal plate of the direct retainer.* (Fig. 18.48).

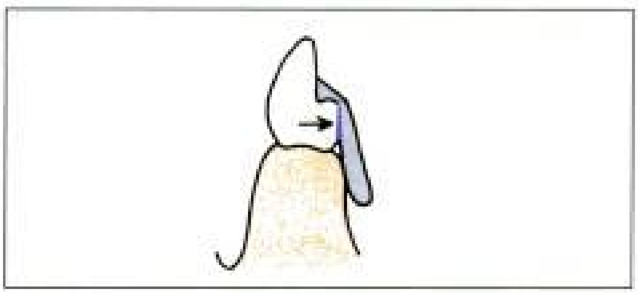


Fig. 18.47: Arrow mark depicts the guiding plane (blue line) prepared on a secondary abutment. The proximal plate of the vertical minor connector should be in close association with the guide plane

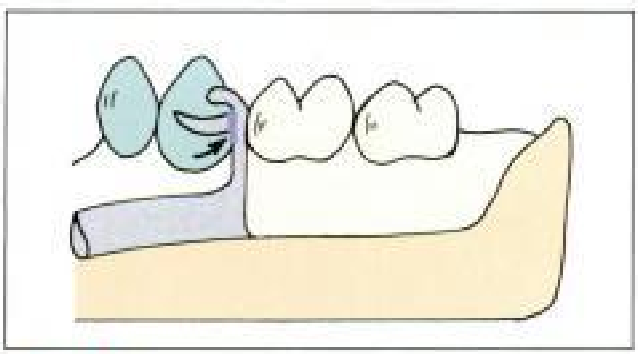


Fig. 18.48: The proximal plate of the direct retainer should be closely associated with the guide plane of the primary abutment

The surface of the tooth along which the proximal plates slide is called a guide plane. A guide plane is called so because they guide the prosthesis (proximal plates) during insertion and removal (Fig. 18.49). When the denture is seated in place, the guiding plane and the proximal plate will be in intimate contact. This contact can be on the occlusal or gingival third of the tooth. But contact with the occlusal third of the tooth near the marginal ridge is preferred because this area can be re-contoured easily (Fig. 18.50). This relationship prevents action of destructive lateral forces on the tooth. Guiding planes play an impor-

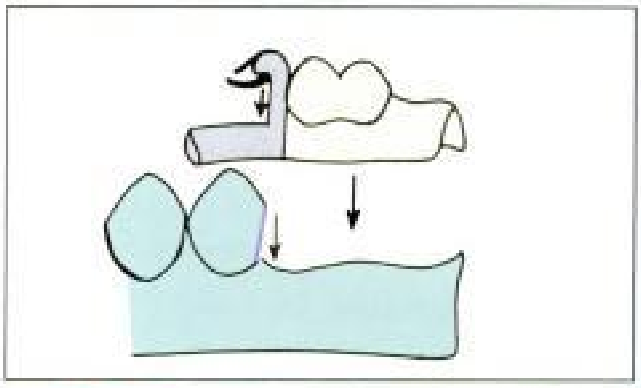


Fig. 18.49: The guide plane functions to guide the placement of the denture **only** along the path of insertion

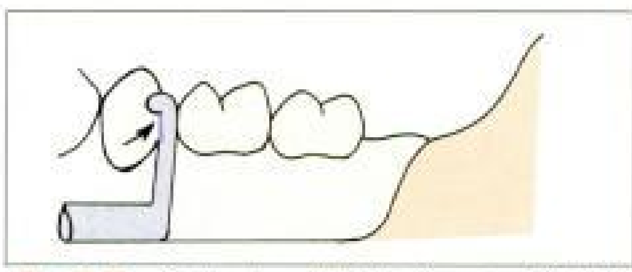


Fig. 18.50a: Guiding plane limited to the occlusal third of the tooth (Preferred)

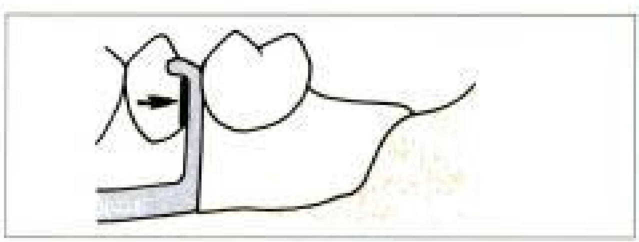


Fig. 18.50b: Long guide planes which require excessive tooth reduction or recontouring

tant role in retention of the prosthesis. (Refer functional requirements of a clasp).

Structure

Guide planes are usually 2-3 mm in occluso-gingival height parallel to the path of insertion. The guide planes should be flat and contain no undercuts (Fig. 18.51). Guide planes do not occur naturally on the abutment teeth, instead they should be prepared by the clinician during **prosthetic mouth preparation.** They are prepared by selective grinding of teeth (enameloplasty) or by appropriate shaping of wax patterns, crowns or cast restorations on the abutment teeth.

Fig. 18.51: Ideal contour of guide plane

Types of Guide Planes

Guide planes are classified based on their function and location as follows:
- Guide planes on abutment teeth supporting a tooth supported partial denture (Fig. 18.52).

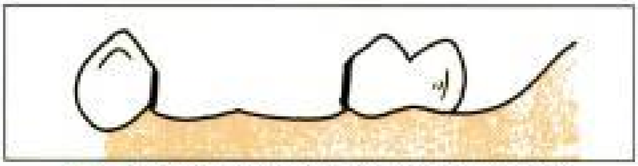


Fig. 18.52: Guide planes for a tooth supported partial denture

- Guide planes on abutment teeth that support a secondary distal extension denture base (Fig. 18.53).
- Guide planes prepared on lingual surfaces of abutment teeth. (Usually they are adjacent to the proximal plate of the minor connector that connects the auxiliary rest) (Fig. 18.54).
- Guide planes on anterior abutments (Fig. 18.55).

The procedures for the preparation of each of the above-mentioned guide planes have been described under prosthetic mouth preparation (Chapter 19) which forms the next phase of treatment after design.

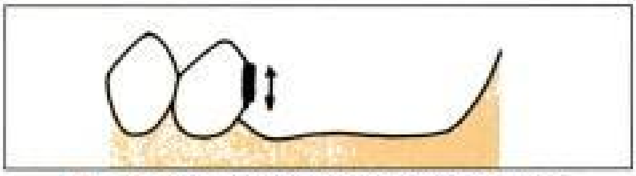


Fig. 18.53: Guide planes for a distal extension denture base

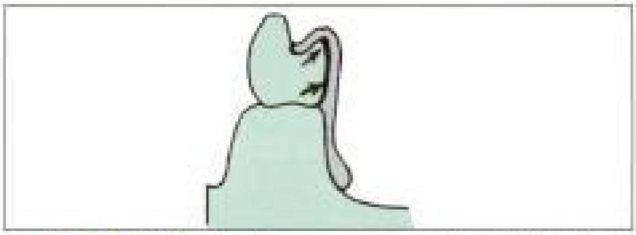


Fig. 18.54: Guide planes on a secondary abutment supporting an auxiliary rest

Fig. 18.55: Guiding planes on anterior abutments (a) Canine (b) Incisors

Advantages of Guiding Planes on Anterior Teeth

Guide planes prepared on anterior teeth have the following advantages:
- Provides parallelism for stabilization.
- Reduces the wedging action between the teeth.
- Reduces the space between the abutment tooth and the denture.
- Increased retention.
- Improves the aesthetics (space between the abutment and the denture is avoided because the denture adapts completely to the guiding plane).

Functions of a Guiding Plane

- It minimizes the wedging stresses on the abutments.
- Makes insertion and removal easier.

- Aids to stabilize the prosthesis against horizontal stresses.
- Aids to stabilize individual teeth.

- Reduces the blockout area and eliminates the space between the minor connector and the tooth. Hence, it improves oral hygiene along with easy maintenance.
- Contributes to indirect retention and frictional retention.

DESIGNINGTHE COMPONENT PARTS OF A RPD

After surveying the primary cast, determining the path of insertion and location of the guiding planes; the component parts of the RPD are designed. In this section, we will discuss in detail about the structure, function, design considerations, indications, contraindications and some specific design considerations for each component used in a partial denture. The design procedure is described in detail consecutively under each component.

Major Connector

It is defined as "*A part of a removable partial denture which connects the components on one side of the arch to the components on the opposite side of the arch*"- GPT.

It connects all the parts on one side of an arch to those on the opposite side. It forms the basic framework of the partial denture. They are basically classified as maxillary and mandibular major connectors.

General Ideal Requirements for Maxillary and Mandibular Major Connectors

A major connector should have certain characteristics. Generally, all major connectors are designed such that they fulfil the following requirements.

- Rigidity: A major connector should not be flexible. It should be rigid enough to uniformly distribute the occlusal forces acting on any portion of the prosthesis without undergoing distortion.
- It should provide vertical support and protect soft tissues.
- It should provide a means of indirect retention whenever required. (explained under indirect retainers).
- It should provide opportunity for positioning denture base where needed.
- It should be comfortable to the Patient.
- It should not allow any food accumulation.
- It should be self-cleansing.

Design Considerations for all Major Connectors

The following general design considerations are followed while designing any major connector. These considerations help to improve the success of the prosthesis.

- Intentional relief: The border of the major connector should be 6 mm away from gingival margins in the maxillary arch in order to avoid any injury to the highly vascular marginal gingiva (Fig. 18.56).

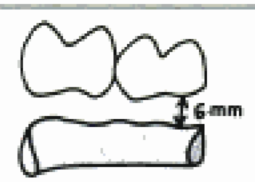


Fig. 18.56: 6 mm **intentional relief** is mandatory for maxillary major connectors to protect the gingival tissues

- In the mandible, the border of the major connector is placed 3 mm away from the marginal gingiva. If this is not possible, it is extended across the marginal gingiva as a lingual plate (Fig. 18.57).
- The borders of the major connector should be parallel to the gingival margins (Fig. 18.58).
- The metal framework should cross the gingival margin only at right angles (Fig. 18.59).
- The part of the framework adjoining the tooth surface should be hidden in the embrasures to avoid discomfort.
- The borders of the major connector should be rounded to avoid interference to the tongue (Fig. 18.60).
- The major connector should be symmetrical and should cross the palate in a straight line.

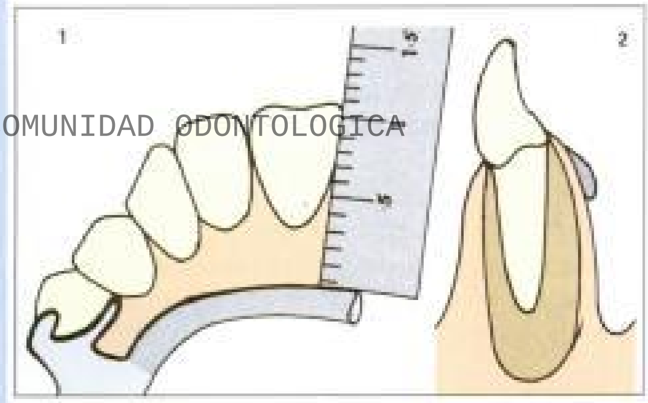


Fig. 18.57a: (1) 3 mm intentional relief is required to protect the mandibular gingival tissues from the major connectors (2) Cross-sectional view

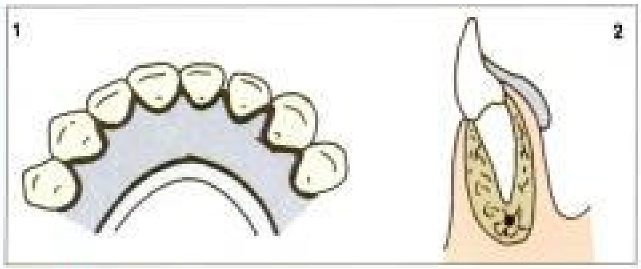


Fig. 18.57b: (1) If intentional relief cannot be provided, the major connector should extend upto the gingival third of the teeth (2) Cross-sectional view

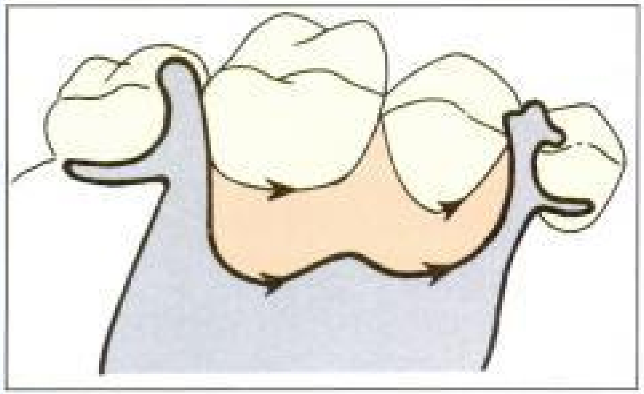
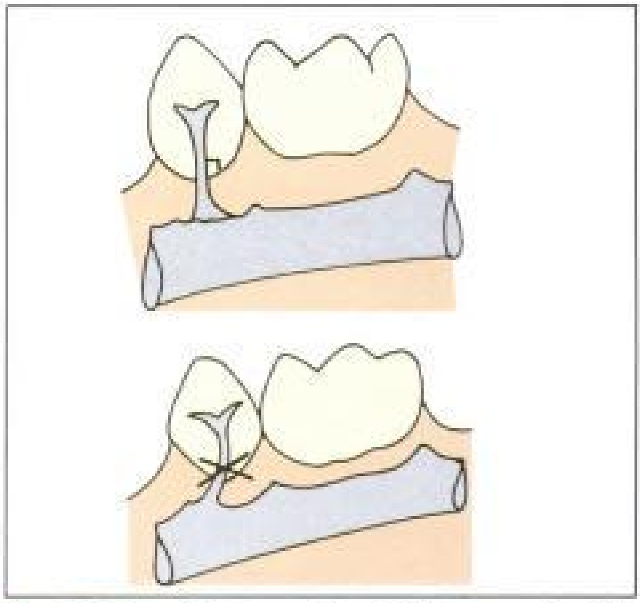
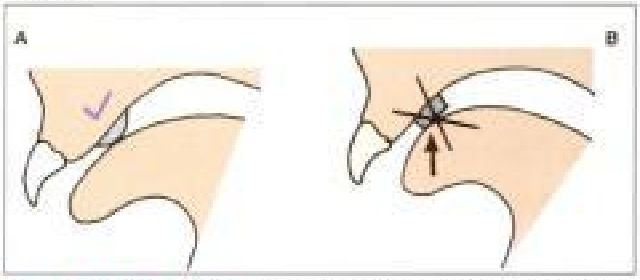


Fig. 18.58: The gingival margin of the major connector should be parallel to the free gingival margin

- The anterior border of the maxillary major connector should end in the valley of the rugae and it should be designed such that it never lies on the crest of the rugae (Fig. 18.61). It is better to avoid covering the rugae area in order to prevent any discomfort during speech.



Figs 18.59a and b: Any portion of the framework which crosses the free gingival margin should do so only at right angles



Figs 18.60a and b: The margins of the major connector should be rounded such that it produces least interference to the tongue

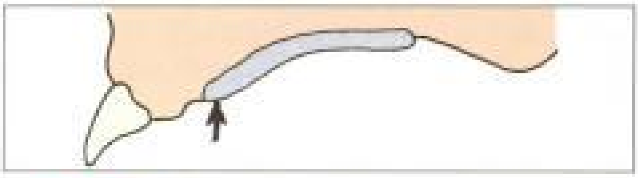


Fig. 18.61a: The anterior margin of a maxillary major connector should always end on valley of the rugae

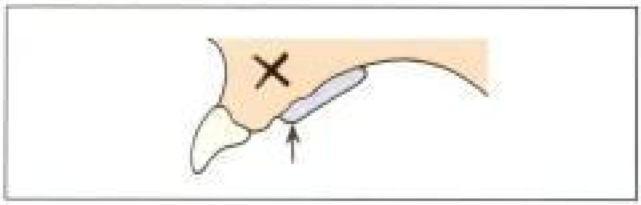


Fig. 18.61b: The anterior margin of a maxillary major connector should never lie on the crest of the rugae

- The major connector should not extend over bony prominences like tori. Relief is given for a small tori, surgical excision is done for a large one (Fig. 18.62).

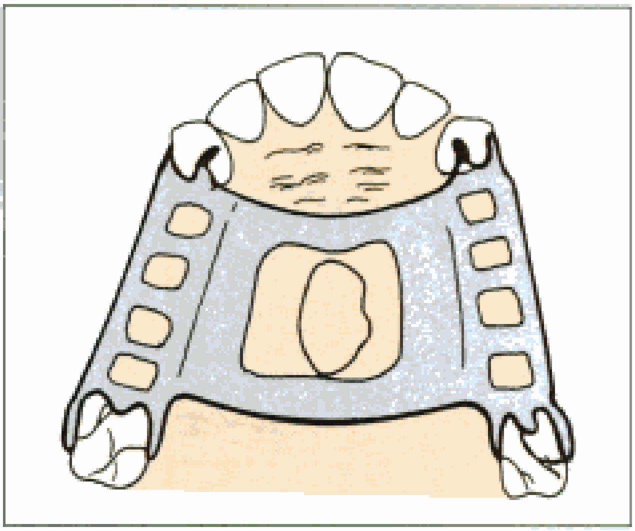


Fig. 18.62: Relief provided to avoid interference from a large inoperable tori

Maxillary Major Connectors

Major connectors used in the fabrication of a maxillary prosthesis are termed as maxillary major connectors. A maxillary major connector should be fabricated based on the above mentioned design concepts. It should fulfill the following additional requirements:

- A beading (rounded thick border) should be given to the posterior margin of the maxillary major connectors to provide a seal with the soft tissue in their margins. The beading will slightly displace the soft tissue when the denture is in position and hence prevent the entry of small food particles between the denture and the soft tissues (Fig. 18.63).

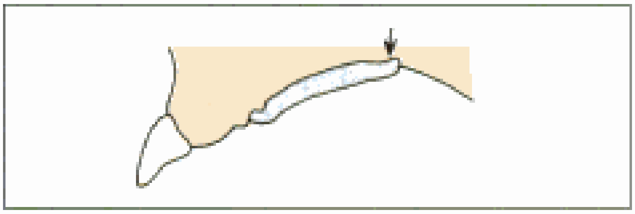


Fig. 18.63: Beading provided at the borders of a maxillary major connector in order to obtain better adaptation and prevent entry of food particles

The beading is created by making a 0.5 to 1-mm groove on the master cast with a spoon excavator. The size of the beading should thin out 6mm near the marginal gingiva (Fig. 18.64).

- Usually relief should not be given for a maxillary major connector. Close adaptation is necessary for retention and stability of the denture. Exceptions include cases with palatal tori or a prominent mid palatine suture

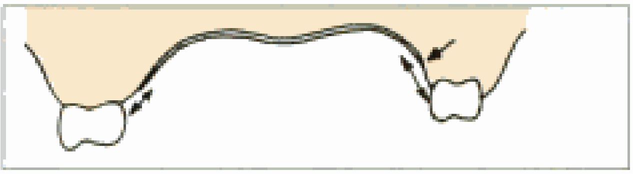


Fig. 18.64: The beading should thin out as it approaches the gingival margins

Types of Maxillary Major Connector

- Single posterior palatal bar
- Palatal strap
- Single broad palatal major connector or Palatal plate type major connector
- Double or anteroposterior palatal bar
- Horseshoe or U-shaped connector
- Closed Horseshoe or anteroposterior palatal strap
- Complete palate.

Single posterior palatal bar It is a bar running across the palate. It has a narrow half-oval cross section, which is thickest at the center. Special casting/pattern waxes, which resemble the shape of this bar, are commercially available. The extent of the bar is marked using a pencil on a cast and the wax pattern is fabricated by adapting the wax over the marked area (Fig. 18.65).

Indication

- For interim partial denture.

Disadvantages

- Poor bony support from the hard-palate due to a narrow antero-posterior width. Vertical support should be improved by adding many rests.
- It cannot be used anterior to the premolar region due to interference to the tongue.
- Can be used only when 1 or 2 teeth are to be replaced on each side because it has poor vertical support

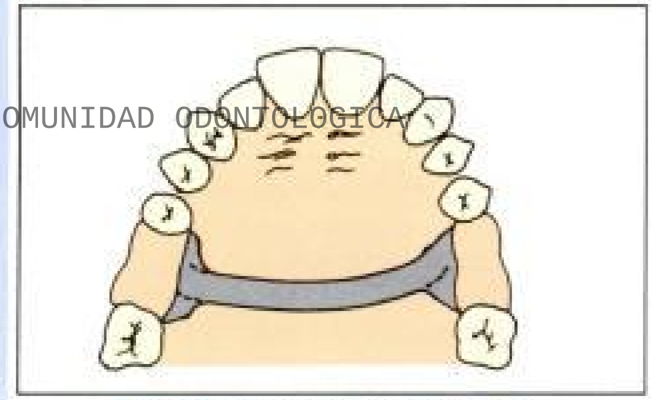


Fig. 18.65: Single posterior palatal bar

- It can be used only in Kennedy's class III cases wherein teeth capable of bearing the load should be present both anterior and posterior to the edentulous space.

Palatal strap It is the most versatile major connector. It comprises of a wide, thin band of metal plate that runs across the palate. Width can be decreased depending on edentulous span. It should be at least 8 mm wide for adequate rigidity. It is fabricated similar to the palatal bar. Prefabricated waxes for a palatal strap are available. This strap extends over 3 planes namely:

- Vault or horizontal plane.
- Right and left lateral slopes of the palate

Indications

- Unilateral distal extension partial denture.
- Bilateral short span edentulous spaces in a tooth supported prosthesis (Kennedy's class III).

Advantages

- Good resistance is obtained with minimum volume of metal (L-bar principle –described later under principles of RPD) (Fig. 18.66).
- It provides excellent resistance against bending and twisting forces acting on the denture because it extends over three different planes (Fig. 18.67).
- Very thin metal is present; hence, it increases patient's comfort.
- Enhanced retention due to increased adhesion and cohesion.

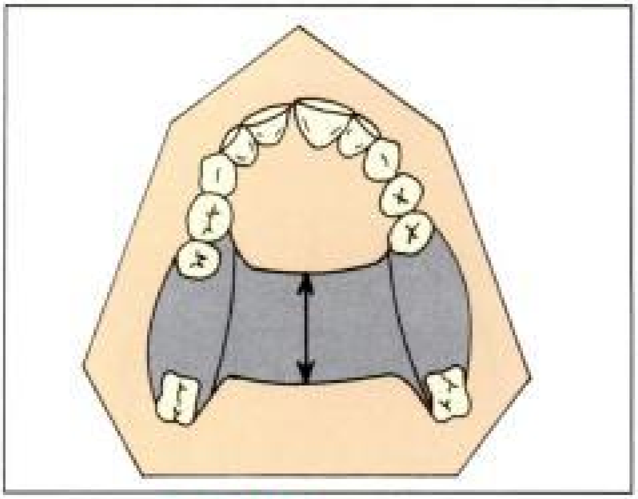


Fig. 18.66: Palatal strap

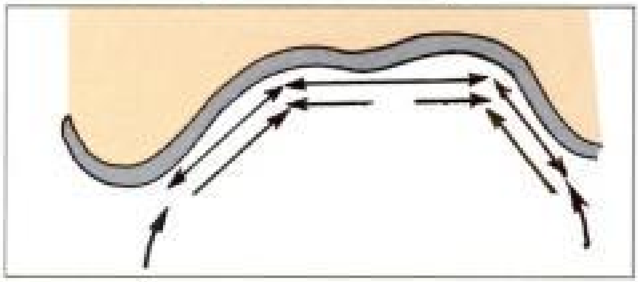


Fig. 18.67: Since the palatal strap extends over three planes, it is rigid even in thin sections

- Has good indirect retention against dislodgment by sticky foods or gravity in an anterior direction.

Disadvantages

- Large palatal coverage.
- Posterior border should end before the junction of hard and soft palate to avoid discomfort.
- The strap cannot be placed across a prominent median suture.
- Can cause papillary hyperplasia.

Single broad palatal major connector or Palatal plate type major connector by Thompson It is also called *anatomic replica palatal major connector*. It has a thin broad contoured palatal coverage. It is broader than a palatal strap (Fig.18.68). Fabrication is similar to that of posterior palatal bar.

It can be used in three forms:

- Plate that covers the area between two or more edentulous spaces.

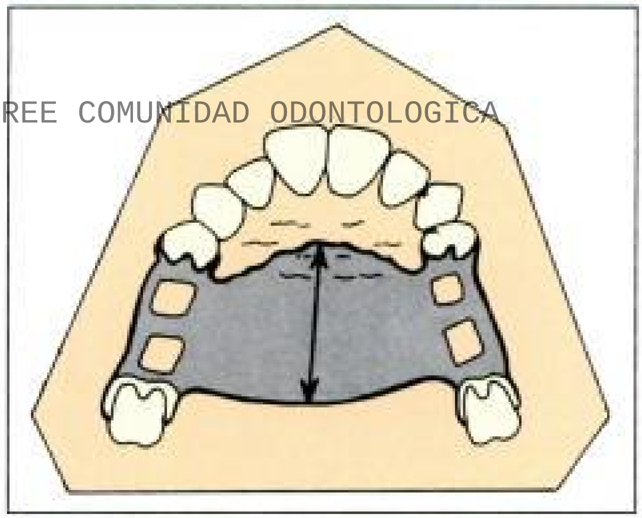


Fig. 18.68: Single broad palatal major connector

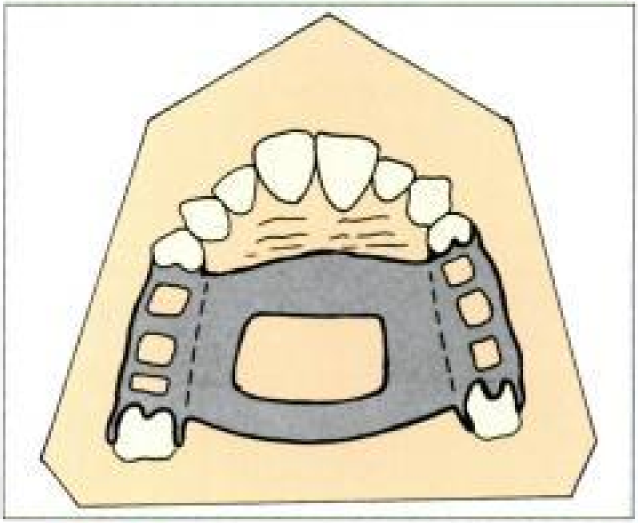


Fig. 18.69: Antero-posterior double palatal bar

- Complete or partial cast plate extending posteriorly to the junction of the hard and soft palate.
- Anterior palatal connector with a provision for extending an acrylic denture base posteriorly.

Indications

- Class I cases with little vertical ridge resorption.
- Cases with 'V' or 'U' shaped palate.
- Cases with strong abutments
- Cases with more than six remaining anterior teeth

Advantages:

- Intimate contact with the palatal tissues over a large area provides good retention due to the presence of interfacial surface tension.
- Provides good vertical support.
- Numerous surface corrugations due to very thin metal provide a very natural feel.

Disadvantages

- Can cause papillary hyperplasia.

Antero-posterior or double palatal bar

- It is a combination of an anterior palatal strap and a posterior palatal bar (Fig. 18.69).
- The anterior strap is narrower than a conventional palatal strap.
- The margins of the strap should lie on the valley and not on the crest of the rugae.
- Posterior bar is half-oval like a single posterior palatal bar.
- The strap and the bar are connected by two longitudinal elements along the lateral slopes of palate giving a circular configuration (Fig. 18.70). This circular configuration provides rigidity.
- The anterior strap lies in three planes like the broad palatal major connector. This also contributes to the rigidity of the prosthesis (L-beam or L-bar principle: discussed later).

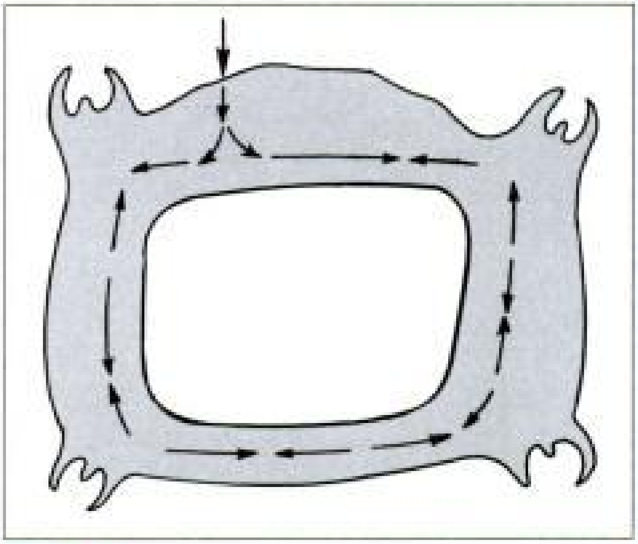


Fig. 18.70: Circular configuration of an antero-posterior double palatal bar aids to increase resistance

- Excellent rigidity but less support. Additional support should be obtained from the remaining teeth that have to be periodontally sound.

Indications
- When anterior and posterior abutment teeth are widely separated.
- Cases with large inoperable palatal tori.
- Patient who wants to avoid complete palatal coverage.
- Long edentulous span in class II modification 1 arch.
- Class IV conditions.

Advantages:
- Rigid
- Strong
- Limited soft tissue coverage.

Disadvantages:
- Limited support from palate.
- Uncomfortable as it has multiple borders, which provides areas of interference to the tongue.

Horseshoe or U-shaped connector As the name suggests this major connector is 'U' shaped running along the arch. It has a thin metal band running along lingual surface of posterior teeth (Fig. 18.71). Anteriorly it becomes more like a thin plate that **covers the cingula** of the teeth. The posterior border extends 6-8 mm onto the palatal tissue. The entire surface and the borders should be smooth and gently rounded.

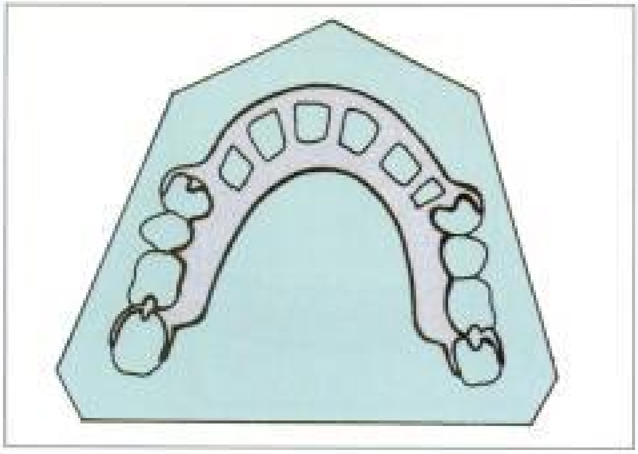


Fig. 18.71: Horseshoe or 'U' shaped maxillary major connector

Indication:
- Used when many anterior teeth are to be replaced.
- Used in presence of tori extending to the posterior border of the hard palate or a prominent median suture.
- Excessive vertical overlap (overbite) of the anterior teeth.

Advantages:
- Reasonably strong.
- Has moderate indirect retention and support.

Disadvantages:
- When vertical forces are applied on either one or both ends it tends to straighten. Hence it cannot be used for distal extension denture bases (Fig. 18.72).
- Greater bulk is required to avoid flexing of the major connector. Increased thickness may cause patient discomfort.

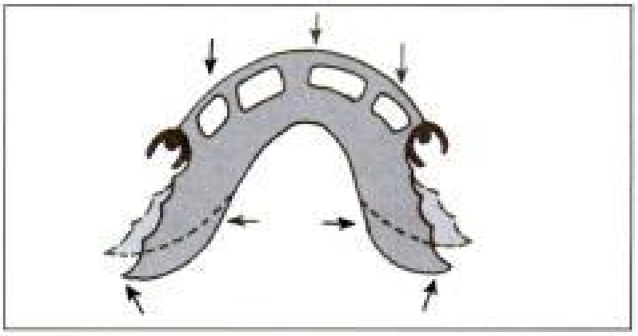


Fig. 18.72: Under stress, the 'U' shaped maxillary major connector may tend to straighten out

Closed Horseshoe or Anteroposterior Palatal Strap It is similar to the 'U' shaped major connector but a strap of metal extends between the two open ends of the horseshoe (Fig. 18.73). The center of the palate is left uncovered. The border should be 6 mm away from the gingival margin. The straps should be of uniform thickness. The posterior strap should be placed as far posteriorly as possible but it should not touch the soft palate. The margins should be smooth and rounded. It differs from a double palatal bar in that the posterior strap is a thin plate.

Indications:
- Used when numerous teeth are be replaced and a torus is present.

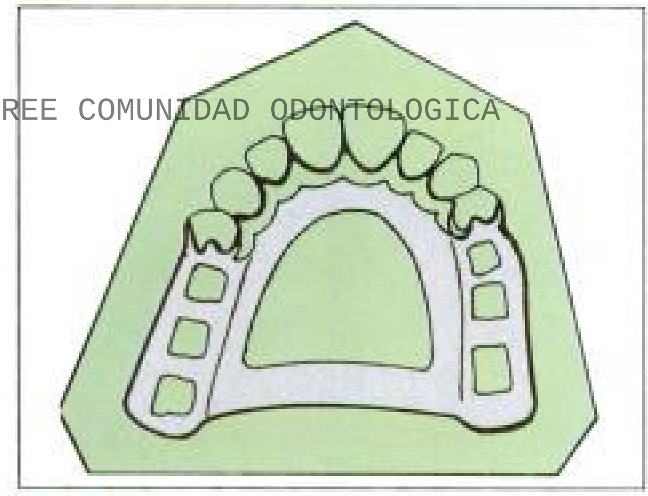


Fig. 18.73: Closed horseshoe maxillary major connector

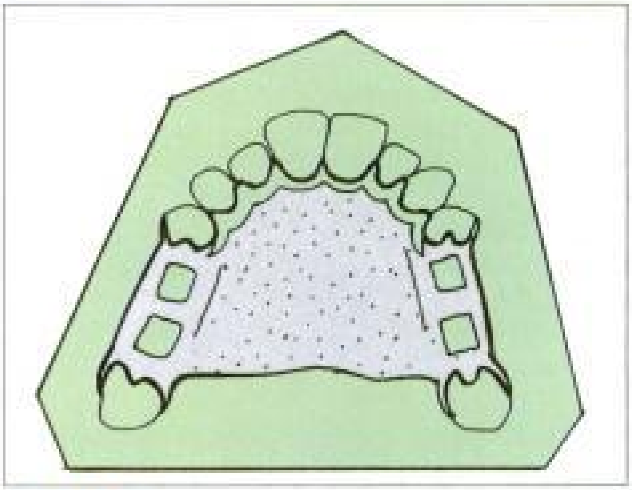


Fig. 18.74: Complete palate maxillary major connector

- It is used in cases with Kennedy's Class I and Class II cases with anterior tooth replacement.

Advantages:

- Rigid due to a circular configuration.
- Additional strength due to L-beam effect and a circular configuration (discussed later).
- Greater support from palate

Disadvantages:

Interference with phonetics, annoyance to tongue and discomfort.

Complete palate This major connector covers the entire palate. Anterior border should be 6mm away for the gingival margin or extend up to the cingula of the anterior teeth. The Posterior border of complete palate should extend to the junction of the hard and soft palate (Fig. 18.74).

A slight border seal can be obtained by giving a beading posteriorly, but a peripheral seal cannot be obtained equivalent to a complete denture. The loss of peripheral seal is due to rebounce of soft tissue after compression. The beading helps to prevent food accumulation between the palate and the connector.

It can be constructed using:

- All acrylic
- A combination of metal and acrylic. Here the metal extends over the anterior half of the palate, while the acrylic covers the posterior part of the palate. the posterior border of the metal contains small projections (meshwork) for retention with acrylic (acrylic will get interlocked with the meshwork (Fig. 18.75).
- All cast metal.

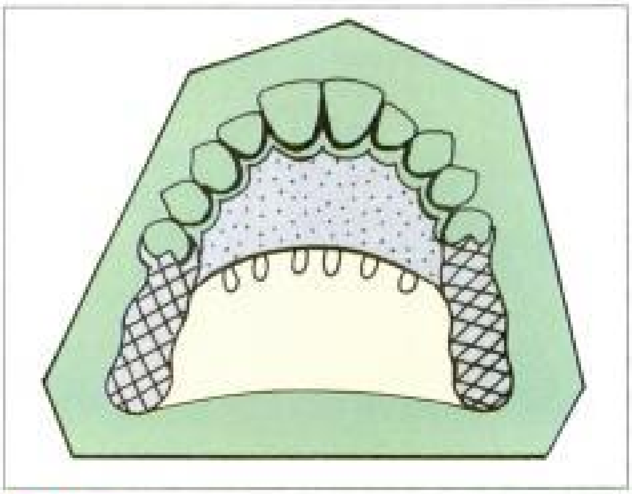


Fig. 18.75: Combination of metal and acrylic denture base. The anterior half is metal and the posterior half is acrylic

Indications:

- Used when many posterior teeth are replaced.
- In cases where anterior teeth are to be replaced along with a Kennedy's class I condition.
- For patients with well developed muscles of mastication or presence of all mandibular teeth. In such cases there will be excessive load and displacing forces, which can only be distributed by a complete palate.
- In cases with flat ridges and shallow vaults where high stability is required.

- It can be used temporarily as a transitional partial denture to accustom the patient to a large palatal coverage before the fabrication of a complete denture.
- In cleft palate cases with a narrow, steep vault.

Advantages:

- Best rigidity and support.
- Metal transmits temperature changes to the soft tissues better than acrylic. This will give a better perception.

Disadvantages:

- Soft tissue reactions like inflammation and hyperplasia.
- Interference with phonetics

Design Procedure for a Maxillary Major Connector

In 1953 Blatterfein described five basic steps for designing a maxillary major connector:

- *Step 1:* The primary stress bearing areas that are to be covered by the denture base should be marked on the cast (Fig. 18.76).

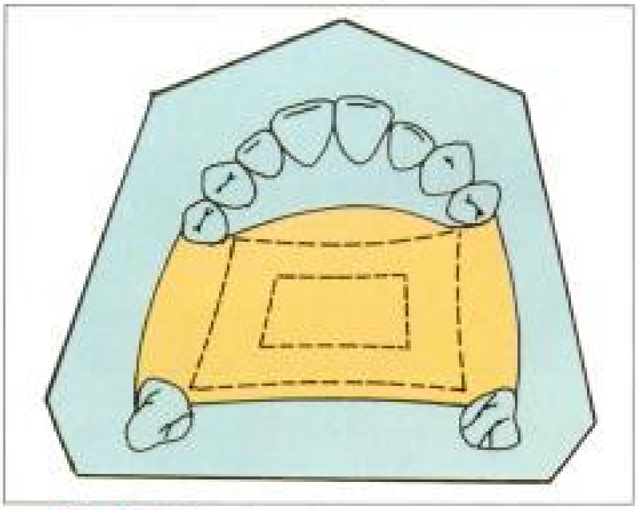


Fig. 18.76: The denture base area is marked on the cast (orange)

- *Step 2:* The nonstress-bearing areas like palatal gingiva, mid-palatine raphe, tissues posterior to the vibrating line should be marked using a different colour on the cast (Fig. 18.77).
- *Step 3:* Next the connector-areas (areas where the major connector is to extend) that are available to place the components of the major connectors should be marked on the cast (18.78).

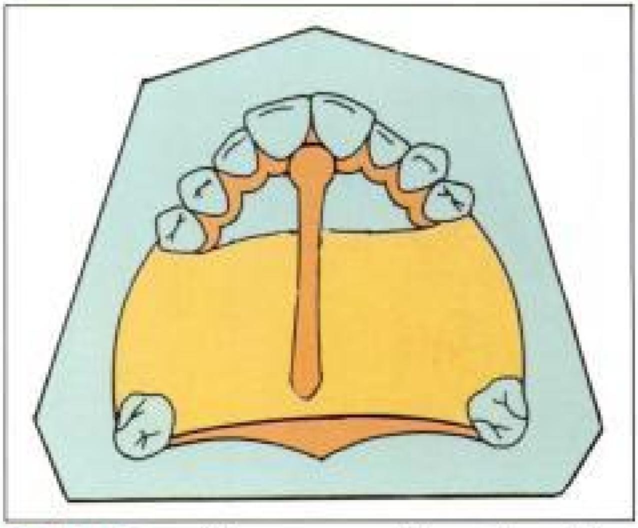


Fig. 18.77: The relief areas are marked over the markings of the denture base area (Red)

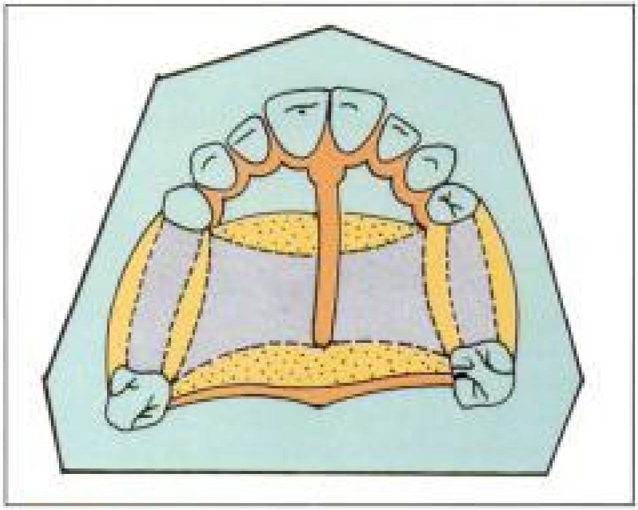


Fig. 18.78: The connector areas are marked (grey)

- *Step 4:* Choosing the connector
  An appropriate connector is selected based on four factors
  - Mouth comfort: It should have minimum bulk and avoid any interference during speaking.
  - Rigidity: It should be highly rigid for bilateral stress distribution.
  - Location of denture base: Determines the type of the connector.
  - Amount of indirect retention required will influence the outline of the major connector.

- *Step 5:* Unification: After deciding on the type of the major connector to be used, the various markings on the master cast (denture base and connector) are connected. This gives the design and extent of the major connector (Fig. 18.79).

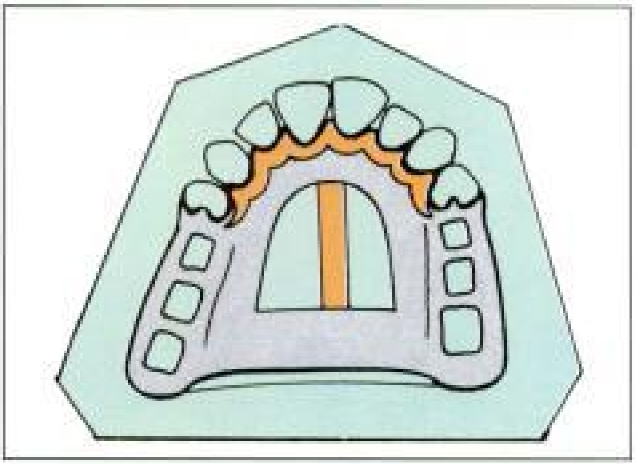


Fig. 18.79: Connector areas are unified (Grey)

Mandibular Major Connectors

The mandibular major connectors are used in mandibular partial dentures. Unlike the maxillary major connector, a mandibular major connector should have adequate clearance for the tongue (Fig. 18.80). They are fabricated using the following design concepts.

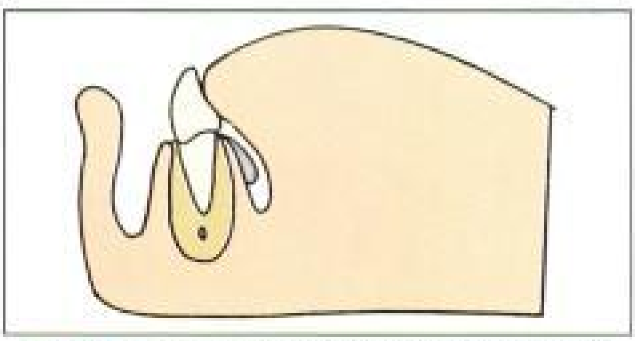
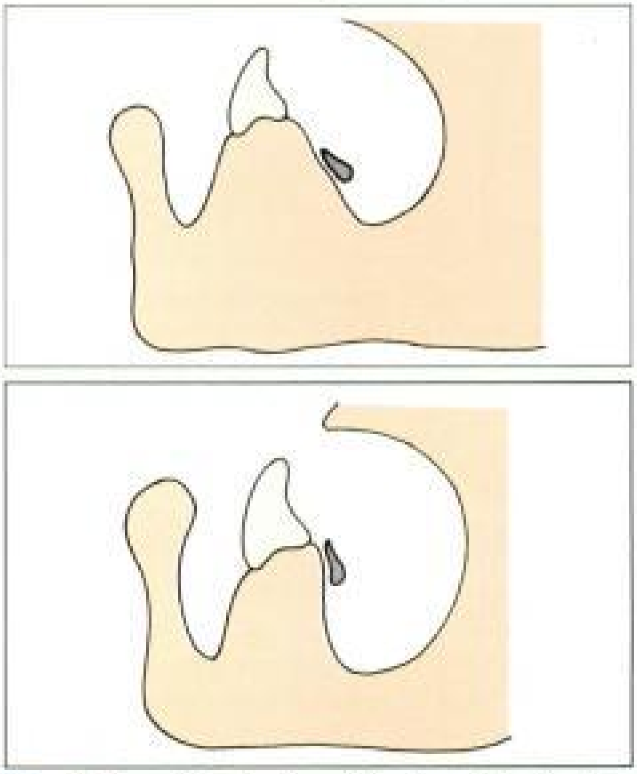


Fig. 18.80: A lingual major connector designed to be in harmony with the lingual musculature

Design considerations

- They are longer and narrower than the palatal connectors due to the interference from the tongue.
- Relief is given in all cases. The amount of relief varies based on:
  - Type of major connector.
  - The amount of slope in the tissue lingual to the anterior teeth.
  - Additional relief should be given for distal extension cases. This is because rotational movement of the denture base can traumatize the gingiva. For Kennedy's class III cases where there is minimal rotation, less relief is sufficient. If the lingual mucosa slopes towards the tongue, maximum relief should be given. On the other hand if the lingual mucosa is vertical, (without a slope) minimum relief is given (Fig. 18.81).



Figs 18.81a and b: The slope of the lingual alveolar plate determines the need for relief in a mandibular major connector. If the slope of the lingual alveolar plate is vertical, minimal relief is sufficient

The space available for the placement of mandibular major connectors can be evaluated using one of the following methods:

Measuring with a periodontal probe: The patient is asked to protrude his tongue and touch the vermilion border of the upper lip so that the tissues in the floor of mouth are activated. The depth of the lingual sulcus is measured near the canines and the central incisors. This is the preferred method (Fig. 18.82).

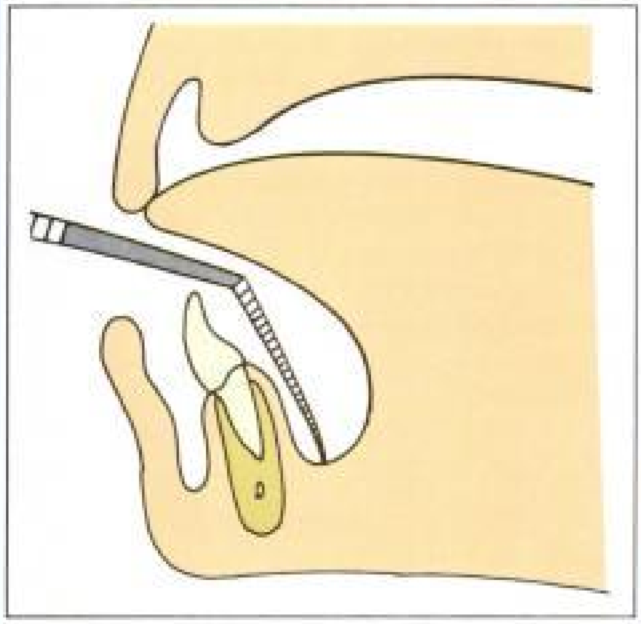
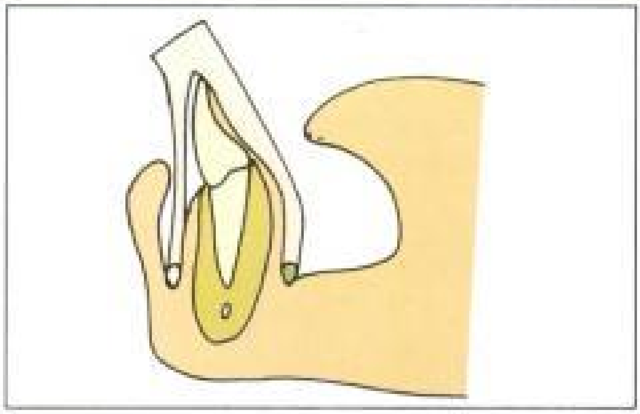


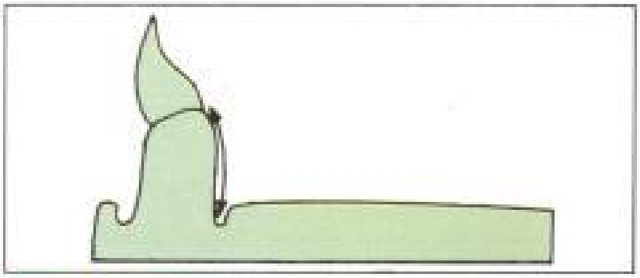
Fig. 18.82: The depth of the lingual sulcus can be measured using a graduated probe when the muscles in the floor of the mouth are made active. The floor of the mouth can be activated by asking the patient to touch his upper lip with his tongue

Using tracing compound: An impression tray whose lingual border is about 3 mm short of an elevated floor of the mouth is used. The lingual sulcus is recorded with the help of tracing compound. After border moulding, the impression is made using this tray. The exact sulcus depth and width are reproduced in the cast poured/made from this impression. This cast is used to fabricate the framework (Fig. 18.83).

There are six common types of mandibular major connectors.

- Lingual bar
- Lingual plate
- Kennedy bar or double lingual bar.
- Sublingual bar
- Mandibular cingulum bar (continuous bar)
- Labial bar





Figs 18.83a and b: The lingual sulcus can also be measured indirectly on a cast prepared from a border moulded secondary impression

Lingual Bar

It is the most commonly used mandibular major connector

- It is half pear-shaped in cross-section with the thickest portion placed inferiorly (Fig. 18.84).
- It is made from a thick (6-gauge) half pear-shaped wax pattern.

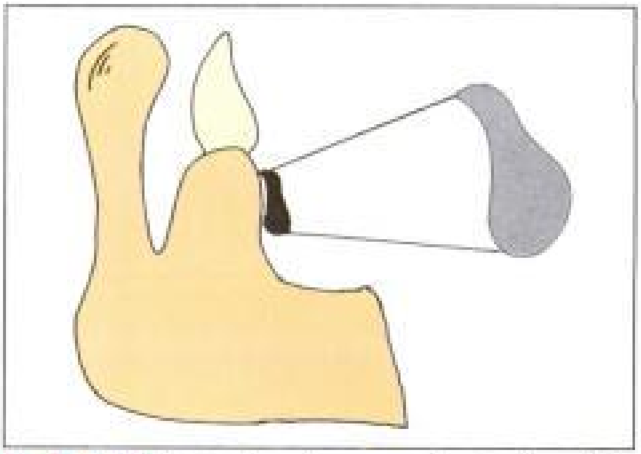


Fig. 18.84: Half pear-shaped cross-section of a lingual bar major connector

- There must be a minimum of 8 mm vertical clearance from the floor of mouth. The upper border of the pattern should have a 3 mm clearance from the marginal gingiva to avoid any soft tissue reaction (Fig. 18.85).

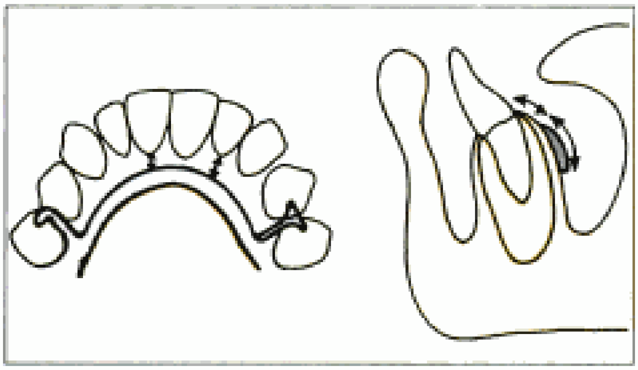


Fig. 18.85: The lingual sulcus should have a minimal depth of 8 mm inorder to place a lingual bar. The bar measures 5 mm in width and should be placed with an intentional relief of 3 mm away from the free gingival margin

- The minimum height of the major connector should be atleast 5 mm.
- Lingual bar should be placed as inferior as possible so that movements of the tongue is not restricted and sufficient space can be available above it.

Advantages:

- It is easy to fabricate.
- It has mild contact with oral tissues and no contact with teeth (no decalcification due to food and plaque accumulation, etc).

Disadvantages:

- Cannot be used in cases with tori (contraindicated).
- In cases with limited vestibular depth, the bar will be thinned out and tends to flex.

Lingual Plate

- It is similar to the lingual bar but the superior border extends up to the cingulum of the lingual surface of the teeth (Fig. 18.86).
- Chrome metal is used because it is very rigid in thin dimensions.
- Superior border is scalloped and has an intimate contact with the teeth. This produces a knife edged margin (Fig. 18.87).

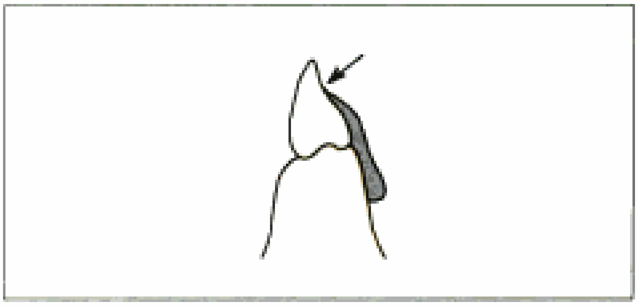


Fig. 18.86: Lingual plate major connector that extends upto the cingulum of the remaining teeth

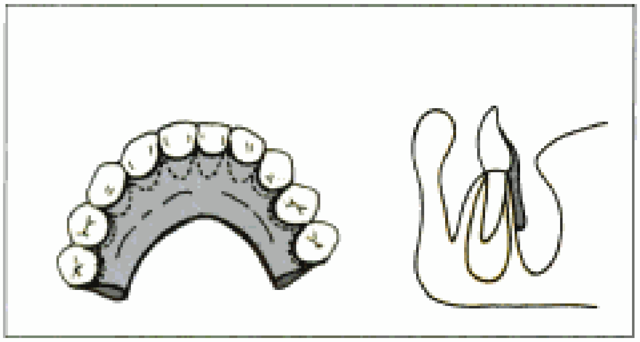


Fig. 18.87: Lingual plate major connector. Occlusal and cross-sectional view

- In cases with large embrasures and spacing, the superior border is made to dip down so that it is not visible externally (Step back design) (Fig. 18.88).

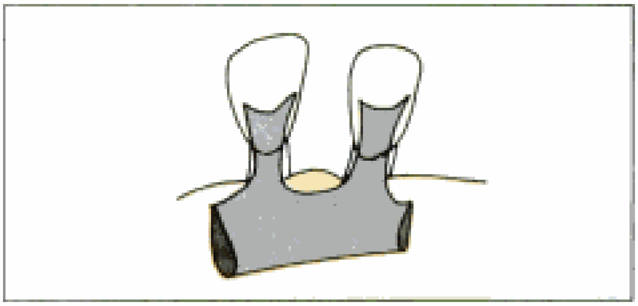


Fig. 18.88: Step back design incorporated into the design of a lingual plate major connector for cases with wide diastema

- Anteriorly, the lingual plate should be supported by rests (described later) located on mesial fossa of the first premolars of either side (Fig. 18.89) if indirect retention is required.

Indications:

- When most posterior teeth are lost and additional indirect retention is required.

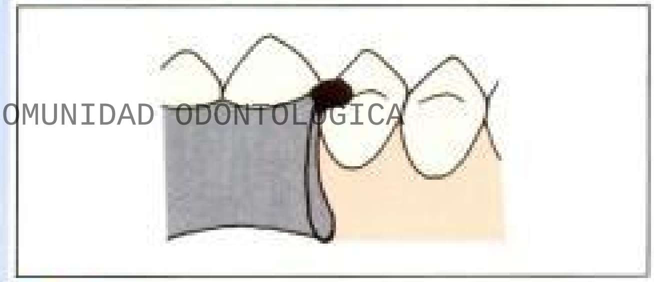


Fig. 18.89: Lingual plate major connectors supported with a rest at the mesial marginal ridge of the first premolar on either side

- When remaining teeth are not periodontally sound.
- When there is no space for lingual bar.
- Presence of inoperable mandibular tori.
- When patient has bilateral distal extension edentulous areas and resorbed ridges and when anterior teeth lack bony support.
- When one or more incisor teeth have to be replaced in the future. The lingual plate is preferred because additional teeth can be added by attaching retention loops to it (Fig. 18.90).
- When there is excessive vertical ridge resorption in Kennedy's class I cases to resist horizontal rotations.

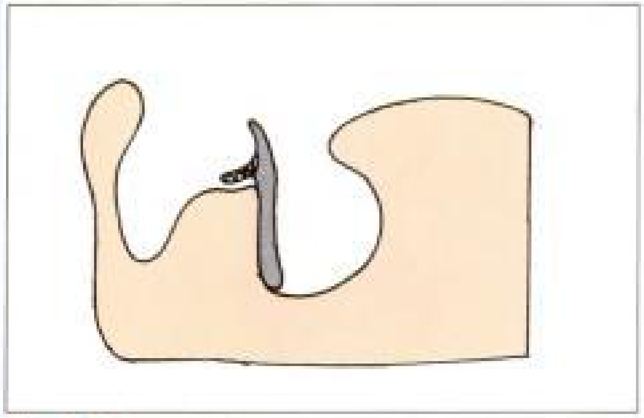


Fig. 18.90: Retentive loops that can be welded to the lingual plate major connector to add an additional tooth to the framework

- In cases with a retrognathic jaw where overeruption can occur. Lingual plates with incisal rests are used here to prevent overeruption.

Advantages:
- Most rigid and stable.
- Provides indirect retention when rests are provided on the premolars.
- Additional tooth replacements can be easily added.

Disadvantages:
- Decalcification of tooth structure due to food and plaque accumulation.
- Irritation of oral mucosa.

Double lingual bar/Kennedy bar

- It is also called lingual bar with cingulum bar (continuous bar) retainer.
- It differs from lingual plate in that the middle portion is taken off.
- Lower part is pear-shaped, similar to single lingual bar.
- Upper bar is half oval, 2-3 mm high and 1 mm thick (Fig. 18.91).

Fig. 18.91: Double lingual bar occlusal and cross-sectional view

- The upper bar should not run in a straight line instead, it should dip into the embrasures.
- If a diastema is present, a step-back design is used (Fig.18.92).

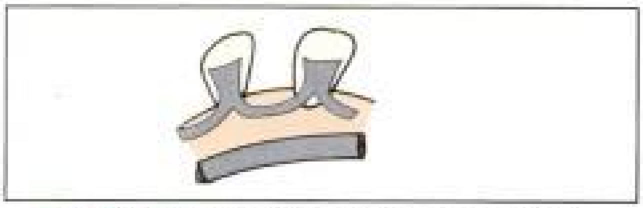


Fig. 18.92: Step-back design incorporated into the superior bar to avoid metal display in diastema cases

- The two bars are connected with the help of a minor connector placed between the canine and the premolar (Fig. 18.93).

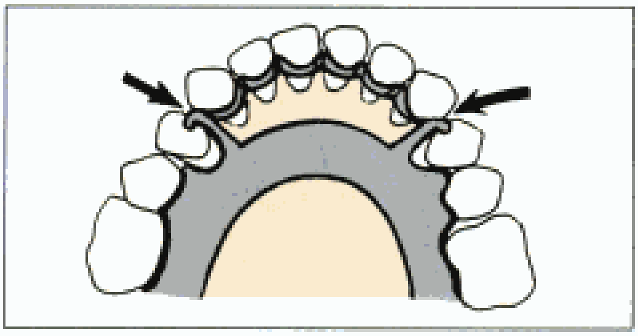


Fig. 18.93: The vertical major connector supporting the mesial premolar rests serves to unite the double lingual bar

- The minor connector is also used to place rests on the mesial fossa of the first premolar.

Indications:
- In cases with large interproximal embrasures needing indirect retention.
- In cases with large diastema to avoid unaesthetic display of metal.

Advantages:
- Provide indirect retention
- Horizontal stabilization
- Inter-proximal embrasures and gingival tissues are not covered allowing free flow of saliva.

Disadvantages:
- Interference with the free movements of the tongue.
- If upper bar is not properly fitting food entrapment may occur.

Sublingual bar It is a modification of the lingual bar. The cross-section is similar to the lingual bar except that it is placed more inferiorly and posteriorly than the lingual bar i.e. overlying the anterior part of the floor of the mouth (Fig. 18.94).

Indications.
- It can be used alongwith a lingual plate if the lingual frenum does not produce any interference.
- It is used in the presence of anterior lingual undercut.
- If the sulcus depth is too little and a lingual bar cannot be placed with atleast 4mm clearance from the free gingival margin.

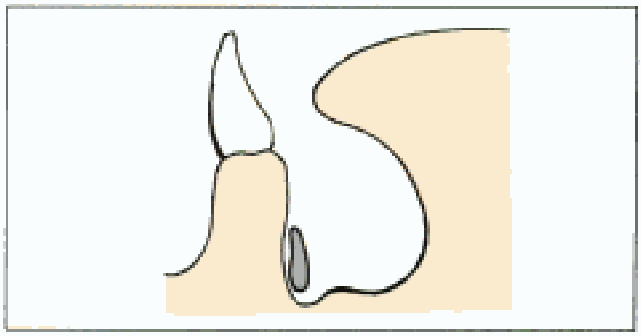


Fig. 18.94: A sub-lingual bar major connector placed deep into the lingual sulcus

Contraindications:
- Lingual tori
- High frenal attachment (lingual frenum).
- Excessive elevation of the floor of the mouth during functional movements.

Cingulum bar
- It is also known as the *'continuous bar retainer'*.
- It is located on or slightly above the cingula of the anterior teeth (Fig. 18.95).
- It may be used alone or with a lingual bar.
- Step-back design is followed for diastema patients.

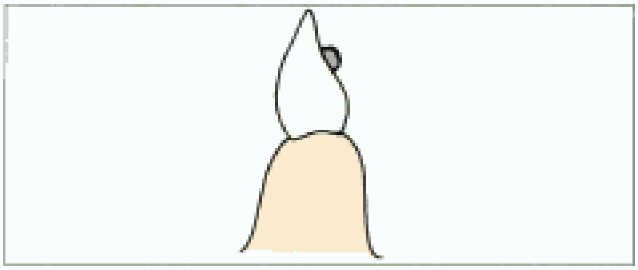


Fig. 18.95: Cross-sectional view of a cingulum bar major connector

Indications:
- In cases with large interproximal embrasures requiring indirect retention.
- In cases with large diastema to avoid unaesthetic display of metal.

Labial bar
- It is a mandibular major connector similar to a lingual bar placed on the labial surface, but it is broader and thicker than a lingual bar (Fig. 18.96).
- It is also half-pear-shaped in cross-section.
- It runs along the mucosa labial to the anterior teeth.

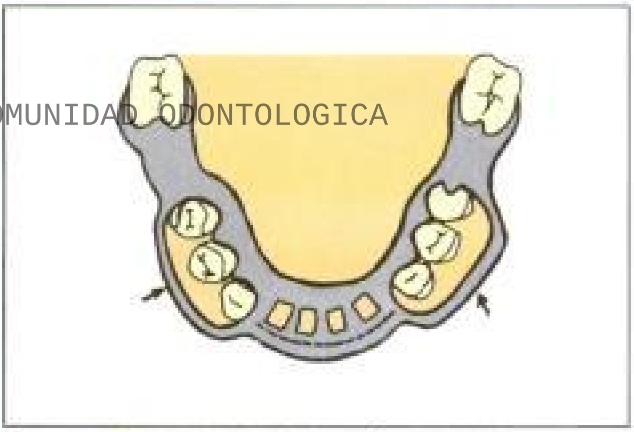


Fig. 18.96a: Labial bar: Occlusal view

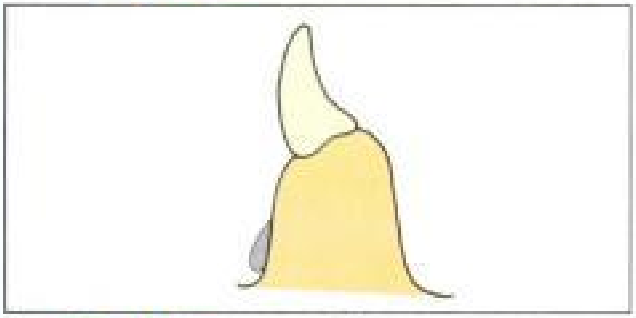


Fig. 18.96b: Labial bar: Cross-secitonal view

- The labial bar is generally longer than the lingual bar.

Indications:

- Used when the teeth are lingually placed or inclined.
- In cases with inoperable mandibular tori.
- Modification of labial bar (swing lock) a hinge is placed at one end and a lock at the other so that there is closer adaptation.

Disadvantages:

- Poor aesthetics.
- Tends to distort lower lip.
- Patient discomfort.

Minor Connectors

Definition

A minor connector is defined as, *"The connecting link between the major connector or base of a removable partial denture and other units of the prosthesis, such as clasps, indirect retainers and occlusal rests"* - GPT.

Functions of the Minor Connector

- It connects the major connector to other parts like clasps, rest, indirect retainers and denture bases.
- It transmits stresses evenly to all components so that there is no concentration of load at any single point
- It transmits the forces acting on the prosthesis to the edentulous ridge and the remaining natural teeth.

Minor Connectors are of Four Types

- Joining the clasp assembly to major connectors
- Joining the indirect retainer or auxiliary rest to the major connector.
- Joining the denture base to the major connector.
- Approach arm in bar type clasp

Minor connectors that join the clasp assembly to the major connector As the name suggests, these minor connectors are used to connect the clasps to the denture. The following design concepts should be considered while fabricating these minor connectors:

- Most minor connectors that support clasp assemblies are located on proximal surface of abutment teeth adjacent to an edentulous area (Fig. 18.97).

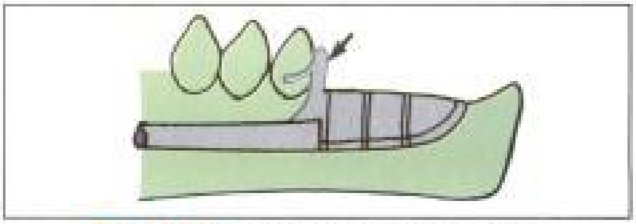


Fig. 18.97: Minor connectors that support clasp assemblies

- It should be broader buccolingually and thinner mesiodistally (Fig. 18.98).
- It should not be bulky to avoid any tongue interference (Fig. 18.99).
- It should be rigid enough to support the active components of a partial denture like retentive clasp etc. Exception: Approach arm of a roach clasp is the only flexible minor connector.

Fig. 18.98: A schematic representation of the lingual view of a minor connector in close association with a primary abutment. Notice that the mesiodistal width of the minor connector is greater lingually than buccally. Buccolingually the width of the major connector covers the width of the proximal surface (guide plane) of the abutment tooth

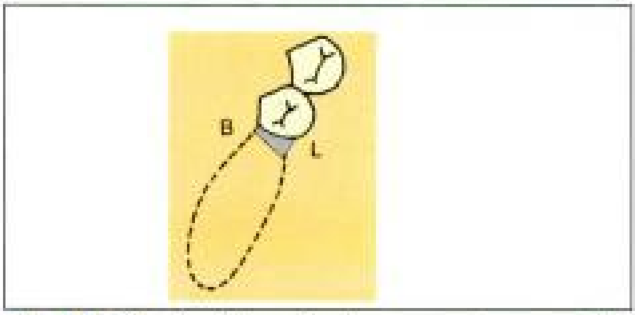


Fig. 18.99: Occlusal view of a minor connector supporting direct retainers

- Since it can be also attached to the rest in the clasp assembly it prevents the vertical tissueward movement of the partial denture.
- It should have a triangular cross section with the thickest portion near the lingual line angle of the tooth and the thinnest portion near the buccal line angle of the tooth. This configuration aids in better teeth arrangement (Fig. 18.100).
- If the clasp assembly is not being placed on the tooth adjacent to the edentulous space, the minor connector is placed in the embrasure between abutment at its neighbouring tooth (Fig. 18.101).

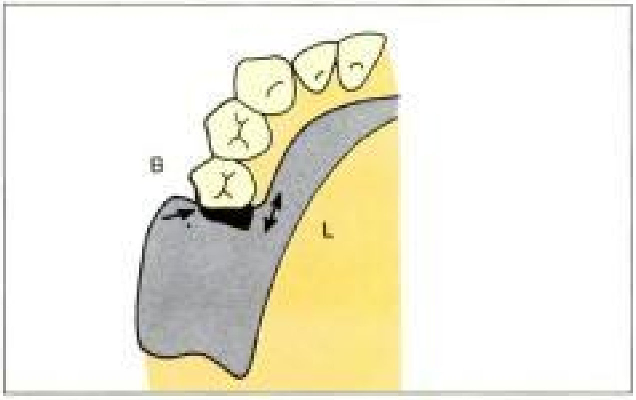


Fig. 18.100: This configuration wherein the minor connector is thicker lingually aids in aesthetic arrangement of teeth

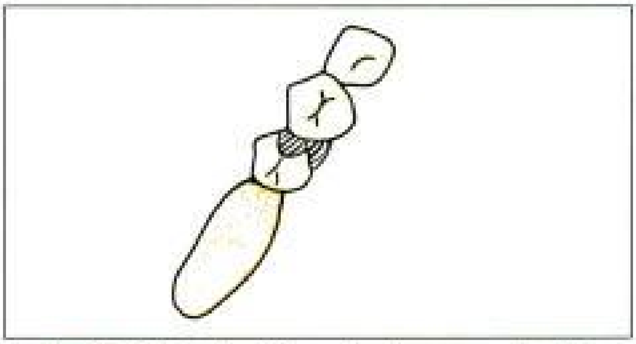


Fig. 18.101: Occlusal view of a minor connector that supports an auxiliary rest

- The Minor connector should never be placed on the convex lingual surface of the tooth.
- The Auxillary supporting strut used to stabilize the ring clasp also comes under this category.

Minor connector that join the indirect retainer or auxiliary rests to the major connector The main function of this minor connector is to provide indirect retention and support to the denture.

- They arise at right angles from the major connector with a rounded junction (Fig. 18.102).

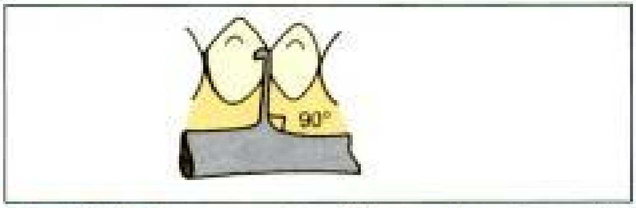


Fig. 18.102: Minor connectors that support auxiliary rests should arise from the major connector at right angles

- They must be designed to fit into the embrasure space so that they are not visible (Fig. 18.103).
- The surface of the minor connector, which contacts the tooth, is known as the proximal plate. Similarly, the surface of the tooth contacted by the proximal plate is known as guiding plane.

Design considerations:

- The operator should remove the undercuts along the proximal surface of the teeth. The

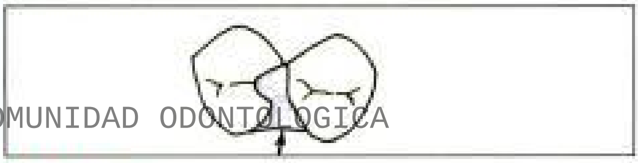


Fig. 18.103: Minor connectors that support auxiliary rests should be triangular in cross-section and fill the embrasure space. If not properly fabricated they may produce interferences and discomfort to the tongue

guide planes are prepared during prosthetic mouth preparation and after preparing the guide planes, the minor connector and its proximal plate are fabricated.

- The area where the minor connector is to be designed should be devoid of undercuts. It should be parallel to the path of insertion.

Minor connectors that join the denture base with the major connector *These minor connectors should fulfill the following requirements:*

- It should be rigid enough to support and resist breakage of the denture base.
- It should allow proper arrangement of natural teeth.
- In maxillary distal extension cases the minor connector should extend up to the maxillary tuberosity.
- In mandibular distal extension cases the minor connector should cover 2/3rd the length of edentulous ridge.

  It is available in three forms:
  - Lattice work construction.
  - Meshwork construction.
  - Bead, wire or nail head minor connectors.

Lattice work:

- It consists of two long struts of metal (16 gauge) placed on the buccal and lingual slopes of the ridge with smaller struts (12 gauge) running over the crest of the ridge connecting the long struts. This resembles lattice framework (Fig. 18.104).
- In the maxilla, the palatal strut is formed by the lateral border of major connector.
- Longitudinal struts should **not** be placed on the crest of the ridge as they can interfere with the arrangement of teeth. They can also produce a cleaving action on the denture base (Fig. 18.105).

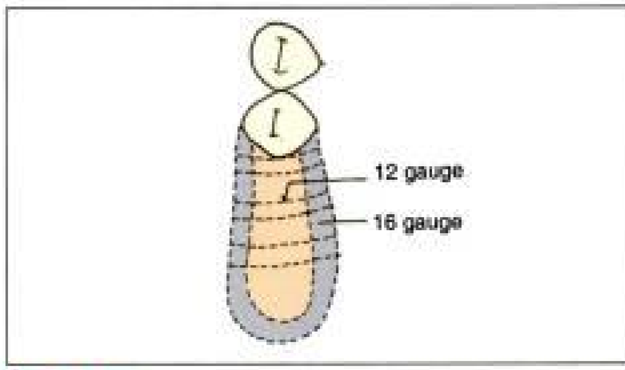


Fig. 18.104: Lattice work denture base minor connector. Notice that the outer longitudinal struts are wider than the inner transverse struts

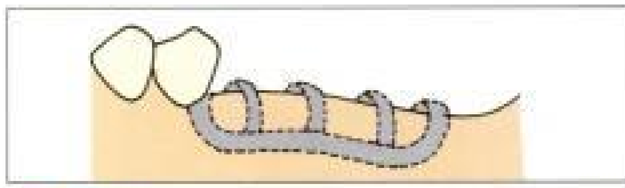


Fig. 18.105: Only the transverse struts should cross the crest of the residual ridge

- Transverse struts should be placed such that they donot interfere with tooth placement.
- Relief is given between the struts and the ridge for acrylic to flow. This is done with the help of tissue stops (Fig. 18.106).

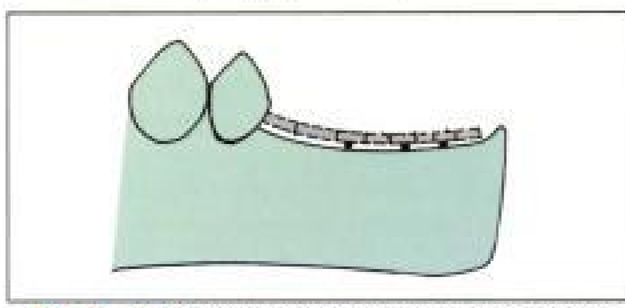


Fig. 18.106: Relief for acrylic is provided between the struts and the ridge with the help of stoppers

Meshwork:

- It consists of a sheet of metal placed over the crest of residual ridge with small holes for retention of acrylic denture base (Fig. 18.107).
- It is mostly used when multiple teeth are to be replaced.

Disadvantages:

- Additional pressure should be applied for acrylic resin to flow into the holes.

Fig. 18.107: Meshwork denture base minor connector

- Retention to the denture base is less, as the holes are smaller and the attachment of acrylic is weaker.

Bead, Wire or Nail Head:

- The minor connector directly lines the edentulous ridge without any relief.
- Acrylic denture base is attached to the outer surface of the minor connector and retention is obtained by the projections of metal on the superior surface. These projections may be beads, nails, or pointing wires (Fig. 18.108).

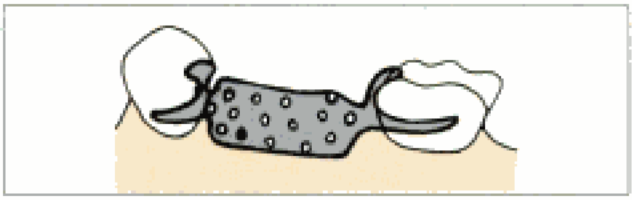


Fig. 18.108a: Beaded denture base minor connector

Fig. 18.108b: Cross-sectional view, notice that no relief is provided for acrylic between the minor connector and the ridge. The tissue surface of these dentures will be of metal and hence they cannot be relined

- Beads are prepared by placing acrylic balls on the meshwork pattern, burntout and cast.
- This minor connector is indicated for tooth supported dentures with well-healed ridges where frequent relining and rebasing are not anticipated.

Advantages:

- Better soft tissue response to metal than acrylic.
- More hygienic.

Disadvantages:

- Relining is difficult
- Weakest attachment.

Tissue stops

- In cases with distal extension denture base a lattice or mesh type minor connector with tissue stops are used to stabilize the framework during packing of the resin.
- It prevents the distortion of the framework.
- The stop gives adequate space for acrylic to flow in-between the framework and the tissue surface of the cast (Fig. 18.109).

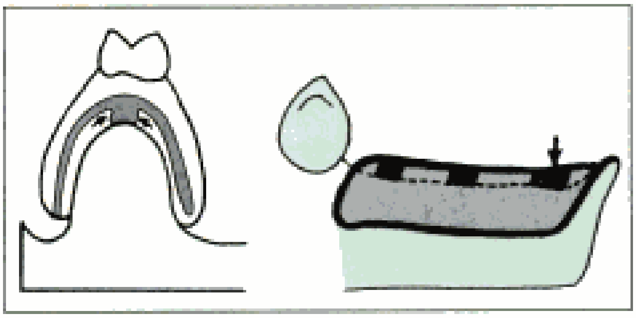


Fig. 18.109: Metal tissue stops provided to obtain a space for acrylic between the metal framework and the ridge

- Stops are prepared by removing two sq.mm of relief wax placed under the minor connector at a level where the posterior border of the connector crosses the center of the ridge. This will become a projection after casting and will act like a stopper (Fig. 18.110).

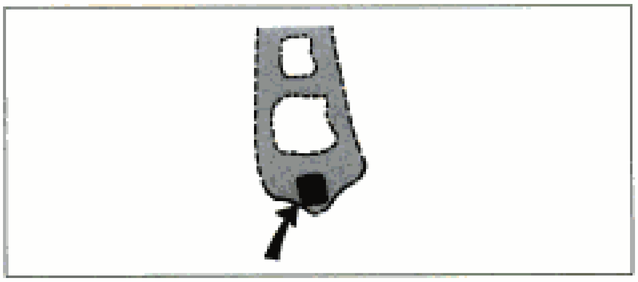


Fig. 18.110: Posterior most tissue stop

Finish lines

The term finish line in a partial denture denotes the junction between the acrylic denture base and the major connector or any polished metal surface.

Internal finish line (IFL): Space between the metal framework and the tissues surface of the cast is provided by adding relief wax onto the edentulous ridge on the master cast. The ledge created by the margin of the relief wax in the metal framework should be sharp and definite. This margin is called the internal finish line (Fig. 18.111).

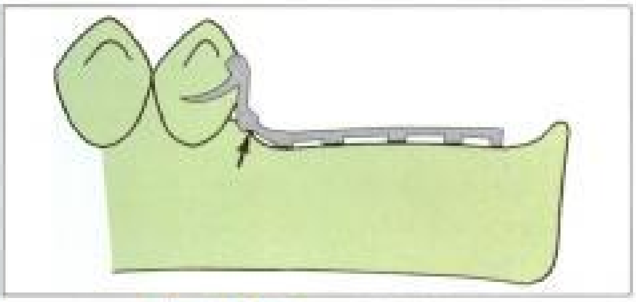


Fig. 18.111: Internal finish line

External finish line (EFL): It is the junction between the acrylic and the exposed metal on the external or polished surface. It must be less than 90^0 at the junction of the major and minor connectors, whereas the junction between the approach arm and the denture base connector should be a butt joint. The external finish line should extend from the lower border of the major connection—denture base minor connector junction to the origin of the direct retainer minor connector near the crest of the ridge (Fig. 18.112).

Design considerations:

- Acrylic resin should be sufficiently thick to avoid fracture.

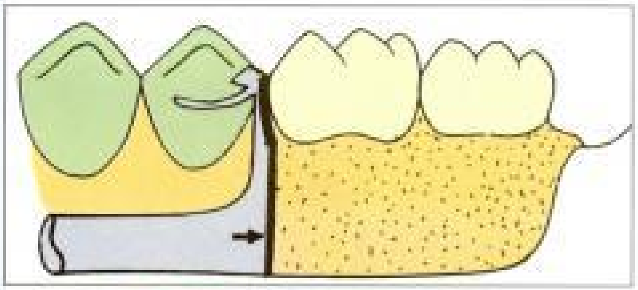


Fig. 18.112: External finish line (red line)

- Acrylic around the lattice or mesh should be smooth or else it will irritate the tongue or mucosa.
- Butt joints are provided at the acrylic metal junction to prevent acrylic from being thinned out and to make the acrylic blend smoothly with the metal. These butt joints are referred to as finish lines (Fig. 18.113).

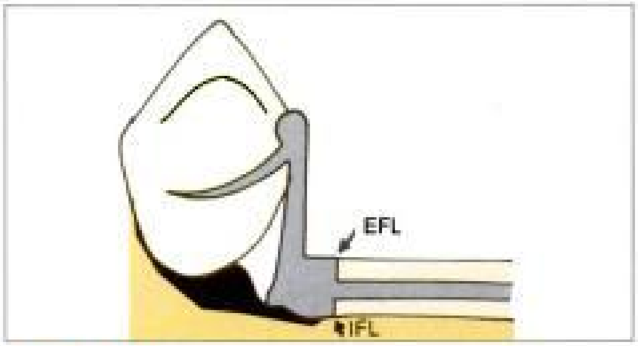


Fig. 18.113: External and internal finish lines providing butt joints for acrylic and metal

- Finish lines are usually present on the internal and external surfaces of major connector. But in the case of metal base minor connector (bead type) the acrylic is processed only on the outer surface so only a single (EFL) butt joint will be present.

Minor connector that serves as an approach arm for bar- type clasp This minor connector almost acts like a clasp. It helps to position the retentive tips of the gingivally approaching clasps (Fig. 18.114a). This type of minor connector has the following characteristics:

- It is not rigid, as it does not have to bear any load. It should have limited flexibility to aid in removal.

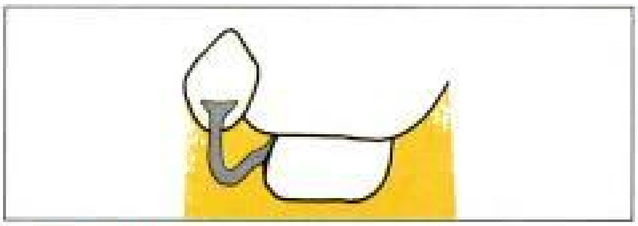


Fig. 18.114a: Approach arm of a bar or roach clasp

- It supports the direct retainer, which engages the undercut of the tooth by approaching it gingivally.

- It is more flexible; hence, the retention is improved by its springy action.

Design considerations:

- Since the minor connector lies below the height of contour of the tooth, it should be made slightly flexible for easy insertion and removal. A partial cut on the root of the minor connector makes it flexible (Fig. 18.114b).

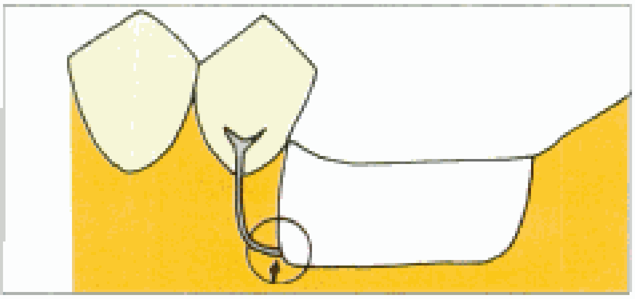


Fig. 18.114b: Flexibility of the approach arm is increased by making a partial cut near it's origin

- This minor connector cannot be used over soft tissue undercuts.

Rest and Rest Seats

Definition of a Rest

Rest is defined as, "*A rigid (stabilizing) extension of a fixed or removable partial denture which contacts a remaining tooth or teeth to dissipate vertical or horizontal forces*" - GPT.

Rest is the component of a prosthesis that serves primarily to transfer the forces acting on the prosthesis along the long axis of abutment teeth.

Definition of a Rest Seat or Rest Area

It is defined as, "*That portion of a natural tooth or a cast restoration of a tooth selected or prepared to receive an occlusal, incisal, lingual, internal, or semiprecision rest*" - GPT.

It is the prepared surface of the tooth (only on the enamel) into which the rest fits. The rest seat should be shallow and saucer-shaped (Fig. 18.115).

Fig. 18.115: Shallow saucer-shaped rest seat preparation occlusal and sagittal view

General Considerations

- The rest acts as a vertical stop to prevent injury to soft tissue under partial denture.
- It helps to hold clasp assembly in position.
- A large occlusal onlay rest can be contoured to re-establish the occlusal plane of a tilted abutment tooth.
- There should be slight movement within the rest seat (like a ball and socket joint) to dissipate horizontal forces and protect the abutment teeth. (Fig. 18.116).

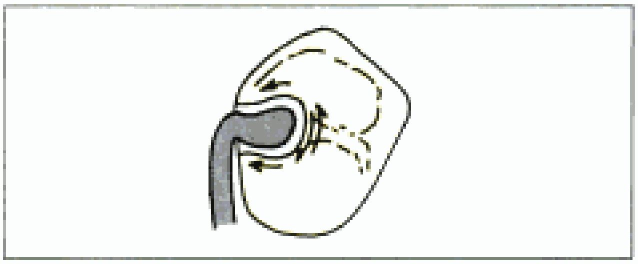


Fig. 18.116: The rest seat should allow slight movement of the rest to dissipate unwanted forces

- Rests should be placed on the proximal surfaces of all the teeth adjacent to the edentulous space. Ideally, the rest should be aligned to the crest of the edentulous ridge but this may not be possible in rotated teeth.
- If the edentulous space has decreased due to drifting, a metal pontic can be placed in this space using two occlusal rests (Fig. 18.117).
- A rest and a properly positioned minor connector can be used for reciprocation.

Classification of Rests

Rests can be classified as follows:

- Based on the relation of the rest to the direct retainer.

Fig. 18.117: A modified rest prepared to fill a minute edentulous space (Pontic clasp)

- Based on the location of the rest.
- Based on the shape and structure of the rest.

  Example: Triangular occlusal rests, 'Boomerang-shaped' Cingular rests, 'V' shaped incisal ress and conservative circular cingular rest.

Based on the Relation of the Rest to the Direct Retainer Based on the relation of the rest to the direct retainer, they can be classified as primary or secondary. Rests that are placed along with the clasp assembly are called *primary rests* and the ones placed for indirect retention, separately, away from the clasp are called *secondary or auxiliary rests* (Fig. 18.118).

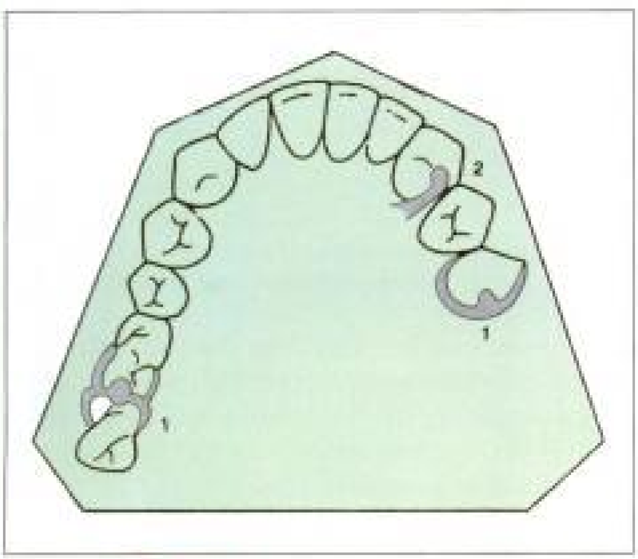


Fig. 18.118: Primary and auxiliary rests (1) Primary rest (2) Auxiliary rest

Auxiliary rests are usually placed where the perpendicular drawn from the midpoint of the terminal abutment axis meets the dentition. The auxiliary rests are connected to the major connector by a minor connector (Fig. 18.119). The auxiliary rest along with the minor connector pro-

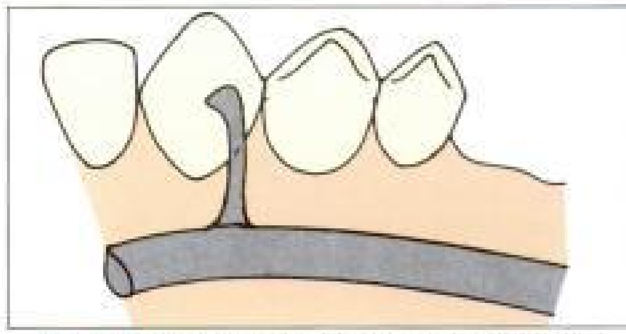


Fig. 18.119: An auxiliary rest connected to the major connector by a vertical minor connector

duce indirect retention. Apart from vertical support, the primary rests are used for direct retention and secondary rests are used for indirect retention.

Based on the position of the rest on the abutment Based on the position of the rest on the abutment it can be classified as:

Occlusal rest: Placed on occlusal surface of a posterior tooth (Fig. 18.120).

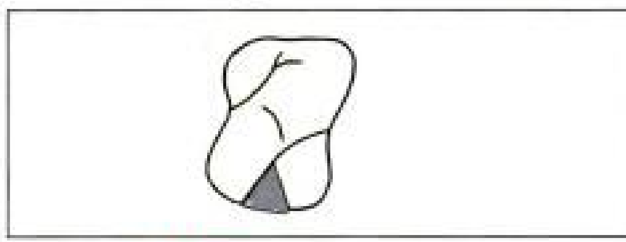


Fig. 18.120: Triangular occlusal rest

Cingulum or lingual rest: Placed on the lingual surface of a tooth, especially in a maxillary canine (Fig. 18.121).

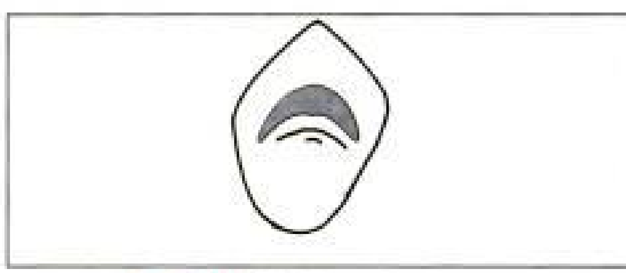


Fig. 18.121: Semilunar cingulum rest

Incisal rest: Placed on the incisal edge of a tooth, usually in a mandibular canine and incisors (Fig. 18.122).

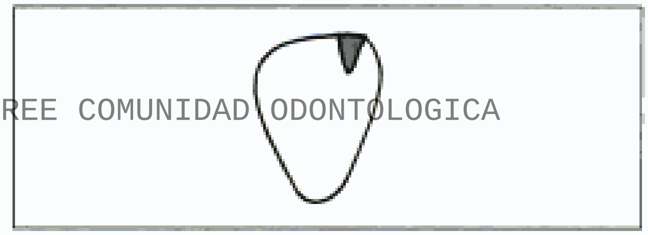


Fig. 18.122: 'V' shaped incisal rest

The morphology of any rest should be such that it restores the tooth form that existed before the rest seat preparation. Now we shall discuss in detail about the structure, function and design of each rest.

Occlusal Rest and Rest Seat

An occlusal rest can be defined as, *"A rigid extension of a partial denture which contacts the occlusal surface of the tooth"*- GPT.

Functions of an Occlusal Rest

- Transmit stress along the long axis of the tooth.
- Secure the clasp in a proper position and maintain the tooth-clasp relationship.
- Prevent spreading of the clasp arms and subsequent displacement of the clasp and the prosthesis.
- Assist in distribution of occlusal load.
- Prevent extrusion of the abutment.
- Avoid plunging of food between the tooth and the clasp.
- Provide resistance to lateral displacement.
- Sometimes contributes to indirect retention.
- Used to close small spaces where a tooth replacement cannot be placed (Fig. 18.123).

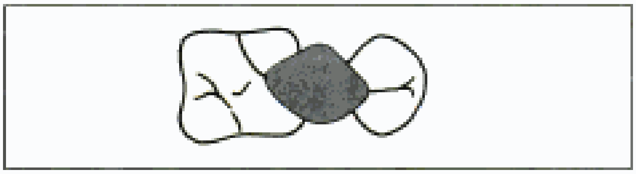


Fig. 18.123: Two occlusal rests used to close a large embrasure or a small edentulous space

- Helps to build up the occlusal plane of a tilted tooth.

Design

- The occlusal rest seat is a triangular-shaped depression, with its base at the marginal ridge and apex at the center of the tooth. Its margins should be smooth and gently curved (Fig. 18.124).

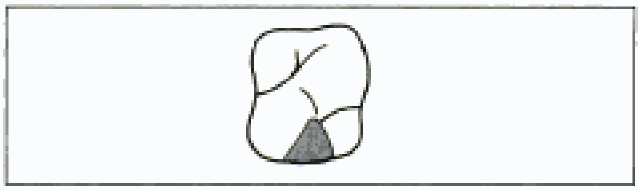


Fig. 18.124: Triangular occlusal rest

- It should follow the contour of the mesial or distal marginal ridge and the triangular fossa.
- The size of the occlusal rest should be
  - One-half the Buccolingual width between the cusp tips (Fig. 18.125).
  - One-third to one-half the mesiodistal width of the tooth (Fig. 18.125).

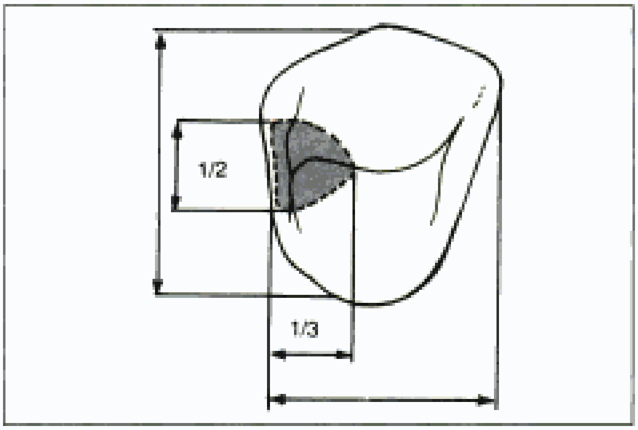


Fig. 18.125: Ideally an occlusal rest should measure ½ the width of the tooth buccolingually and ⅓rd the width of the tooth mesiodistally

- The angle between the line drawn along the proximal surface of the tooth and the floor of the rest seat should be less than 90° (Fig. 18.126).
- If it is more than 90°, the forces acting on the prosthesis will not be transmitted along a long axis of the abutment tooth. Instead these forces will be transmitted along an inclined plane. Hence, the prosthesis will slip from the abutment tooth (Fig. 18.127).

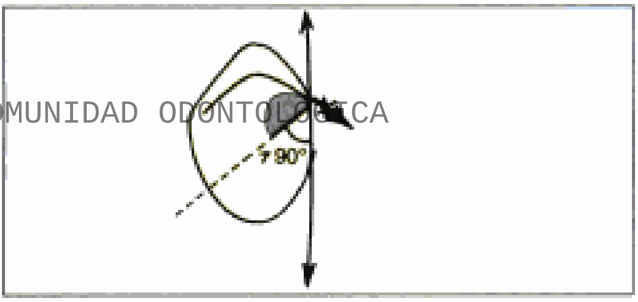


Fig. 18.126: The floor of the rest seat should be less than 90° to the long axis of the tooth drawn along the proximal surface

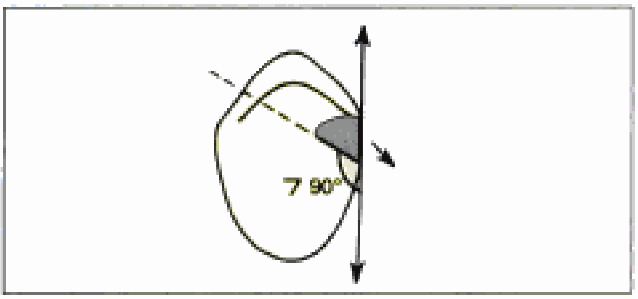
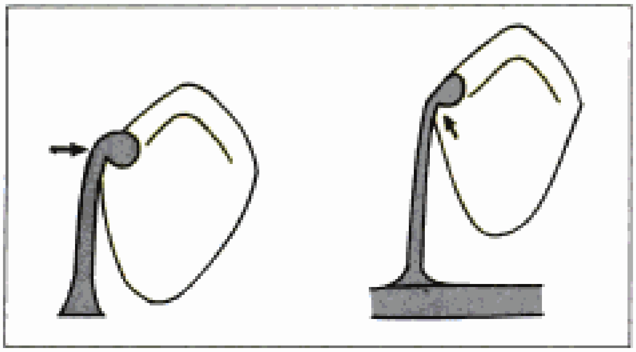


Fig. 18.127: If the floor of the rest seat is greater than 90° to the proximal long axis, the rest will slip proximally during occlusal loading

This may also produce orthodontic movement of the abutment teeth leading to pain and bone loss.

- Improper preparation at the marginal ridge can predispose to fracture. The rest seat should be 0.5 mm thick at its thinnest portion and 1.0 - 1.5 mm thick where it crosses marginal ridge (Fig. 18.128).



Figs 18.128a and b: (a) The thickness of the rest should be adequate at its junction with the minor connector (b) Inadequate rest-seat preparation may produce thinning of the rest-minor connector junction leading to fracture of the same

- The rest seat can also be prepared on restorations like cast gold and amalgam.
- Rest seats on amalgam can be used only for interim or temporary partial dentures. The restoration may tend to fracture if the rest seat is used for a permanent denture.
- Cast gold (inlay, onlay, crown) restoration on an abutment tooth can be used to prepare rest seats for a permanent prosthesis.

Lingual or Cingulum Rest and Rest Seats

As the name indicates, these rests are prepared on the lingual surface or above the cingulum of the anterior teeth and the canine.

- They are usually fabricated on maxillary canines.
- A cingulum rest cannot be prepared in mandibular canines due to the inadequate thickness of enamel.
- They are better than incisal rests because they transfer the occlusal forces along the long axis of the tooth.
- Lingual rests may be used on incisors only when the canines are missing. As the incisors have reduced alveolar support, multiple incisal rests are often used. An occlusal rest placed on the mesial fossa of a premolar is better and more preferred than a lingual rest on the anteriors.
- Lingual rests are nearer to the center of rotation of the tooth. Hence, they help to avoid tipping of the abutment (Fig. 18.129).
- Cingulum rests are preferred to incisal rests because they are situated nearer the center of the tooth and leverage forces are less. They are also more esthetic and durable as they are resistant to breakage and distortion.
- The outline form is half-moon-shaped extending as a smooth curve from one marginal ridge to the other (Fig. 18.130). It should cross the center of the tooth incisal (above) to the cingulum (Fig. 18.131). The line angles should be rounded. The rest seat is 'V' or boomerang-shaped.

Design considerations A cingulum rest seat should have the following characteristics:

- 2.5 to 3 mm mesiodistal length (Fig. 18.132).

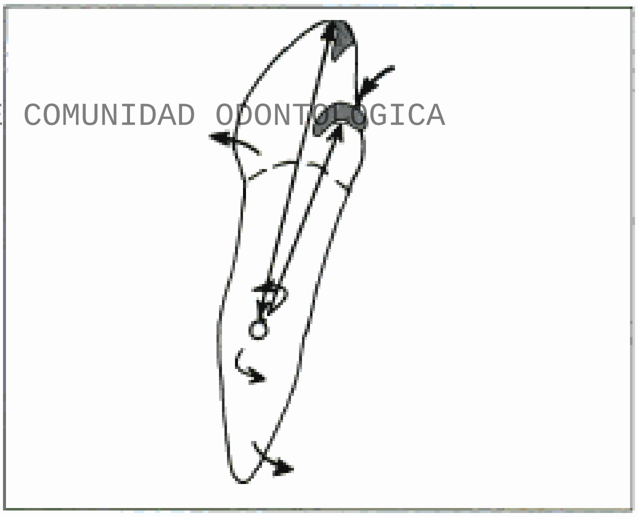


Fig. 18.129: Rests which are closer to the axis of rotation will produce less torsional forces on the abutments

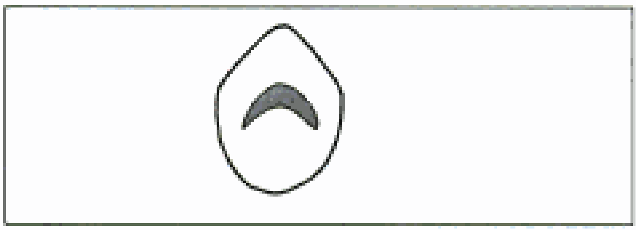


Fig. 18.130: A semilunar cingulum rest

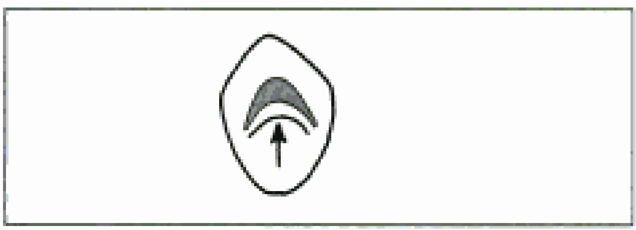


Fig. 18.131: The cingulum rest should be more incisal as it crosses the midline of the tooth. It should be prepared incisal to the cingulum and not on it

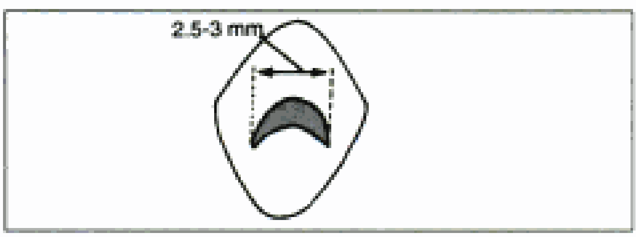


Fig. 18.132: Ideally cingulum rests should be around 2.5 to 3 mm wide mesiodistally

- 2 mm labiolingual width (Fig. 18.133)
- 1.5 mm deep (Fig. 18.134).

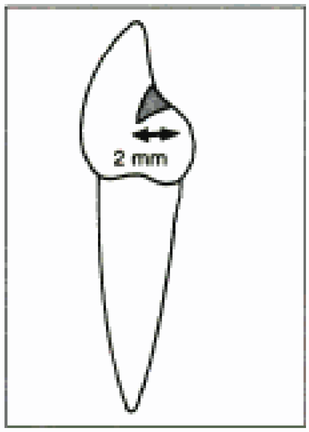


Fig. 18.133: A cingulum rest should be 2 mm wide labio-lingually

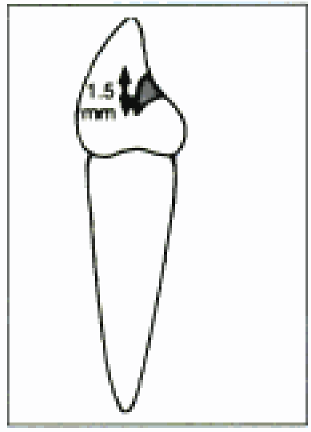


Fig. 18.134: A cingulum rest should be 1.5 mm deep when measured inciso-gingivally

- The V-shaped notch has two inclines namely the labial and lingual (Fig. 18.135). These inclines meet at the apex (deepest part) of the rest seat. The labial incline is parallel to the labial surface of the tooth. The lingual incline runs perpendicular to the labial incline. The lingual incline meets the labial incline at the apex of the rest seat (Fig. 18.136).

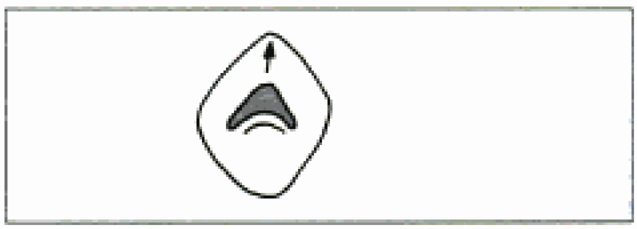


Fig. 18.135: Mesial and distal inclines of a cingulum rest

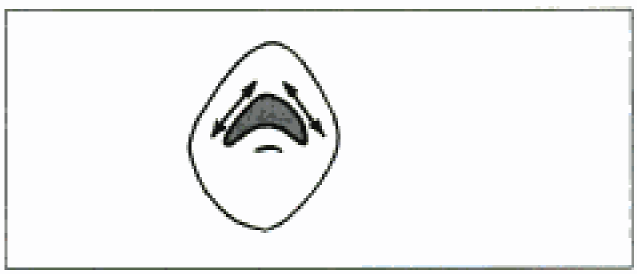


Fig. 18.136: The labial and lingual inclines meet at the apex of the rest

- The apex of the 'V' is directed incisally (Fig. 18.137).
- If they are prepared on crowns, the rest seat should be prepared in the wax pattern itself.

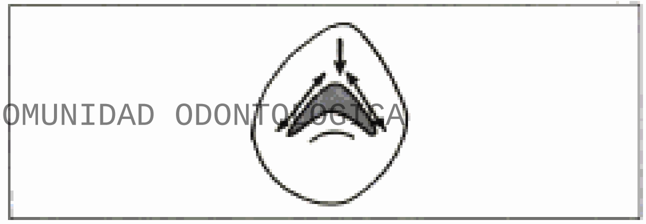


Fig. 18.137: The apex of the rest should be located closer to the incisal edge at the midline of the tooth

The wax pattern should have an accentuated cingulum to facilitate preparation (Fig. 18.138).

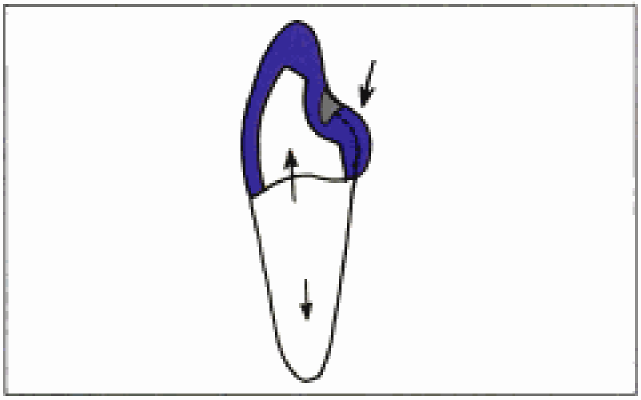


Fig. 18.138: Rest seat prepared on a wax pattern. Notice the accentuated cingulum contoured in the pattern to facilitate the placement of the rest

Indications for lingual or cingulum rests Lingual rest seat preparation on the enamel is prepared only if:

- The cingulum is prominent
- The patient practices good oral hygiene
- The caries index is low.

Incisal Rests and Rest Seats

- Incisal rests are less desirable than lingual rests.
- It is usually prepared on sound teeth especially the canines. If incisors are used, multiple rests are required for better stability and protection to the abutments.
- Incisal rests are mainly used as indirect retainers (auxiliary rests).
- If cast restorations are planned in anterior teeth, incisal rests are contraindicated. In such cases, a lingual rest seat should be made on the wax pattern of the cast restoration.
- They are frequently used on mandibular canines and rarely on maxillary canines. They are avoided on maxillary canines for aesthetic reasons.
- They are placed on mesioincisal or distoincisal angle of the tooth depending on the type of clasp designed. If clasp is not to be placed, the disto-incisal angle is preferred for aesthetics.
- The rest seat is a 'V' shaped notch located on the incisal edge of the anterior teeth. It is prepared on the incisal edge 1.5 - 2 mm away from the proximoincisal angle (Fig. 18.139).

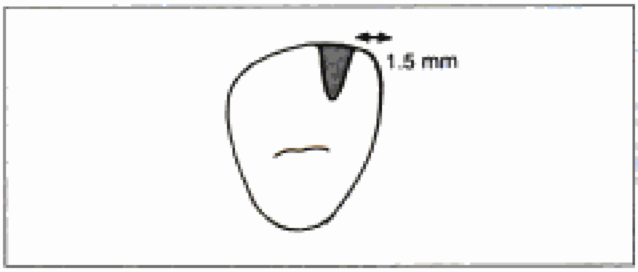


Fig. 18.139: The incisal rest should not be placed on the proximo-incisal angle of the abutment instead it is prepared 1.5-2.0 mm away from it

- The rest seat should be 2.5 mm wide and 1.5 mm deep. The deepest part of preparation should be towards the long axis of the tooth mesiodistally. The notch should be smooth (Fig. 18.140).

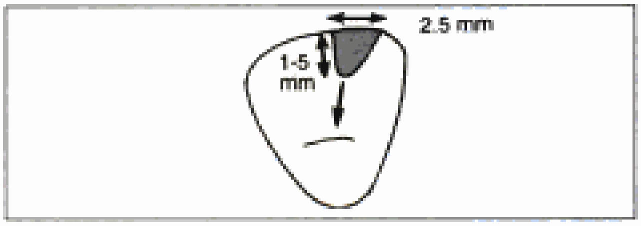


Fig. 18.140: The incisal rest should measure 2.5 mm mesiodistally and 1.5 mm occlusogingivally. The apex of the rest seat should point towards the long axis of the tooth mesiodistally

- The rest seat should extend into the facial surface to act as a locking device. This avoids the tipping movement of the tooth (Fig. 18.141).
- A shallow enamel preparation is made on the lingual surface to accommodate the minor connector and prevent discomfort to the tongue (Fig. 18.142).

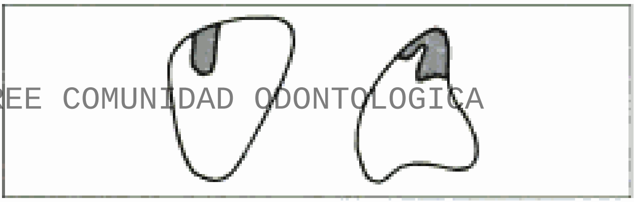


Fig. 18.141: Facial extension of the incisal rest to provide a lock for the rest

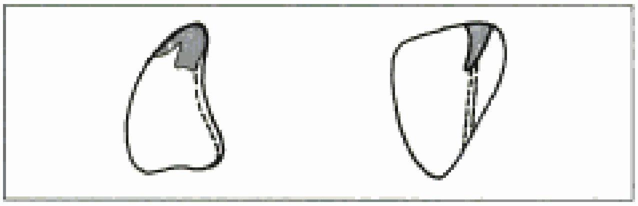


Fig. 18.142a: A shallow channel like preparation should be prepared on the lingual surface of the abutment for the placement of the minor connector

- Multiple incisal rests should be connected lingually by a plate of metal (Fig. 18.142b)

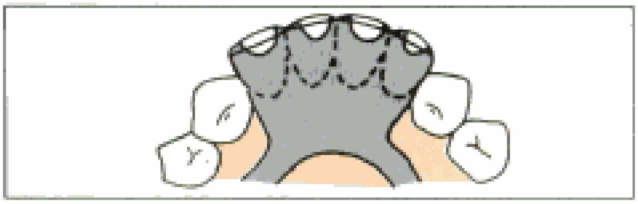


Fig. 18.142b: When multiple incisal rests are placed, each. One is not individually connected to the major connector. Instead they are interconnected with a metal plate which is connected to the major connector

Indications: Full incisal rests may be given in the following clinical conditions:

- Tooth morphology does not permit other designs.
- When the incisal edge is completely lost, the incisal rest can restore the lost contour.
- When more stability is required.
- Guidance is required for placement of the restoration.

After designing the location and position of the rests, the rest seats should be prepared. The rest seats are prepared during prosthetic mouth preparation phase (phase IV) prior to making the secondary impression. The outcome of the rest is totally dependent on the rest seat preparation. The rest is fabricated along with the framework.

The technique for the preparation of each rest seat is described in detail in the next chapter 'Prosthetic mouth preparation'. Students should remember that when questioned about a particular rest, they should also explain about the technique for preparing the corresponding rest seat.

Direct Retainers

Definitions

Direct retainer *"A clasp or attachment applied to an abutment tooth for the purpose of holding a removable denture in position".*

"It is that component part of a removable partial denture that is used to retain and prevent dislodgement, consisting of a clasp assembly or precision attachment"—GPT

Retention *"Retention is that quality inherent in the prosthesis which resists the force of gravity, the adhesiveness of foods, and the forces associated with the opening of the jaws"* – GPT.

Direct retention *"Retention obtained in a removable partial denture by the use of clasps or attachments which resist removal from the abutment teeth"* - GPT.

Indirect retention *"Retention obtained in a removable partial denture through the use of indirect retainers"* - GPT.

Classification

Direct retainers are broadly classified as:

- Extracoronal direct retainers (Clasps):
  - Manufactured retainers (Dalbo)
  - Custom-made retainers:
    - Occlusally approaching (Circumferential or Aker's clasp)
    - Gingivally approaching (Bar or Roach's clasp)
- Intracoronal direct retainers (Attachments):
  - Internal attachment
  - External attachment
  - Stud attachment
  - Bar attachment
  - Special attachments

Extracoronal Direct Retainers (Clasps)

An extracoronal direct retainer is defined as, *"A part of a removable partial denture which acts as a direct retainer and/or stabilizer for the denture by* *partially encircling or contacting an abutment tooth"* - GPT.

"It is that component of the partial denture that rests against the external enamel surfaces of an abutment tooth and aids in bracing and retention".

General considerations A clasp should be located at the undercut area in relation to the determined path of insertion and removal of the prosthesis (Fig. 18.143).

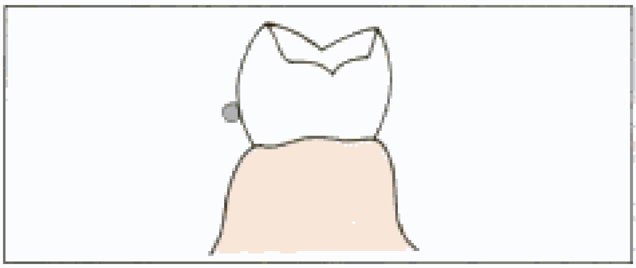


Fig. 18.143: The clasp should cross the height of contour and engage an undercut to provide retention

In 1916 Prothero proposed the Cone theory to explain the basis for clasp retention. He described the shape of the crown of premolars and molars to be equivalent to two cones (upper and lower) sharing a common base (Fig. 18.144). The upper cone resembles the occlusal half of the tooth and the lower cone resembles the cervical half of the tooth. A clasp tip that ends below the junction of the two cones will resist movement in the upward direction, because it has to deform (straighten out) to be released across the junction of the bases of the two cones. The degree of resistance to deformation determines the amount of clasp retention.

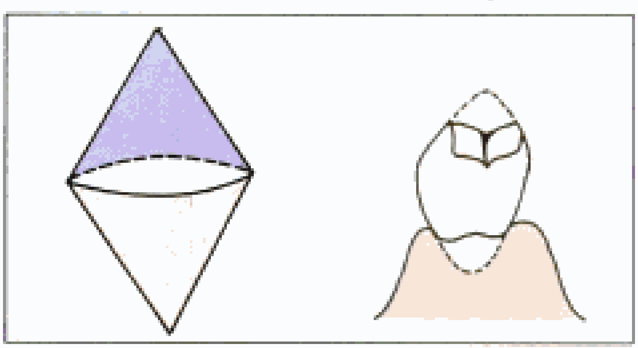


Fig. 18.144: According to Prothero's Cone theory, the tooth is considered as a pair of cones sharing one base. Hence the height of contour of the tooth is considered as the base of the cone and all retentive components of the denture should cross the height of contour

Component parts of a clasp (Fig. 18.145a)

The component parts of a clasp have been described in detail here. These components may be rigid or flexible. The flexible components are designed below the height of contour so that they provide retention when they engage the undercut at the same time they can flex and pass through the height of contour without requiring much effort during insertion or removal.

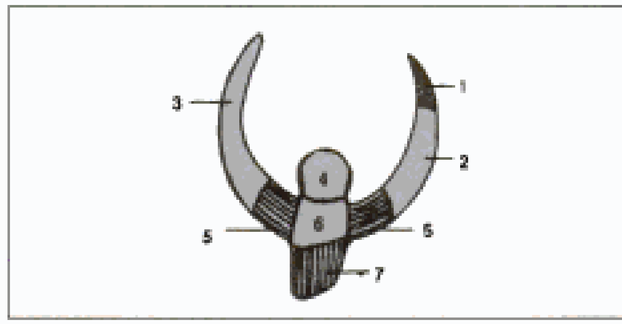


Fig. 18.145a: (1) Retentive terminal (2) Retentive clasp arm (3) Reciprocal arm (4) Occlusal rest (5) Shoulder (6) Body (7) Minor connector

In a conventional clasp design, the tip of the retentive arm is the only flexible component. All the other parts are rigid and hence, placed above the height of contour (widest circumference of the tooth).

Retentive arm *"A flexible segment of a removable partial denture which engages an undercut on an abutment and which is designed to retain the denture"* – GPT.

It is that part of the clasp comprising of the retentive clasp arm and retentive terminal. The retentive clasp arm is not flexible and is located above the height of contour. The retentive terminal is flexible and lies below the height of contour (Fig. 18.145b).

Height of contour is defined as *"A line encircling a tooth designating its greatest circumference at a selected position"*—GPT. Kennedy named the greatest convexity of the tooth as the height of contour. Cummer called it as the guideline that helps in the placement of the components of the clasp. DeVan named the surfaces sloping superiorly as the suprabulge area and the surfaces sloping inferiorly as the infrabulge area.

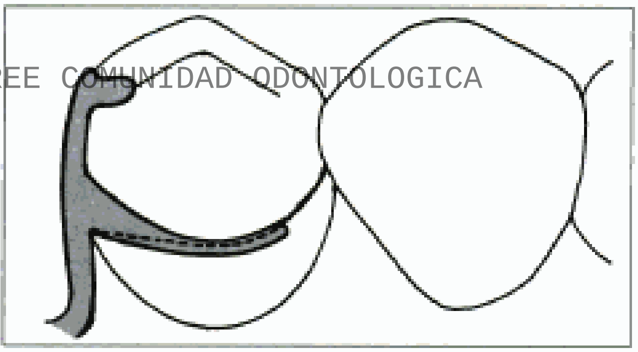


Fig. 18.145b: The retentive terminal (the only flexible component of the clasp) is the only component that crosses the height of contour during insertion and removal

Reciprocal arm "*A clasp arm or other extension used on a removable partial denture to oppose the action of some other part or parts of the prosthesis*". - GPT.

It is located on the side of the tooth opposite to the retentive arm. It resists the lateral forces exerted by the retentive arm when it passes through the height of contour during the placement and removal of the RPD (Fig. 18.146).

Fig. 18.146: The reciprocal arm (RC)serves to counter act the forces of the retentive arm (RT) and stabilize the abutment

It is always placed in the supra-bulge area (above the height of contour). It may act as an indirect retainer when placed on an abutment located anterior to the fulcrum line (axis of rotation) of the partial denture. Thus, the rigid reciprocal arm can resist the rocking of the denture base (Fig. 18.147).

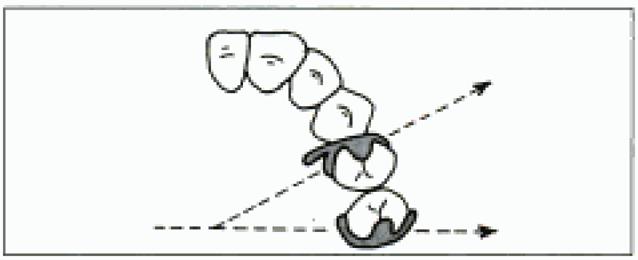


Fig. 18.147: In a secondary abutment anterior to the fulcrum line (line of rotation of the denture during function) the reciprocal arm functions as a indirect retainer by preventing the lifting of a denture

General functions of the reciprocal arm can be enlisted as follows:

- Provides stability and reciprocation against the retentive arm.
- The denture is stabilized against horizontal movements.
- Acts as an indirect retainer (prevents rocking) to a minor degree.

Shoulder It is the part of the clasp that connects the body to the clasp terminals. It lies above the height of contour and provides stabilization against horizontal displacement (Fig. 18.148).

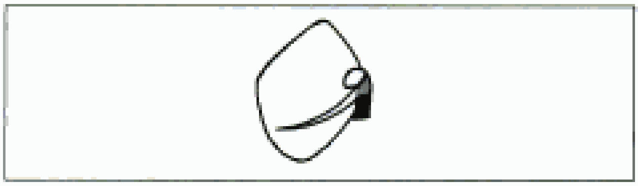


Fig. 18.148: Shoulder of a clasp

Body Part of the clasp that connects the rests and shoulders of the clasp to the minor connectors. It is rigid and lies above the height of contour (Fig. 18.149). The body of the clasp is designed such that it contacts the guide plane of the abutment during insertion and removal. The tissue surface of the body of the clasp, which is closely related to the guide planes, is known as a *proximal plate of the direct retainer*.

Figs18.149a and b: (a) Proximal view of the body of the clasp (b) Buccal view of the body of the clasp

Rest "*A rigid (stabilizing) extension of a removable partial denture which contacts a remaining tooth or teeth to dissipate vertical or horizontal forces*"- GPT.

It is the part of the clasp that lies on the occlusal or lingual or incisal edge or surfaces of the tooth. It resists tissueward movement of the clasp by acting like a vertical stop (Fig. 18.150). The preparation and structure was described in detail in

Fig. 18.150: An occlusal rest attached to the direct retainer

the previous section. The rest also helps to maintain the retentive arm of the clasp in position.

Minor connector *"The connecting link between the major connector or base of a removable partial denture and other units of the prosthesis, such as clasps, indirect retainers and occlusal rests"* - GPT.

Here, it joins the clasp with the remaining part of the metal framework. In a gingivally approaching clasp it is also known as the *approach arm* (Fig. 18.151).

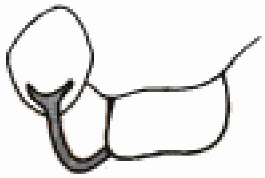


Fig. 18.151: Approach arm of a Roach clasps

Principles of Clasp Design

The basic principle of clasp design is *encirclement* i.e. to obtain more than 180° of continous contact for Aker's clasp and a minimum of 3-point contact for Roach clasps. Other principles of design include:

1. Occlusal rest should be designed to prevent tissue-ward displacement of the denture.
2. Each retentive terminal should be opposed by a reciprocal component.
3. *Balanced retention* should be present (i.e. if a buccal retentive clasp is present on one side, the same should be present in the opposite side and vice-versa).
4. Path of escapement should never coincide with the path of removal.
5. Only the minimum necessary amount of retention should be used.
6. Primary abutment clasp of a distal extension denture base should never exert tipping forces on the abutment.
7. It is preferable to place the reciprocal elements at the height of contour and the retentive element below the height of contour.

Functional Requirements of a Clasp

The functional requirements of a clasp include

- Retention
- Stability
- Support
- Reciprocation
- Encirclement
- Passivity

Each of these functional requirements are provided by various components in a clasp. The clasp and its parts should be designed appropriately to achieve the functional requirements.

Retention *"Retention is that quality inherent in the prosthesis which resists the force of gravity, the adhesiveness of foods, and the forces associated with the opening of the jaws"* - GPT.

Retention is the most important function of the clasp; hence, it is the most important functional requirement. The purpose of a clasp is lost if the retention is lost. Retention is provided by the retentive arm of the clasp. The tip of the retentive arm (retentive terminal) should lie in an undercut to the selected path of insertion. The undercut used for retention is known as a *retentive undercut* or *preferred undercut*.

This undercut should be identified during survey. If an undercut is absent it should be created using any one of the four methods described under surveying. The retentive arm should be fabricated according to the following design considerations.

Technical design considerations The following factors should be remembered while designing a retentive arm for a clasp:

- The retentive arm of the clasp provides retention. The terminal third of the retentive arm is flexible and it engages the undercut. Middle third of the retentive arm has minimum

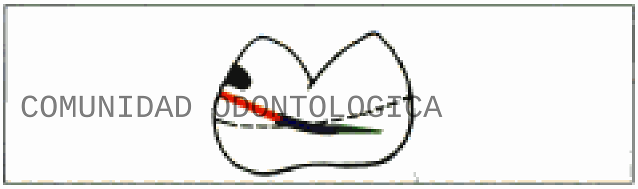


Fig. 18.152: The proximal third of the retentive arm should be placed above the height of contour. The middle third of the retentive arm should be at the height of contour. Only the terminal third is flexible and should be placed below the height of contour to engage a undercut

flexibility. Proximal third is rigid and is located above the height of contour. (Fig. 18.152).

- The location and degree of a tooth undercut available for retention is relative to the path of insertion of the partial denture. Path of Insertion is defined as "*The direction in which a prosthesis is placed upon and removed from the abutment teeth* "-GPT (Fig. 18.153).

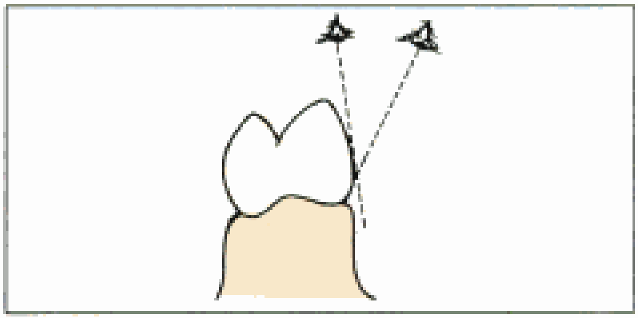


Fig. 18.153: Location and extent of the undercuts may vary according to the view angle. Similarly the location and extent of the undercut will vary according to the path of insertion

- A clasp has rigid and flexible components. The rigid components of the clasp should be placed in the non-retentive areas of the tooth for a given path of insertion. This is because they cannot deform to cross the height of contour.
- The clasp design for each abutment must be separately considered. For a clasp to be retentive, the retentive terminal must be placed in the undercut area of the tooth (Fig. 18.154).

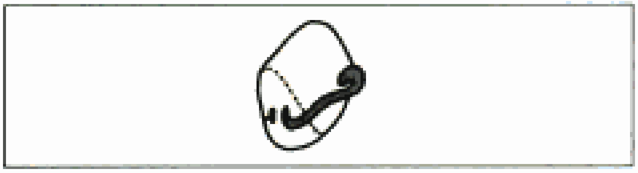


Fig. 18.154: The retentive terminal should always be located at the undercut

The retentive terminal is forced to deform when a vertical dislodging force is applied. The retentive terminal exhibits a certain amount of resistance to deformation. This resistance is proportional to the flexibility of the clasp arm. *It is this resistance to deformation that generates retention (Fig. 18.155).* The flexibility of the clasp varies with the type of alloy being used (Discussed below).

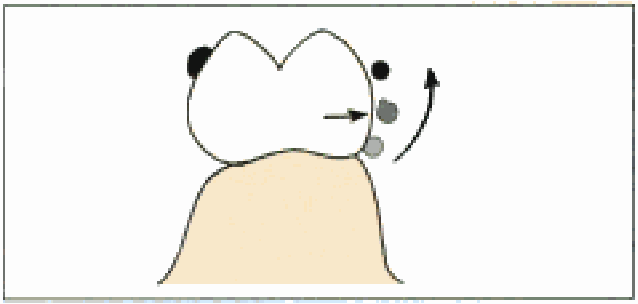


Fig. 18.155: During removal notice that the retentive terminal at the undercut is forced to deform and cross the height of contour. The resistance to deformation offered by the retentive arm generates retention for the denture

- The retentive undercut will be present only in relation to a given path of insertion. The retentive undercut is absent in conditions where the direction of dislodgement of the clasp arm is similar to the direction along which the clasp arm was inserted (Fig. 18.156). Hence it is important to maintain a single path of insertion that does not coincide with the path of displacement.
- Retentive undercuts should be located with the help of a surveyor. The cast should be tilted

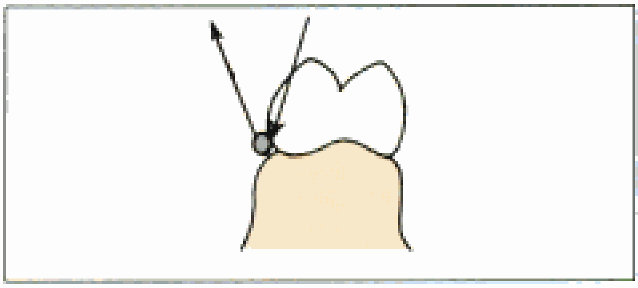


Fig. 18.156: Path of displacement is any path of movement of the clasp without resistance. Hence, there will be no height of contour obstructing the movement of the retentive arm along any path of displacement. If the path of insertion and displacement of the denture are parallel to one another it simply means that there is no retentive undercut present along the path of insertion

in a surveyor to achieve a unique path of insertion. The following factors should be considered while determining the path of insertion.

- Tissue undercuts
- Location of vertical minor connectors
- Origin of bar clasp arm
- The denture bases.

For a detailed discussion about path of insertion refer surveying.

- A good path of placement and removal is obtained by the contact of the rigid parts of the framework with the parallel surfaces of the abutment. These parallel tooth surfaces guide the denture during insertion and removal and are called guiding planes. These guiding planes that are prepared on the tooth act as an additional retentive unit.

  Guiding planes are defined as *"Two or more vertically parallel surfaces of abutment teeth so oriented as to direct the path of placement and removal of partial dentures"* -GPT. Guiding planes should be as parallel as possible to the path of insertion of the denture. If they are not parallel, trauma to the teeth and supporting structures will occur during insertion and removal of the denture. This leads to periodontal breakdown of the abutment teeth and strain to the parts of the denture. *In the absence of guiding planes, the retention from the clasp will be meagre or practically non-existent.*
- When the dislodging forces are not acting on the denture, the retentive terminal should be in a passive relationship with the tooth. If the retentive arm is not passive, orthodontic movement of the abutment will occur. This is due to the continuous pressure exerted by the clasps on the abutment teeth.

Factors Affecting Retention

Depth of the undercut

The deeper the undercut, the greater is the retention. A retentive undercut has three dimensions, namely:

a. Buccolingual width of the undercut
b. Distance between the survey line and the tip of the clasp arm (occlusogingival height)

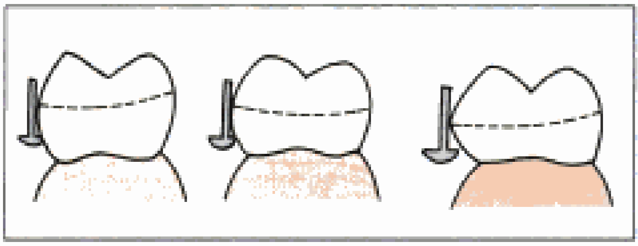


Fig. 18.157: Based on the depth of the undercut, the type of material for making the clasp is selected. *Note:* While measuring the undercut, the periphery of the disc and the shank of the undercut gauge should contact the tooth

c. Mesiodistal depth (gives the length of the clasp arm below the height of contour).

a. Buccolingual width of the undercut: This dimension is the most important. It is measured using an undercut gauge in thousands of an inch. Clasp alloys are selected based on this measurement (Fig. 18.157). Alloys with greater flexibility (low modulus of elasticity) are used against deeper undercuts.

- For a 0.010-inch undercut - cast chrome alloy is used.
- For a 0.015-inch undercut - gold alloy is used.
- For a 0.020-inch undercut - wrought wire is used.

b. The distance between the survey line and the tip of the retentive clasp: This affects the length of the clasp arm, which in turn affects the flexibility of the clasp (Fig. 18.158).

c. The Mesiodistal length of the clasp arm below the height of contour: Longer clasp arms offer more flexibility. The flexibility of the clasp is directly proportional to the cube of the length. Increased flexibility decreases the magnitude of the horizontal stresses acting on the abutment (Fig. 18.159).

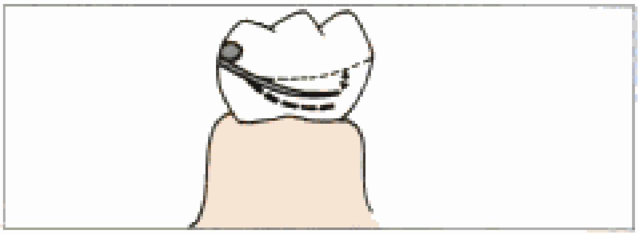


Fig. 18.158: The distance between the height of contour and the retentive terminal affects the length and flexibility of the clasp

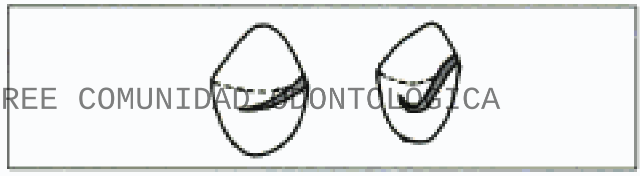


Fig. 18.159: For the same tooth, looping the retentive arm in order to increase its length improves the flexibility

d. *Taper of the clasp arm:* The clasp arm should taper uniformly from its origin to the tip. The dimension at the tip should be half of that in the origin (Fig. 18.160).

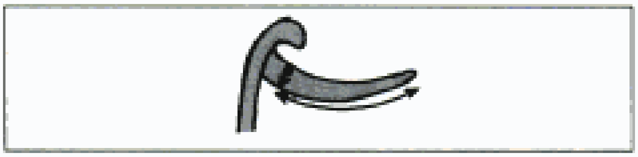


Fig. 18.160: The retentive arm should taper such that it reduces to half its width from the proximal to the terminal end. To obtain a good functional taper, cobalt chromium clasps should be atleast 15 mm long

e. *Cross-sectional form:* A half round clasp arm is flexible only in one plane (inward or outward) whereas a round clasp, is flexible in all planes. Round clasps are superior but they are avoided due to difficulty in fabrication. Half round clasps flex in one direction (away from the tooth surface) (Fig. 18.161). A cast retentive clasp arm is used mainly in tooth supported partial dentures because they need to flex only during placement and removal of the denture.

In a Kennedy's class I situation, the clasp has to flex during functional movements also. It should flex universally or disengage the tooth when vertical forces are applied. A round clasp is preferred in these conditions. Only a round clasp can engage an undercut away from the denture base.

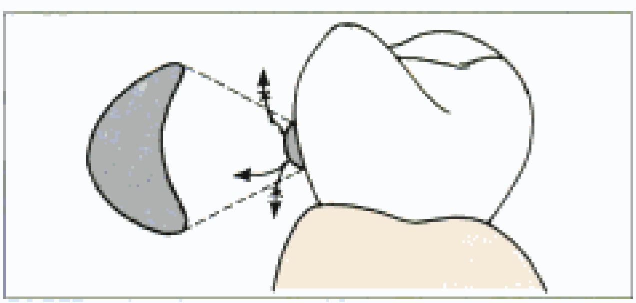


Fig. 18.161: Half round clasp (flexes in a single direction)

Approach of the Clasp Arm

The gingivally approaching clasp arm has a better retention as it pushes against the height of contour during dislodgement (Fig. 18.162) (*Push type retention*).

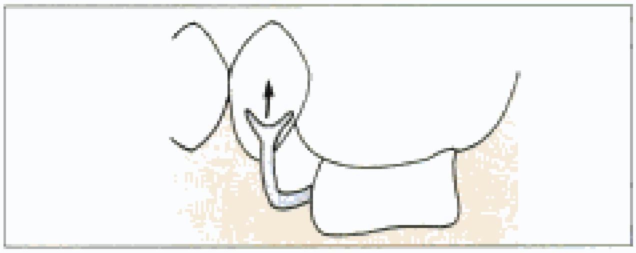


Fig. 18.162: A bar clasp showing push type retention

Stability It is defined as, "*The quality of a denture to be firm, steady, or constant, to resist displacement by functional stresses, and not to be subject to change of position when forces are applied*" - GPT.

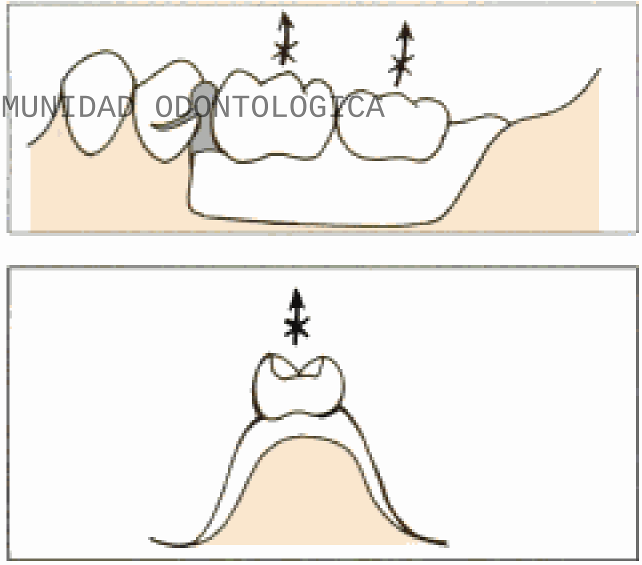
- All components of the clasp except the retentive arm provide stability.
- Cast circumferential clasps offer greater stability because it has a rigid shoulder.
- Wrought clasps have a flexible shoulder and bar clasps do not have a shoulder; hence, they offer lesser stability.

Support It is defined as, "*To hold up or serve as a foundation or prop for*" - GPT.

- It is the resistance to the movement of the denture in a gingival direction (along the path of insertion). (Whereas retention is the resistance to the movement of the denture against the path of insertion) (Fig. 18.163).
- It is provided by occlusal, lingual and incisal rests.

Reciprocation It is defined as, "*The means by which one part of a prosthesis is made to counter the effect created by another part*"- GPT

- It is provided by a rigid reciprocal arm.
- It resists the stresses generated by the retentive arm. It also stabilizes the denture against horizontal movement. In other words, it helps to hold the tooth when the retentive arm is active. If the reciprocal arm is absent there will no resistance available for the action of the retentive arm (Fig. 18.164).



Figs 18.163a and b: Retention is the resistance to movement of the denture against the path of insertion

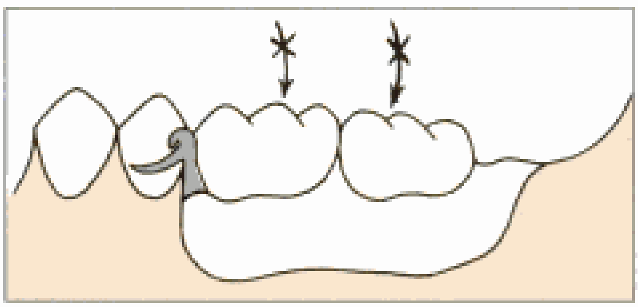


Fig. 18.163c: Support is the resistance to movement of the denture towards the path of insertion

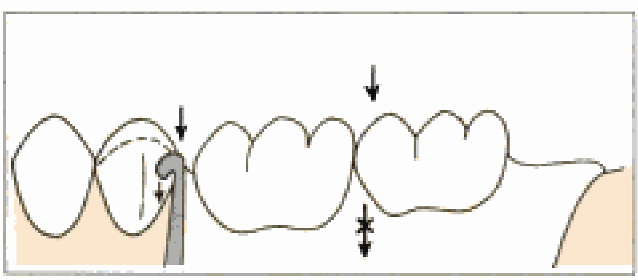


Fig. 18.163d: Support is provided by rests which act as vertical stops

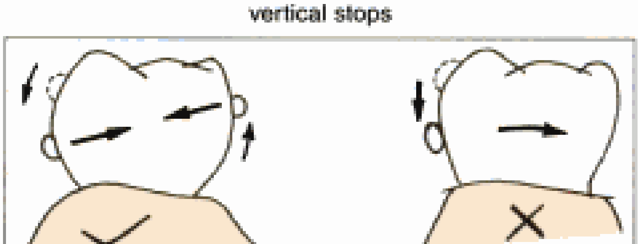


Fig. 18.164: Reciprocation is essential to stabilize the tooth against the deleterious effects of the retentive arm

- It should be placed preferably at the junction of the gingival and middle thirds of the abutment tooth (always above or at the height of contour).
- It should contact the abutment tooth along with or before the retentive arm during insertion and removal.
- Other parts which offer reciprocation are:
  - Lingual plate major connector.
  - An additional occlusal rest placed on the opposite side of the tooth alongwith the minor connector.

Encirclement " *It is the property of the clasp assembly to encompass more than 180° of the abutment tooth either by continuous or broken contact to prevent dislodgement during function*"

Each clasp must encircle more the 180° of the abutment tooth. Encirclement can be either a continuous contact as in circumfrential clasp or a broken contact as in bar clasp with at least 3 different areas of contact (Fig. 18.165). The three points of contact are:

- Retentive terminal
- Occlusal rest
- Reciprocal arm

This embracement prevents the clasp assembly from moving out of the confines of the tooth during function.

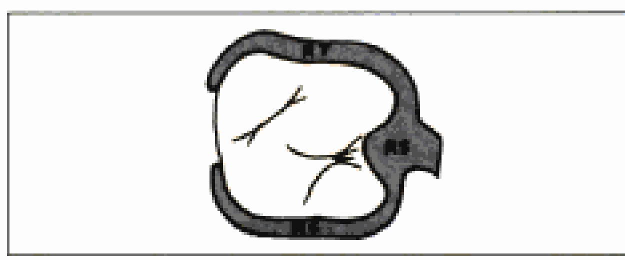


Fig. 18.165: 180° encirclement provided by the retentive arm (RT) rest (RS) and reciprocal arm (RC)

Passivity It is defined as "*The quality or condition of inactivity or rest assumed by the teeth, tissues, and denture when a removable partial denture is in place but not under masticatory pressure*" – GPT.

The retentive function should act only when dislodging forces are present. If the clasp is not seated properly, the retentive forces act continuously on the tooth leading to pain and tenderness.

Types of clasps

The types of clasps are:

- Circumferential or Aker's clasps
- Vertical projection or Bar or Roach clasps
- Continuous clasp

Cast circumferential clasp: "A clasp that encircles a tooth by more than 180 degrees, including opposite angles, and which usually has total contact with the tooth (throughout the extent of the clasp), with atleast one terminal being in the infrabulge (gingival convergence) area" - GPT.

Vertical projection clasp / Bar clasp / Roach clasp: "A clasp having arms which are bar type extensions from major connectors or from within the denture base; the arms pass adjacent to the soft tissues and approach the point or area of contact on the tooth in a gingivo-occlusal direction" - GPT.

Continuous clasp: "A metal bar usually resting on the lingual surface of teeth to aid in their stabilization and to act as an indirect retainer" - GPT.

Cast Circumferential Clasp

They are popularly known as Aker's clasps. These clasps embrace more than half of the abutment tooth. They may show a continuous or a limited three-point contact with the tooth. This architecture helps the clasp to hold the abutment firmly enough to prevent the rotation of the denture. They approach the undercut from an occlusal direction.

Advantages:

- Easiest clasp to make and repair.
- Less food retention
- Best when applied in a tooth supported partial denture.
- Derives excellent support, bracing and retention.

Disadvantages:

- It covers a large tooth surface area. It also alters the Buccolingual width of the crown (Fig. 18.166).This affects the normal food flow pattern leading to food accumulation. This causes decalcification of the tooth structure. Damage to soft tissue will occur due to lack of physiological stimulation.
- Difficult to adjust with pliers because of it's half-round configuration.

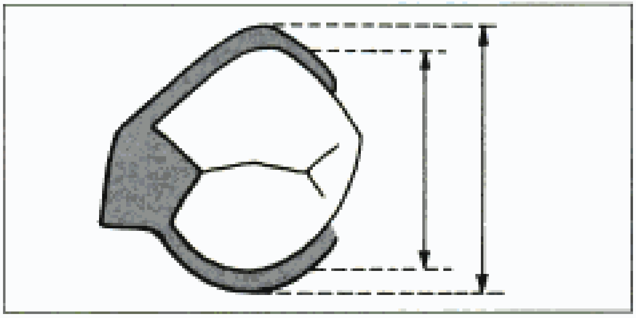


Fig. 18.166: Notice that a cast circumferential clasp alters the width of the tooth and hence the occlusal table

- If these clasps are placed high (more occlusally) on the tooth, the width of the food table increases leading to generation of greater occlusal forces.
- All cast circumferential clasps *should never* be used to engage the mesiobuccal undercut of an abutment adjacent to the distal edentulous space (Fig. 18.167). Hence, they cannot be used for cases with an undercut away from the edentulous space.

Fig. 18.167: An occlusally approaching Aker's clasp should **never** be used to engage the mesiobuccal undercut of a primary abutment in a distal extension denture base

Types of Cast Circumferential Clasps

Cast circumferential clasps can be of 11 different types. They are:

1. *Simple circlet clasp* (Fig. 18.168)

- Most versatile and widely used.
- Best for tooth supported Partial dentures.
- It approaches the undercut from the edentulous space.

Fig. 18.168: Simple circlet clasp

Fig. 18.169: Reverse circlet clasp

Fig. 18.170: Multiple circlet clasp

- It engages the undercut, located away from the edentulous space.
- Clasp can be adjusted only in one direction (i.e. buccolingually but not occlusogingivally).
- They cannot be used for distal extension cases as they engage a mesio buccal undercut.

2. *Reverse, circlet or reverse approach clasp* (Fig. 18.169)

- This clasp is used when the retentive undercut on the abutment tooth is located adjacent to the edentulous space.
- Consider a distal edentulous condition. Usually the clasp will arise from the distal surface of the abutment to reach the mesial undercut. But this clasp is designed in such a way that the clasp arises from the mesial side and ends on the distal undercut.
- Usually Bar clasps are preferred for distal extension cases. These clasps are used when a bar clasp is contraindicated. E.g.
  - If there is an undercut area in the ridge
  - Presence of a soft tissue undercut caused by buccoversion of the abutment tooth.
- These clasps are used in distal extension denture base to control the stresses acting on the terminal abutment teeth on the edentulous side.

Disadvantages:

- If sufficient occlusal clearance is not present, the thickness of the clasp has to be reduced. This will affect the strength of the clasp.
- The occlusal rest away from the edentulous space does not protect the marginal ridge of the abutment tooth adjacent to the edentulous space. Hence, an additional rest must be placed to provide the necessary protection.
- Poor aesthetics as the clasp runs from the mesial to the distal end of the facial surface.
- Wedging may occur between the abutment and its adjacent tooth if the occlusal rest is not well prepared.

3. *Multiple circlet clasp* (Fig. 18.170)

- It is a combination of two simple circlet clasps *joined at the terminal end of the reciprocal arms.*
- It is used for sharing the retention with additional teeth on the same side of the arch when the principal abutment tooth has poor periodontal support.
- It is a mode of splinting weakened teeth.
- It's disadvantages are similar to that of simple and reverse circlet clasps.

4. *Embrasure clasp or modified crib clasp* (Fig. 18.171a)

- It is a combination of two simple circlet clasps *joined at the body.*
- It is used on the side of the arch where there is no edentulous space.
- The clasp crosses the marginal ridges of two teeth to form the double occlusal rest. The clasp emerges on the facial surface and splits into two retentive arms. Each retentive arm engages the undercut located on the opposite side of the tooth.
- Interproximal tooth structure should be removed to provide sufficient thickness of the metal. The clasp may break if the metal is too thin.

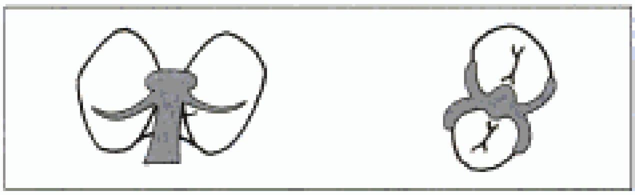


Fig. 18.171a: Embrasure clasp

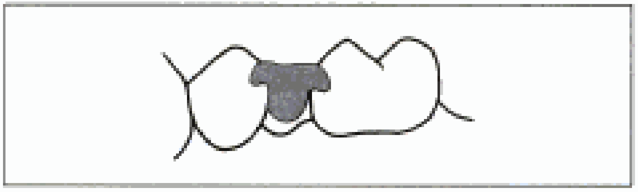


Fig. 18.171b: Pontic clasp

- Indications: It is used in Kennedy's class II and class III cases without any modifications.
- Occasionally, a very small edentulous space can be closed by a modified embrasure clasp called pontic clasp (Fig. 18.171b).

5. *Ring clasp* (Fig. 18.172)

- Consider a distal edentulous condition with a distolingual undercut where a reverse circlet clasp cannot be placed (no buccal undercut). In such cases, the retentive arm is extended all around the tooth from the distobuccal end to termiante in the distolingual undercut across the mesial side of the tooth.
- It is used in cases with lingually tipped molar abutments. Mandibular molars usually tip mesiolingually and the maxillary molars tip mesiobuccally. Hence, the retentive undercut will be on the mesiolingual side for the lower molar and mesiobuccal side for the upper molar.
- As the clasp is long, additional support should be provided by adding an auxiliary *bracing arm* from the denture base minor connector to the center of the ring clasp on the buccal surface. (Fig. 18.173).

Disadvantages:

- Alteration in the food flow pattern.
- It cannot retain its physical qualities.

Fig. 18.172: Ring clasp

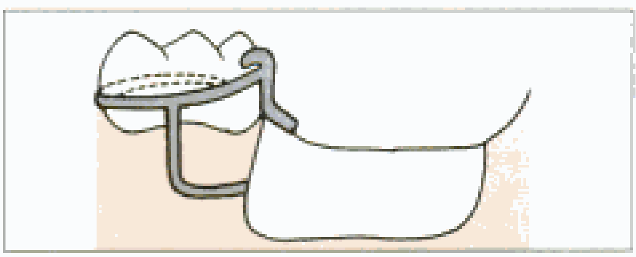


Fig. 18.173: Auxiliary bracing arm to reinforce the ring clasp

- Difficult to adjust or repair.
- Increased tooth surface coverage.

Contraindications:

- If the buccinator's attachment lies close to the lower molar.
- If the bracing arm will have to cross a soft tissue undercut.

6. *Fishhook or hairpin clasp or reverse action clasp* (Fig. 18.174)

- It is a type of simple circlet clasp, which after crossing the facial surface of the tooth loops back to engage the proximal undercut beneath its point of origin. It is used in conditions where the undercut is near the edentulous space.

Fig. 18.174: Hairpin clasp

- Upper arm is rigid and the lower arm is flexible. The upper arm should be positioned above the height of contour in such a way that it does not interfere with occlusion.

Indications:

- The undercut is adjacent to edentulous area.
- Presence of a soft tissue undercut.

Disadvantages:

- It has poor aesthetics.
- It tends to trap and accumulate food debris.

7. *Onlay clasp* (Fig. 18.175)

- It is an extension of a metal crown or onlay with buccal and lingual clasp arms.
- It is used in the occlusal surfaces of submerged abutment teeth (that are below the occlusal plane) so that the normal occlusal plane can be restored with an onlay.

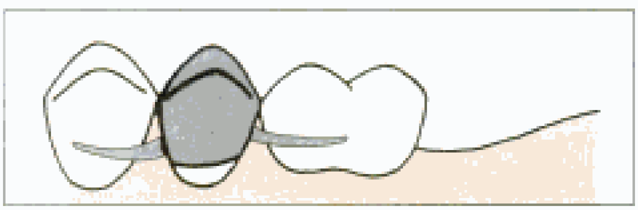


Fig. 18.175: Onlay clasp

- If the onlay clasp is made of chrome alloy, the opposing tooth should be protected with a gold crown. Because the chrome alloy can produce massive attrition of enamel.

- As this clasp covers large amount of tooth structure, it may lead to breakdown of enamel surfaces. Hence, it should be used only in a caries resistant mouth.

8. Combination clasp (Fig. 18.176)

- A cast circumferential clasp cannot be used when an undercut is adjacent to the edentulous space, as it will produce destructive rotatory forces on the distal abutment.
- In such cases, a flexible wrought wire retentive arm is used to replace the rigid cast alloy retentive arm. These clasps are called combination clasps as they combine the two.
- As it has a greater flexibility it can be placed in a deeper undercut without any hazard to the abutment.

Fig. 18.176: Combination clasp

- It is used in maxillary canines and premolars due to its superior aesthetics.

Advantages:

The round configuration of the wrought wire gives two advantages

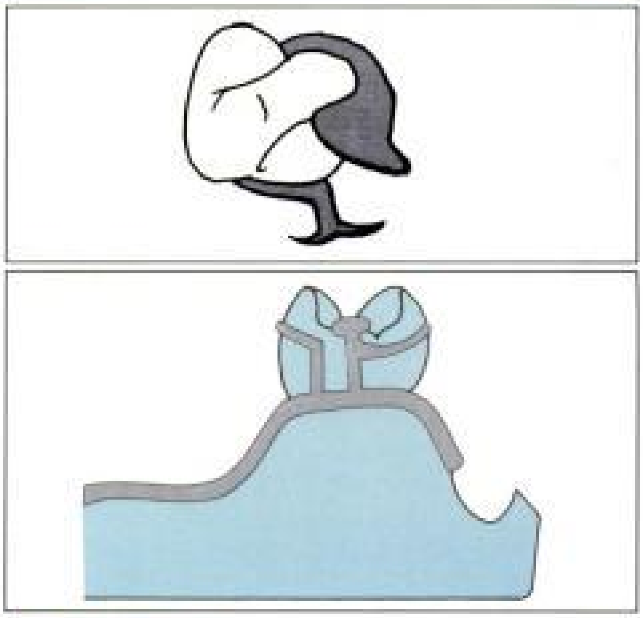
- It has a thin line contact, which collects less debris and is easy to maintain.
- It can flex in all planes.

Disadvantages:

- Tedious lab procedures.
- Easily breaks or distorts.
- Poor stability.

9. Half and half clasp (Fig. 18.177)

- It has a retentive arm arising from one direction and a reciprocal arm arising from another.
- Two minor connectors are needed for this design. The first minor connector attaches the occlusal rest and the retentive arm to the major connector. The second minor connector connects the reciprocal arm, which is similar to the bar clasp with or without an auxiliary rest.



Figs 18.177a and b: Half and half clasp: (a) occlusal view, (b) proximal view

- This design produces large tooth coverage, which can be reduced by converting the reciprocal arm into a short bar with an auxiliary occlusal rest.
- This design is intended to provide dual retention.

10. Back-action clasp (Fig. 18.178a)

- It is a modification of the ring clasp.
- Here the minor connector is connected to the end of the clasp arm and the occlusal rest is left unsupported.

Disadvantages:

- Lack of support to the occlusal rest reduces its function.
- It has both biological and mechanical unsound principles.

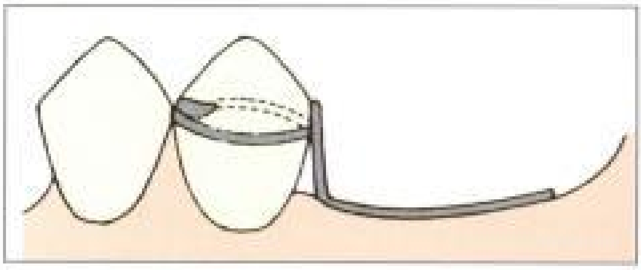


Fig. 18.178a: Back action clasp

11. Grasso's clasp or VRHR clasp (Fig. 18.178b)

Developed by Grasso, this clasp consists of a vertical reciprocal arm, an occlusal rest and a horizontal retentive arm each arising separately from the major connector. It is more of a proposed concept.

Advantages:

- Minimizes tooth contact without compromise in efficacy.
- Does not require the preparation of guide planes.
- Suitable for posterior teeth with high survey lines.
- The placement of the retentive arm is more aesthetic.
- The balance between the retentive and reciprocal components prevents the whiplash effect of the retentive arm.

Disadvantages:

- Difficult to maintain as the block out zone between the base of the reciprocal arm and the tooth tends to collect food debris.

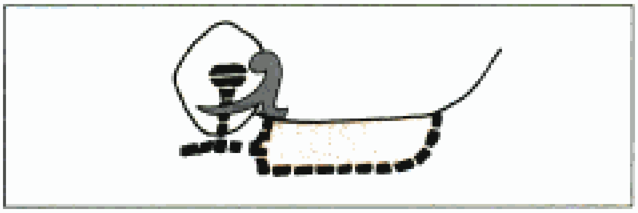


Fig. 18.178b: Grasso's clasp or vertical reciprocal horizontal retentive (VRHR) clasp

Vertical Projection or Roach or Bar Clasp

These clasps approach the undercut gingivally. It has a push type of retention, which is more effective than the pull type retention provided by the circumferential clasp.

Parts of a Bar Clasp

Only the retentive arm of a bar clasp varies from that of a cast circumferential clasp. All other components like the rest, shoulder, body, proximal plate and the reciprocal arm are similar to the ones present in a cast circumferential clasp.

The retentive arm in a bar clasp comprises for two parts namely the gingival approach arm and the retentive tip.

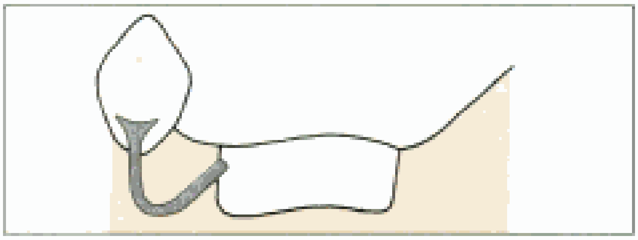


Fig. 18.179: Approach arm

Approach Arm (Fig. 18.179)

It is a minor connector that connects the retentive tip to the denture base minor connector. It is semi circular in cross section and should cross the gingival margin at a right angle. The approach should closely adapt over the soft tissues and cannot be fabricated over soft tissue undercuts. This is the *only flexible minor connector* designed in a RPD.

Retentive terminal (Fig. 18.180)

It varies for each type of bar clasp. It should end on the surface of the tooth below the undercut. It can be paired or singular. The terminal, which enters the undercut, is called *retentive finger* and the other terminal is called the *non-retentive finger*. It helps to give a push type retentive force.

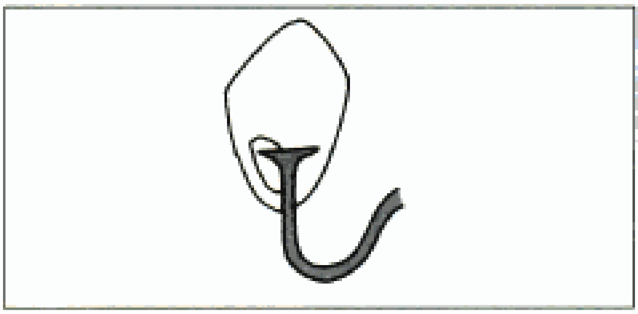


Fig. 18.180: Retentive finger that engages an undercut

Advantages of bar clasps

- It is easy to insert and difficult to remove.
- It is more aesthetic, as it covers less tooth structure.

Disadvantages of bar clasps

- It tends to collect food debris.
- It has increased flexibility but reduced bracing and stabilization.
- Additional stabilizing units are needed.

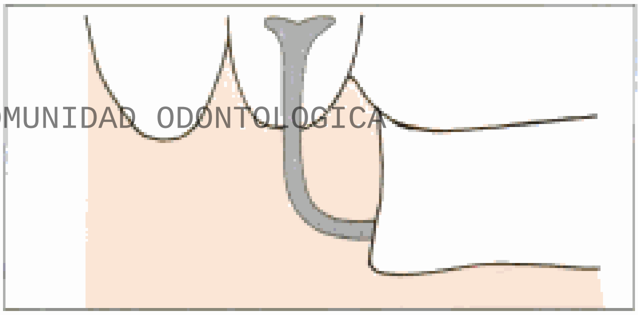


Fig. 18.181: The approach arm should cross the free gingival margin at a right angle

Design considerations

- Approach arm should not impinge as it crosses the soft tissue.
- No relief is given so the tissue surface of the approach arm should be smooth and polished.
- Approach arm should cross the gingival margin at a 90° angle (Fig. 18.181).
- It is used if the favourable undercut is present near the edentulous area.
- The approach arm is a minor connector arising from the denture base. It arises from the edentulous area near the undercut. It runs vertically upwards to the height of contour of the abutment where it splits into its terminal ends.
- The tip of the retentive terminal should always point to the occlusal surface.
- The bar clasp should be placed as low as possible on the tooth.

Types of Bar Clasps

Bar clasps have been classified based on the shape of the retentive terminal. Each type is described in detail below.

T clasp (Fig. 18.182)

- Used in a distal extension denture base with a distobuccal undercut

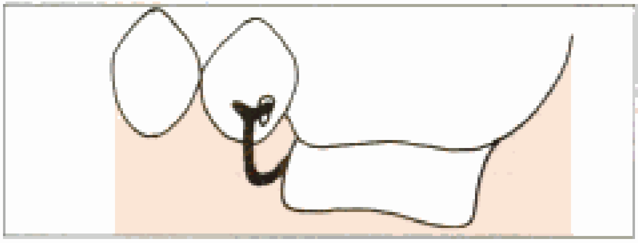


Fig. 18.182: T clasp

- Can also be used for a tooth supported partial denture with natural undercuts. Since the clasp is designed to use the existing undercuts without creating new ones, it is referred to as *clasping for convenience*.
- It should not be used on a terminal abutment tooth if undercut is located away from edentulous space.
- Should not be used over a soft tissue undercut
- The clasp has good aesthetics but due to the flexibility of approach arm it lacks the bracing quality.

Modified T clasp (Fig. 18.183)

- It is similar to T clasp but the non-retentive finger (usually the mesial terminal) of the 'T' terminal is removed.
- It is used in canines and premolar for better aesthetics.

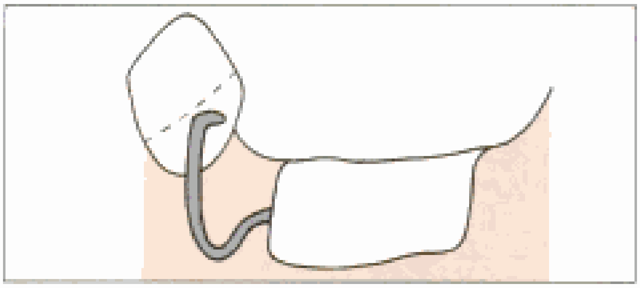


Fig. 18.183: Modified T clasp

Disadvantages

- It does not have 180° encirclement.

Y clasp (Fig. 18.184)

Y clasp is basically a T clasp modified to suit certain abutments where height of contour is high at faciomesial and faciodistal line angles but low at the center of the facial surface.

I clasp (Fig. 18.185)

- Used on distobuccal surface of canines for aesthetics.
- Only the tip of the clasp (2-3 mm) contacts the tooth. Hence, stability and encirclement is decreased.

Infrabulge clasp or mirror view clasp: by MM DeVan (Fig. 18.186)

- The approach arm for the retentive terminal arises from the border of the denture base,

Fig. 18.184: Y clasp

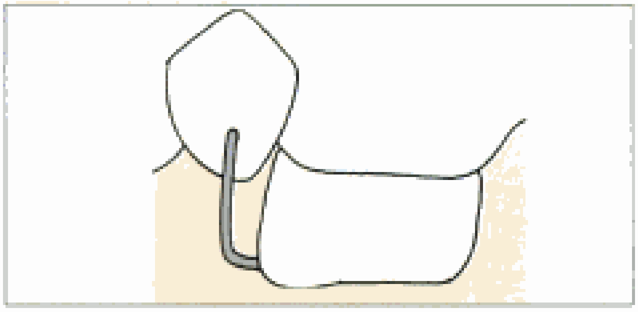


Fig. 18.185: I clasp

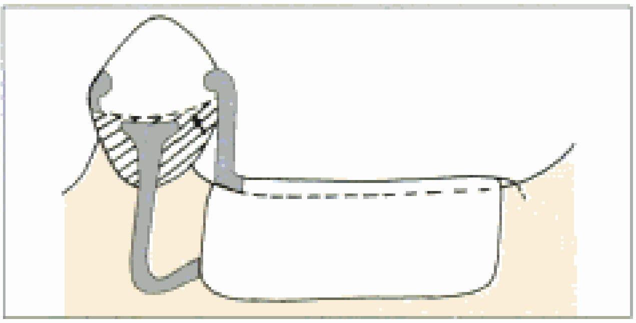


Fig. 18.186: Mirror view clasp. Note: the lingual surface of the abutment is plated

either as an extension of a cast base or attached to the border of a resin base.

- There are two occlusal rests on each abutment tooth.
- The lingual aspect of the abutment may be plated (supported) or left open.
- It is more flexible because the portion of the metal base that gives rise to the approach arm has an incomplete cut. The cut is prepared either by machining or placing a thin matrix band during casting (Fig. 18.187).
- The retentive arm can also be made of wrought wire, which has higher flexibility. The wire may be soldered to the metal base or embedded in the resin base.

Fig. 18.187: A half cut made to increase the flexibility of the approach arm

Advantages:

- More aesthetic as it is placed more interproximally.
- Increased retention without any tipping action on the abutment.
- Resists distortion during handling.

I-bar

It is a modified I type roach clasp introduced by Kratochvil. It has a mesial rest arising from a major connector, an I-bar retentive arm and a long proximal plate.

It is designed to reduce tooth contact. A detailed explanation about the design of an I-bar partial denture is described in chapter 22. Krol in 1973, modified kratochvil's I-bar system and introduced the RPI and RPA systems, both of which have been described in chapter 22.

Intracoronal Direct Retainers (Attachments)

Intracoronal direct retainers are called so because a part or the whole of the retentive components are located within the anatomical contour of the abutment teeth. They are of the following types:

- Internal attachment
- External attachment
- Stud attachment
- Bar attachment
- Special attachments

Generally all attachments have male and female components that are manufactured using standard measurements. They are not custom fabricated like a direct retainer. Hence, the only design consideration for an attachment is preparing the tooth to place the female component of the retainer.

Internal Attachment

It is also known as *precision attachment* or *frictional attachment* or key and *keyway attachment* or *parallel attachment* or *slotted attachment*.

Table 18.1: Differences between circumferential and bar clasps

Circumferential clasp	*Bar clasp*
• It approaches the undercut from the occlusal aspect of the abutment.	• It approaches the undercut from the gingival aspect of the abutment.
• It arises above the height of contour of the abutment.	• It arises below the height of contour of the abutment.
• It has a rigid minor connector.	• It has a flexible minor connector. The minor connector for the bar clasp is called approach arm.
• It is easier to remove. This is because only the retentive terminal should flex to be relieved from the undercut.	• It is easier to seat but difficult to remove because the minor connector should flex alongwith the retentive arm to be relieved from the undercut.
• It has a *pull type* retention. That is the retentive tip should pull occlusally to engage the undercut.	• It has a *push type* retention. That is the retentive tip should push occlusally to engage the undercut.
• Due to continuous tooth contact, it has a good bracing effect.	• Due to limited 3-point tooth contact, it has less bracing effect.
• It is less aesthetic, due to more metal exposure.	• More aesthetic as it is present below the height of contour.
• It has reduced food debris accumulation as it adapts more closely to the tooth.	• Increased food debris accumulation, because a space exists between the minor connector and the abutment surface and the length of the clasp assembly is more.
• Easy to repair due to it's simple design.	• Difficult to repair as the design is more complex.
• It increases the width of the occlusal table because the retentive arm arises near the occlusal surface of the abutment. It increases the occlusal load on the abutment.	• No such problem as it is placed in a lower position.
• Due to increased tooth coverage it may cause decalcification.	• No decalcification due to limited 3-point contact.
• It can be used in tilted abutments and in cases with soft tissue undercuts.	• It cannot be used in cases with tilted abutment and soft tissue undercuts.

Definition: "A retainer, used in removable partial denture construction, consisting of a metal receptacle and a closely fitting part: the former is usually contained within the normal or expanded contours of the crown of the abutment tooth and the latter is attached to a pontic or the denture frame work" - GPT.

"A retainer consisting of a metal receptacle (matrix) and a closely fitting part (patrix). The matrix is usually contained within the normal or expanded contours of the crown on the abutment tooth and the patrix is attached to a pontic or a removable partial denture".

The patrix engages the vertical walls built into the crown of the abutment tooth to create frictional resistance during removal (Fig. 18.188). Dr Herman ES Chayes first formulated this principle in 1906.

Some of the commonly used internal attachments are:

- Ney-Chayes attachment.
- Stern Goldsmith attachment.
- Baker attachment.

Advantages:

- Elimination of visible retentive components.
- Elimination of visible vertical support element through a rest seat.

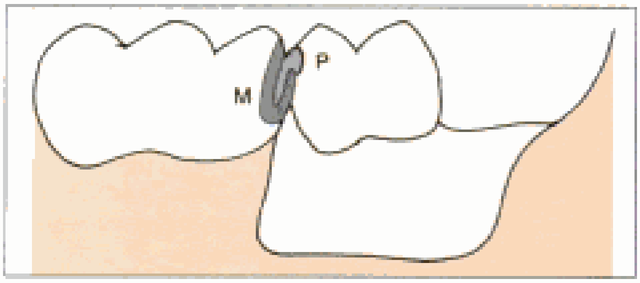


Fig. 18.188: Matrix (M) and Patrix (P) of a intracoronal retainer

- Provides some horizontal stabilization.
- Stimulation of underlying tissues due to intermittent vertical massage.

Disadvantages:

- Preparation of abutments and castings.
- Complicated clinical and lab procedures.
- Wear resulting in loss of frictional resistance.
- Difficult to repair and replace.
- Least effective in teeth with small crowns.
- Difficulty to place it completely within the circumference of the abutment tooth.

Contraindications:

- Large pulp (this limits the depth of the receptacle.)

- Short crowns offer lesser frictional resistance.
- Cost

The internal attachments do not permit horizontal movement of the prosthesis. The horizontal tipping and rotational forces acting on the denture are transmitted to the abutment teeth. They should not be used in tissue supported distal extension denture bases, because, these dentures show horizontal movement due to the resiliency of the supporting soft tissues (Fig. 18.189). Since the attachments do not permit horizontal movements of the denture, these movements are transferred to the abutment which is deleterious to the health of the abutment.

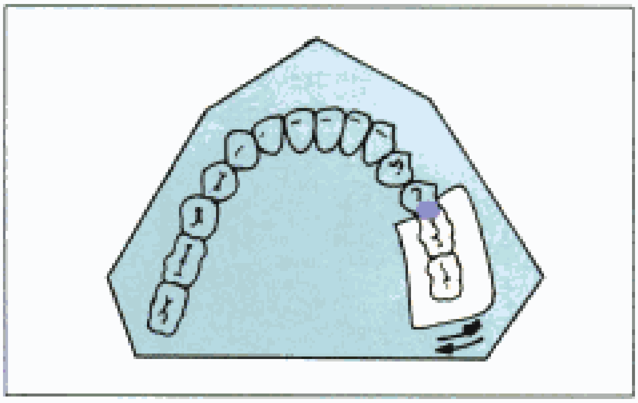


Fig. 18.189: When used in distal extension denture bases, intracoronal retainers transfer deleterous horizontal forces to the abutment

They can be used for distal extension denture bases if there is some form of stress breaker (like a hinge) is present between the movable base of the denture and the rigid attachment. Addition of stress breakers complicates the design of the denture; hence, internal attachments are generally avoided in distal extension denture bases.

External Attachment: e.g. ASC52, DALBO, CEKA, and ERA

These attachments are more aesthetic, resilient and easy to insert. They are indicated for an anterior prosthesis in a young patient with a large pulp chamber (Fig. 18.190).

Disadvantages:

- Bulky attachment requires more space within the removable partial denture.

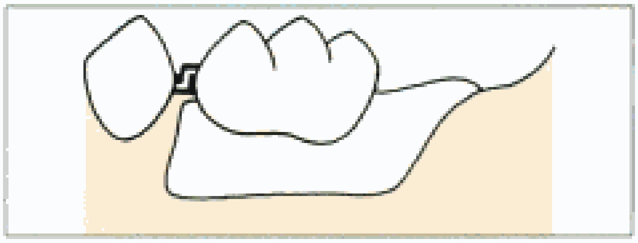


Fig. 18.190: External attachment

- Weak and breaks easily.
- Difficult to replace.

Stud Attachment: e.g. GERBER, DALLA BONA, and ROTHERMAN

This attachment acts like a stress director. They are used for overdenture abutments (Fig. 18.191).

Advantages:

- More versatile
- Decreased leverage
- Can be used on malaligned abutments.
- Easy to adjust and repair.

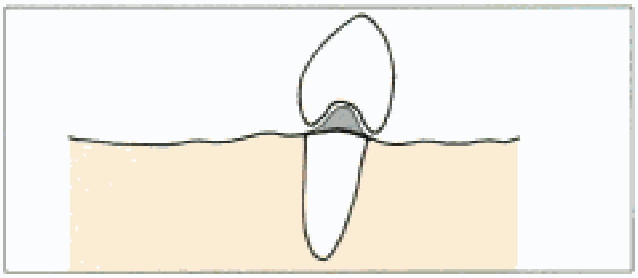


Fig. 18.191: Stud attachment

Disadvantages:

- It has a tipping effect on the abutment teeth.
- Complex design.
- Cannot be used in cases with limited space.
- Expensive.

Bar Attachment: e.g. DOLDER, HADER

It is used when there is bone loss around the abutment teeth (Fig. 18.192).

Advantages:

- Rigid splinting
- Cross-arch stabilization
- It can be used along with other attachments or implants for a combined fixed-removable prosthesis.

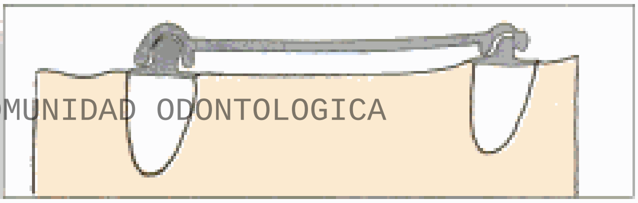


Fig. 18.192: Bar attachment

Disadvantages:
- Space requirement.
- Needs frequent soldering.
- Difficult to maintain oral hygiene.

Special Attachment

These retainers are different from both intracoronal and extracoronal retainers and hence are classified separately. They are of two types namely:
- Retention based on frictional resistance.
- Retention based on placement of an element in the undercut.

Both types have an intracoronal or an extracoronal locking device to provide retention (Fig. 18.193).

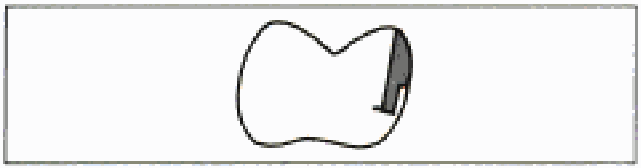


Fig. 18.193a: Intracoronal locking device

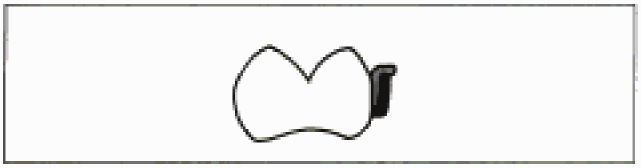


Fig. 18.193b: Extracoronal locking device

Advantages:
- Highly aesthetic as the visible clasp components are absent.
- It reduces torque and tipping forces on the abutment.

Special attachments are also classified as locking and non-locking types. The non-locking types can be used for Kennedy's class I and class II case. Commonly used special attachments are:
- Neurohr spring-lock attachment.
- Neurohr-Williams shoe attachment.
- Dowel rest attachment.
- Zest anchor device.
- Intracoronal magnets.
- Hannes Anchor or IC plunger.
- Servo Anchor SA or Ceka.
- Bona Ball.
- Rotherman.
- Long copings.

Neurohr spring-lock attachments (Fig. 18.194) Dr. F.G. Neurohr devised a spring-wire lock system in 1930. It uses a tapered vertical rest within the contour of the abutment tooth. A single buccal clasp arm with ball tip engages the undercut in the abutment. By this design the occlusal forces on the denture base are transmitted nearly parallel to the long axis of the abutment.

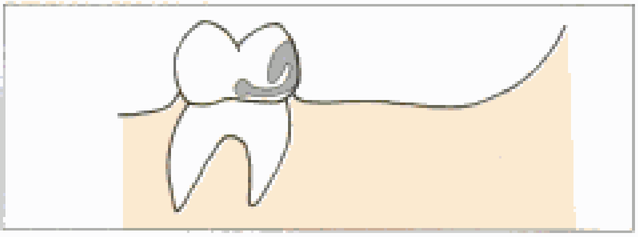
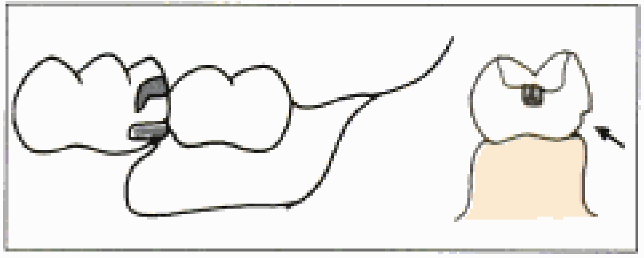


Fig. 18.194: Neurohr spring-lock attachment

Neurohr-Williams shoe attachment: (Fig. 18.195) Dr. Franklin Smith devised this attachment. It is a modification of the Neurohr spring-lock attachment. Here, an additional groove is prepared on the distobuccal line angle.



Figs 18.195a and b: Neurohr-Williams shoe attachment: (a) lateral view, (b) proximal view

A short retentive clasp arm made up of wrought wire is fabricated to engage the small, horizontal, distobuccal groove made on the abutment. The wrought wire is fabricated such that it is hidden within the denture base. The part of the wrought wire submerged inside the acrylic is called the *shoe*. The lateral walls of the rest are parallel and help to resist horizontal rotation.

Indications:

- Can be used for tilted abutments where a conventional clasp cannot be given.
- It can be used for anterior abutments for aesthetic reasons.

Advantages:

- It acts as a stress breaker during distal rotation.
- Lowered leverage point of applied force.
- Multiple options for the placement of a retentive area.
- Internal reciprocation.
- Internal indirect retention.
- Very aesthetic.
- Simple in form.
- More stable.

Disadvantages:

- The abutment may migrate anteriorly.
- Poor retention in cases with short or tapered abutments, deep bite and large pulps.
- Extensive and requires a complex procedure.

Dowel rest attachment (Fig. 18.196) Dr. Morris.J.Thompson developed this design. It has a box shaped rest seat. A dimple (depression) is created on the lingual surface of the abutment. A box (projection) is fabricated on the lingual arm of the denture framework such that it fits into the dimple.

There are no visible clasps but retention is achieved by the locking of the dimple and the box. The lingual arm is an extension from the major connector. It is separated from the major connector by an incomplete cut made by either machining or by placing a matrix during casting to increase its flexibility.

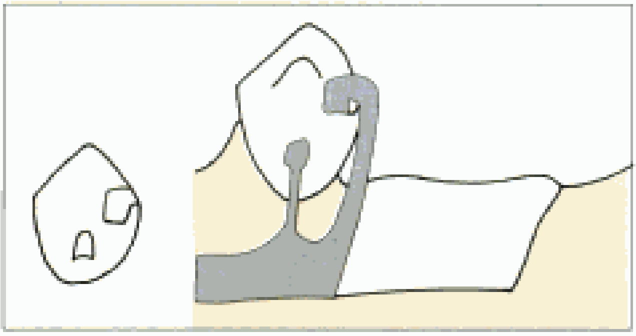


Fig. 18.196: Dowel rest attachment

Advantages:

- No contact of the prosthesis with the abutment.
- The flexible lingual arm provides a stress breaking effect.
- Less food accumulation.
- Aesthetic and easy to maintain.
- Can be used alongwith fixed partial dentures.

Disadvantages:

- Limited horizontal stability.
- More force is transmitted to the edentulous ridge.

Zest Anchor device (Fig. 18.197a) It has a nylon male post attached to the denture base, which fits into the female insert in the abutment.

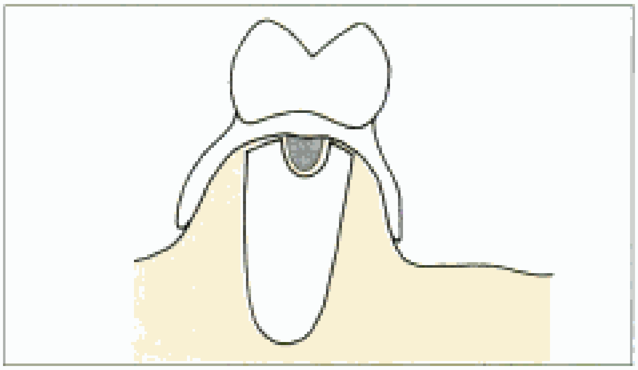


Fig. 18.197a: Zest Anchor device

Intracoronal magnets (Fig. 18.197b) Magnets with opposite polarity are placed on the rest seats and the denture base. The magnetic attraction produces retention.

Hannes Anchor or IC plunger (Fig. 18.198) Here the male plunger fits in to a dimple on the

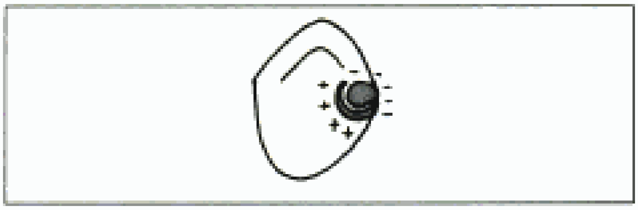
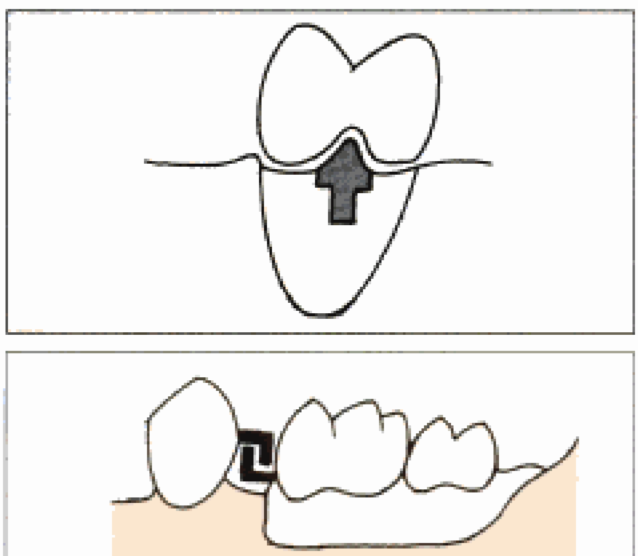


Fig. 18.197b: Intracoronal magnets

Fig. 18.198: IC Plunger

proximal surface of the abutment. This dimple is located below the height of contour of the abutment tooth.

Servo Anchor (SA) or Ceka (Fig. 18.199) Here, the female retaining device is placed on the denture base and the male device is attached to the abutment tooth.



Figs 18.199a and b: Servo anchor

Bona ball (Fig. 18.200) It is similar to the Servo Anchor SA or Ceka attachment.

Rotherman (Fig. 18.201) It has a low profile retaining device. The male component is attached

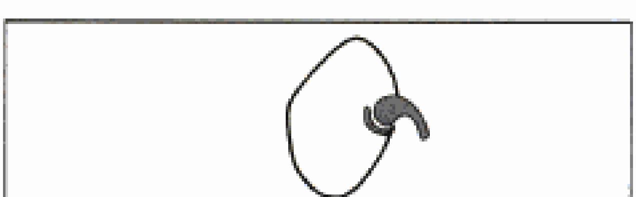


Fig. 18.200a: Bona ball—male component in the denture

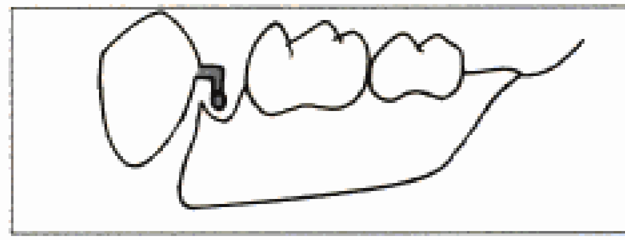


Fig. 18.200b: Bona ball—male component in the abutment

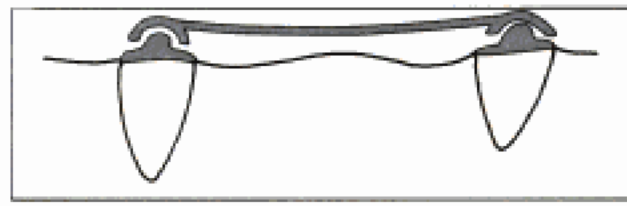


Fig. 18.201: Rotherman low profile retaining device

to the abutment. The female retentive clip is attached to the denture base. Compressing or spreading the retentive clips alters the retention.

Long copings (Fig. 18.202)
They are used in cases with compromised dentition like treated cleft palate cases, cross bite, deep bite etc. An overdenture is placed on the copings.

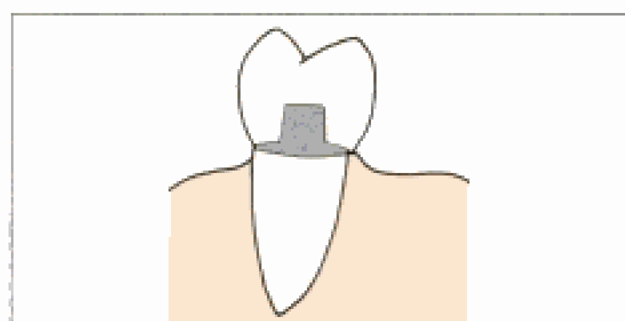


Fig. 18.202: Long coping overdenture attachment

Indirect Retainers

Definition

"A part of a removable partial denture which assists the direct retainers in preventing displacement of distal extension denture bases by functioning through lever action on the opposite side of the fulcrum line"- GPT.

An indirect retainer is one, which helps the direct retainer to prevent displacement of the distal extension denture by resisting the rotational movement of the denture around the fulcrum line established by the posterior most occlusal rests (Fig. 18.203).

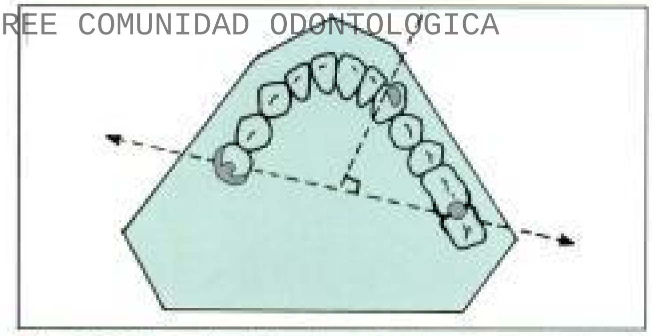


Fig. 18.203: The basic function of the indirect retainer is to prevent rotational movement of the denture. Consider the above diagram wherein the denture will rotate in its terminal abutment axis. Placing an auxiliary rest perpendicular to the midpoint of the terminal abutment axis will prevent rotation and provide indirect retention

Forces Acting on the Denture

The response of the prosthesis to various forces acting on it plays an important role in indirect retention. During function, the denture is subjected to various rotational forces. These forces produce rotational movements of the denture. Movements of the denture can occur in three planes.

Movement towards the tissue

This movement is prevented by the presence of rests. Rests are a part of the clasp assembly located on the occlusal surface of the teeth. The rests act as a vertical stop when the occlusal forces push the denture down (towards the tissue) (Fig. 18.204).

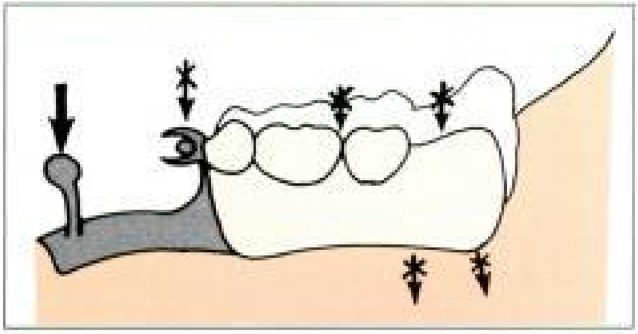


Fig. 18.204: Occlusal (primary and auxiliary) rests prevent the tissue-ward movement of the denture due to vertical forces

Movement towards the teeth (away from the tissue)

These forces affect the retention of the denture. This movement is prevented by the activation of the direct retainer, which is passive in normal conditions (Fig. 18.205).

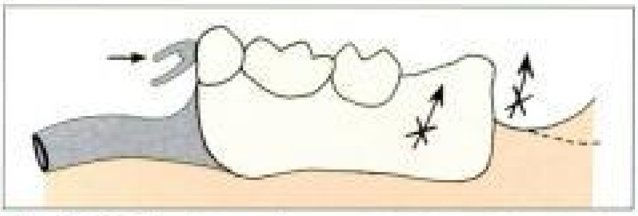


Fig. 18.205: The clasps (direct retainers) provide retention to the denture by engaging the undercuts

Movement in buccolingual direction (horizontal)

This movement affects the stability of the denture. The movement is prevented by the action of the stabilizing components of the denture. E.g.: major connector, denture flange, etc. (Fig. 18.206).

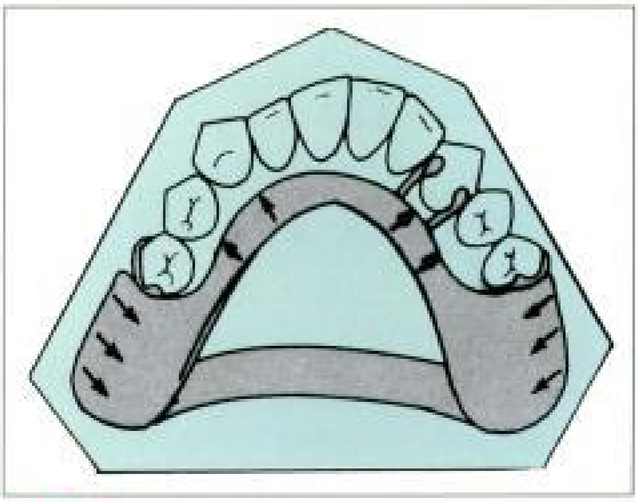


Fig. 18.206: Stability or resistance to horizontal displacement is provided by the major connecter and denture bases

Fulcrum Lines

When any one of the above mentioned forces act on a denture, the denture tends to rotate around a fulcrum line (axis of rotation). This fulcrum line is usually formed at the terminal abutment axis (line joining the two posterior-most rests). A fulcrum line is defined as *"An imaginary line around* *which a partial denture tends to rotate"* - GPT (Fig. 18.207). There are two types of fulcrum lines namely:

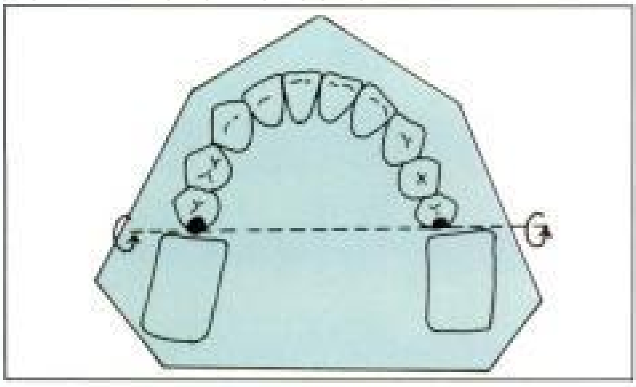


Fig. 18.207: A fulcrum line passing through the terminal abutment axis

Retentive fulcrum line

"An imaginary line, connecting the retentive points of clasp arms, around which the denture tends to rotate when subjected to forces, such as the pull of sticky foods"- GPT (Fig. 18.208).

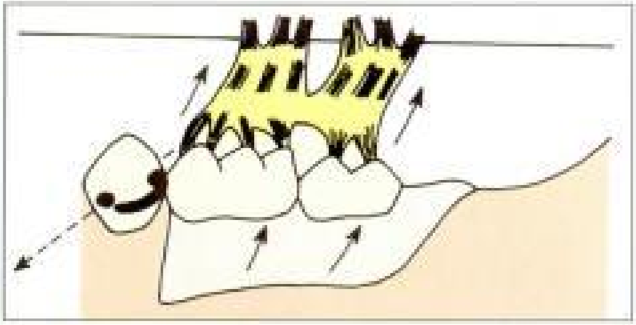


Fig. 18.208: A retentive fulcrum line passing through the retentive tips of clasp arms that withstand the pull of the denture due to sticky food. Once the denture begins to rotate the retentive arm becomes active and provides retention by engaging the undercut

Stabilizing fulcrum line

"An imaginary line, connecting occlusal rests, around which the denture tends to rotate under masticatory forces" - GPT.

The distance between the fulcrum line and the point of application of the force determine the amount of rotation. If the fulcrum line is located away from the point on which the force is applied, the rotation of the denture is minimal. In order to prevent the rotation of the denture, the fulcrum line should be moved away from the area of force application. This is achieved by adding an additional rest away from the edentulous area (Fig. 18.209).

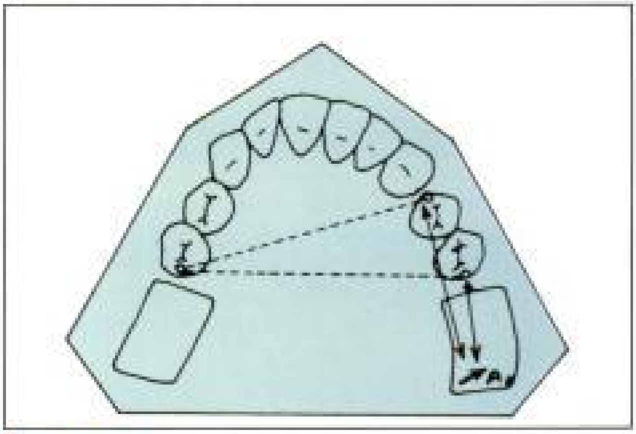


Fig. 18.209: Moving the stabilizing fulcrum line away from the point of action of occlusal forces provides indirect retention

Principle of Indirect Retainers

Consider a long bar which has a single support. When the bar is pulled up on one end, the other end goes down. Now, if the same bar has another support on the other end, then the bar will not go down on that end (Fig. 18.210).

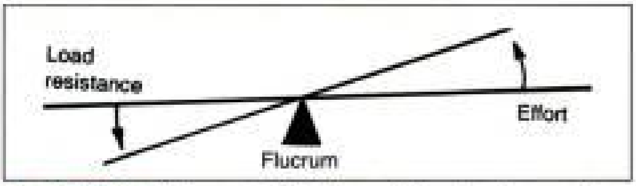


Fig. 18.210a: It is easy to lift a bar with a single support as it will act like a fulcrum and allow free rotation of the bar

This is the same mechanism present in an indirect retainer. When the denture tends to rotate along the retentive fulcrum line, the denture rotates around the single support i.e. the direct retainer. Providing an additional support away from the fulcrum line in the form of occlusal rest can prevent the rotation of the denture and function as an indirect retainer (Fig. 18.211).

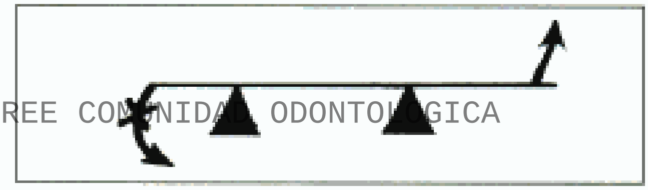


Fig. 18.210b: The same bar supported by more than one support cannot be easily lifted at one end because the support away from the effort (E) will prevent downward movement of the bar. If additional force is applied to lift the bar, the support away from the effort will act as the fulcrum of rotation. Since the fulcrum of rotation is away from the effort, additional force is required to destabilize the bar. (i.e.) The second support has indirectly improved the retention of the bar

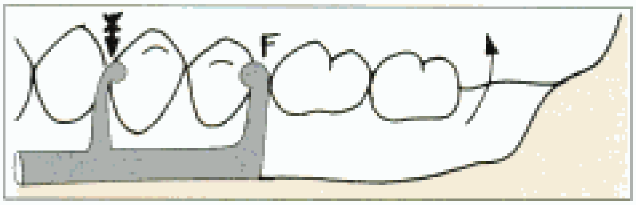


Fig. 18.211: When the denture is lifted away from the tissues, it tends to rotate around the direct retainer. Adding an auxiliary rest anterior to the point of rotation of the denture will function as an indirect retainer and prevent rotation of the denture

Factors Affecting the Effectiveness of The Indirect Retainers

Effectiveness of the direct retainer

If the rest and the direct retainer fail to retain the clasp assembly, there will be total displacement of the denture instead of rotation. In such cases, the indirect retainer cannot help to retain the denture. In other words, the indirect retainer is useless if the direct retainer does not function properly.

Distance from the fulcrum line

The action of the indirect retainer increases with the increase in the distance between the fulcrum line and the point of application of the force.

The factors to be considered here are:

- Length of the distal extension base: For long span ridges the indirect retainer should be placed as far anteriorly away from the fulcrum line as possible.
- Location of the fulcrum line: Ideally the indirect retainer should be located at a point perpendicular to the midpoint of the fulcrum line (Fig. 18.212).

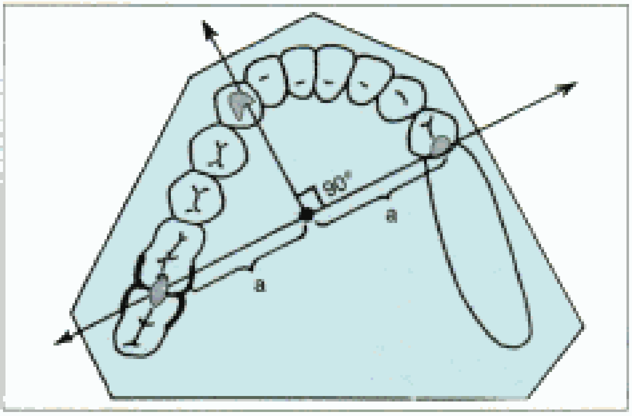


Fig. 18.212: Maximum function of an indirect retainer is obtained when it is placed at a point perpendicular to the midpoint of the axis of rotation

- Distance of the indirect retainer from the fulcrum line: The indirect retainer should be placed as far as possible away from the fulcrum line (Fig. 18.213).

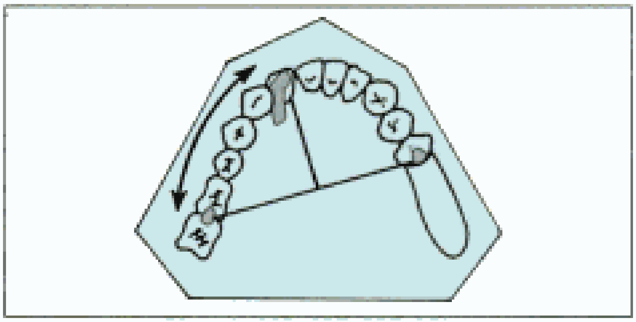


Fig. 18.213: Greater the distance between the indirect retainer and the fulcrum line greater is the indirect retention

- Rigidity of the connectors supporting the indirect retainer: If these connectors are flexible, the efficacy of the indirect retainer is lost.
- Effectiveness of the supporting tooth surface: the indirect retainer should be placed on a definite rest seat. Tooth inclines and weak teeth should not be used for placing an indirect retainer.

The Functions of the Indirect Retainers

- It shifts the fulcrum line away from the point of application of the force, thereby counteracting the lifting force and stabilizing the denture (Fig. 18.214).

Fig. 18.214: The indirect retainer also shifts the fulcrum line away from the point of application of the force. This increases the force threshold required to destabilize the denture

- It counteracts horizontal forces by providing support and stability to the denture. Support and stability is obtained from the contact of the proximal plate of the minor connector with the axial tooth surface (Fig. 18.215).

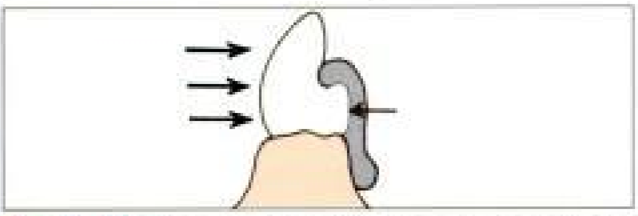


Fig. 18.215: The proximal plate of a minor connector supporting an auxiliary rest helps to stabilize the abutment against horizontal forces

- Anterior teeth can be splinted and protected against lingual movement with an indirect retainer.
- It may act as an auxiliary rest to support a part of the major connector.
- The dislodgement of indirect retainer (rest) from its rest seat when the denture base is depressed indicates the need for relining.

Types of Indirect Retainers

The most commonly used type of indirect retainer is a rest connected to a minor connector. In some cases indirect retention is obtained without a rest. In the following section, we shall discuss about the different types of indirect retainers and their salient features.

1. Auxiliary occlusal rest

- Most frequently used.
- It is located on the occlusal surface as far as possible away from the distal extension base.
- It is placed perpendicular to the midpoint of the fulcrum line. If this perpendicular ends on the incisal area it is avoided. This is because the incisors are single rooted teeth and have a vertical tooth surface that cannot support a rest. Also a rest in the incisal area produces more interference to the tongue. In such cases it is usually shifted to the mesial marginal ridge of the first premolar on either side.
- In Kennedy's class I cases bilateral rests on first premolars are used.
- In case of a Kennedy's class II it is placed on the first premolar of the opposite side.

2. Canine extension from the occlusal rest

- In some cases a finger like extension (*Lug seat*) from a premolar rest is placed on the lingual slope of the adjacent canine (Fig. 18.216).
- It is used when the first premolar must also act as a primary abutment. Primary abutment

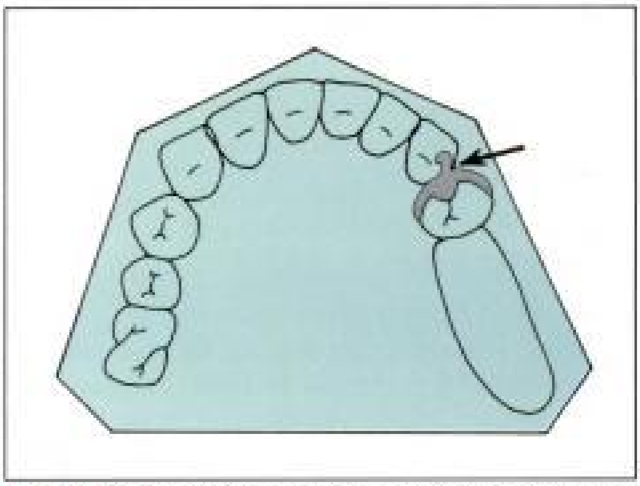


Fig. 18.216a: Lug seat extension from the adjacent premolar primary abutment. It serves as an indirect retainer by shifting the fulcrum line anteriorly

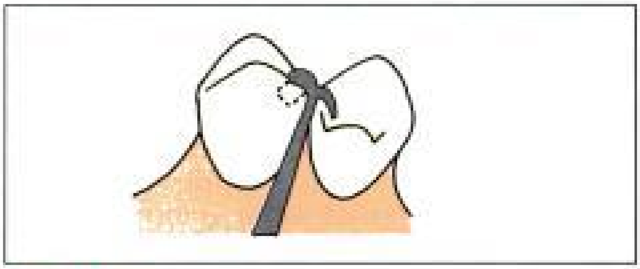


Fig. 18.216b: Lug seats do not require a separate minor connector for support. They are superior to a conventional cingulum rest in that they require less tooth preparation and do not produce any tipping forces on the canine

is defined *"A tooth used for the direct support of a fixed or removable dental prosthesis"* – GPT.

- This design avoids the tipping action produced in a single *cingulum* canine rest.

3. Canine rest

- If the mesial marginal ridge of the first premolar is close to the fulcrum line, canine rest is used.
- This design can be modified by placing the minor connector anterior to the canine. The minor connector hooks back into the cingular rest seat. This increases the efficacy of the indirect retainer (due to increase in distance from the fulcrum line).

4. Continuous bar retainers and linguoplates

- As they rest on unprepared lingual inclines of anterior teeth, they are not indirect retainers but they help to provide indirect retention.
- They are converted to indirect retainers when they have a terminal rest.
- In Kennedy's class I and class II cases, these retainers should be placed just above the middle third of the anterior teeth to avoid unwanted tooth movement (Fig. 18.217).

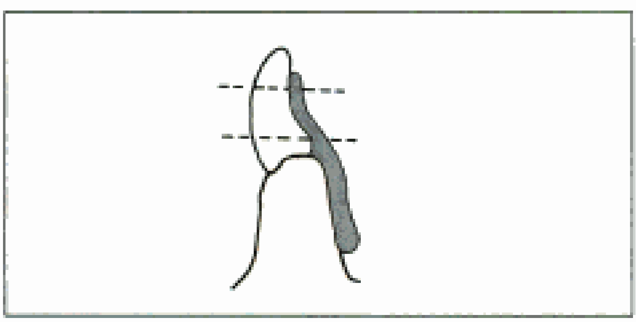


Fig. 18.217: Continuous bar retainers and linguoplates can act as indirect retainers. They should extent over more than 2/3rd the tooth surface to provide indirect retention

5. Modification areas

Consider a class II modification 1 case, in which the fulcrum line runs from the left second premolar to the right second molar. Here, the supportive element of the direct retainer (rest) on the right first premolar can act as an indirect retainer (Fig. 18.218) because it is far enough from the axis of rotation.

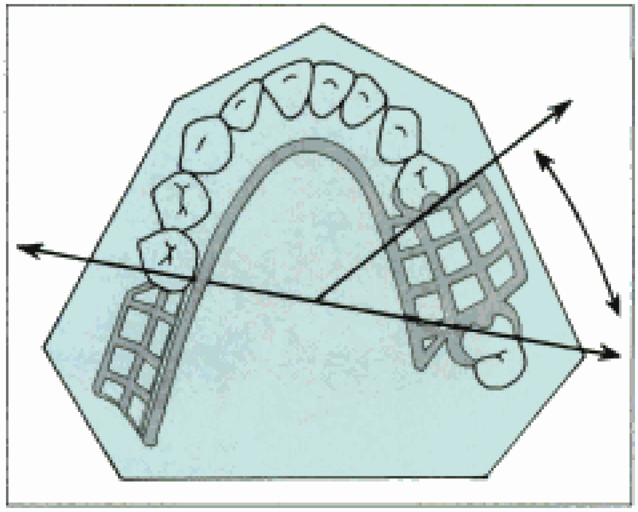


Fig. 18.218: Direct retainers (of a modification space) located anterior to the terminal abutment axis may also act as indirect retainers provided they are far enough from the fulcrum line

- If the occlusal rest on the secondary abutment is far enough from the fulcrum line, it can act as an indirect retainer (Fig. 18.219). *Secondary abutment is a tooth, which is used for support alongwith the primary abutment. It does not provide direct support.*

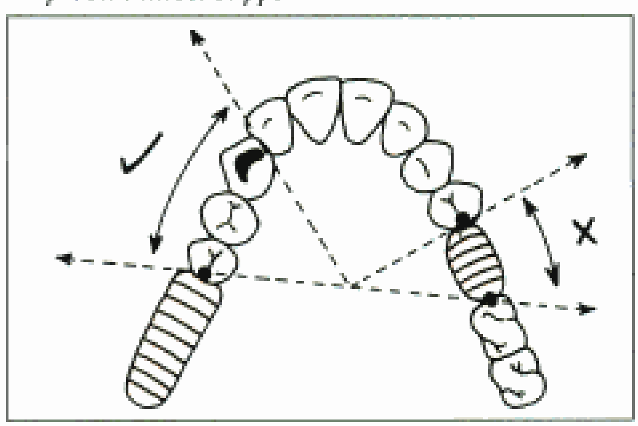


Fig. 18.219: If a secondary abutment is present farther away from the fulcrum line than the direct retainers of the modification space, it will be more efficient as an indirect retainer

- If only one tooth is missing in the modification area, the occlusal rest on this side should provide support for the unsupported major connector alongwith indirect retention.

  Consider a mandibular class II modification 1 case. The teeth missing include 36,37 and 46.

The rest on 15 is avoided, as it is closer to the fulcrum line. A rest on 13 is used as an indirect retainer and a support to the major connector (Fig. 18.220).

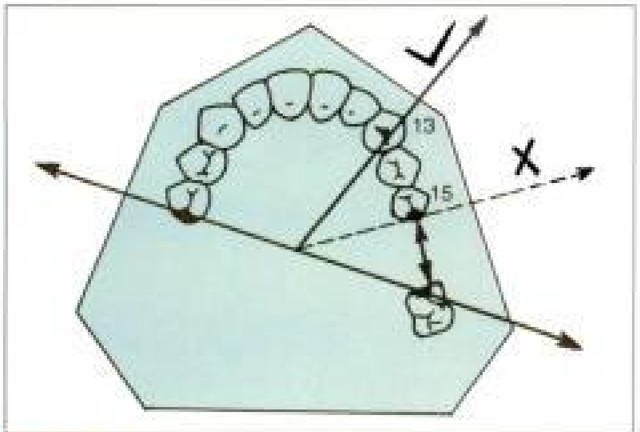


Fig. 18.220: If the direct retainer in the modification space does not have sufficient distance from the fulcrum line to act as an indirect retainer. Separate auxiliary rests should be placed as far anterior as possible away from the fulcrum line to act as indirect retainers

6. Rugae support

- As the rugae area is firm and well placed, it can be used for indirect retention for a palatal horseshoe major connector. Also this horseshoe lacks adequate posterior retention. Hence, the rugae support is used as an indirect retainer.
- The tissue support derived from the rugae is less effective than a tooth supported indirect retainer.

7. Direct indirect retention

- Sometimes, the reciprocal arm of a direct retainer located anterior to the fulcrum line may also act as an indirect retainer (Fig. 18.221).

8. Indirect retention from major connectors

- In the mandibular arch, retention from the denture base is enough to avoid the movements of the denture away from the tissues.
- In the maxillary arch, full palatal coverage is usually necessary for additional indirect retention especially when only anterior teeth are present.

The major connector provides indirect retention due to its rigidity. Some major connectors extend over two or three planes and produce L-beam effect that aid to improve the indirect retention (Fig. 18.222). *Indirect retention from the major connector is obtained from it's resistance to distortion.*

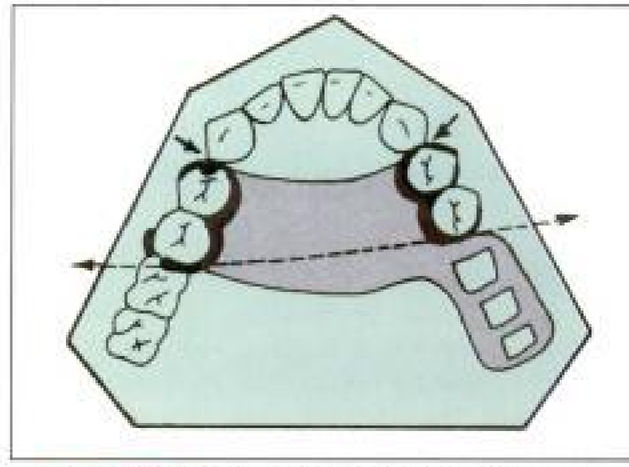


Fig. 18.221: Reciprocal arms of direct retainers far enough from the fulcrum line can act as indirect retainers

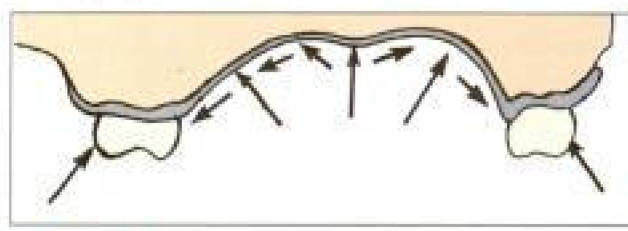


Fig. 18.222: Rigid major connectors resist distortion by distributing the forces acting on them and provide indirect retention

Denture Base

Denture Base is defined as, "*That part of a denture which rests on the oral mucosa and to which teeth are attached*".

"*That part of a complete or removable partial denture which rests upon the basal seat and to which teeth are attached*"-GPT.

Ideal Requirements

The requirements of an ideal denture base are:

- Accurate tissue adaptation with minimal change in volume.
- Thermal conductivity.
- Sufficient strength to resist fracture or distortion under function.

- Cleansability.
- Ability to be relined if necessary.
- Cost effective.

- Low specific gravity; weightlessness within the oral cavity.
- Ability to achieve a good finish

Types of Denture Bases

The most commonly used types of denture bases include:

- Acrylic
- Metal
- Combination

Acrylic resin denture bases

Acrylic resin denture bases are used alongwith acrylic tooth replacements. It is mainly used for distal extension partial dentures. They are attached to the framework by minor connectors. The resin should be atleast 1.5 mm thick to have adequate strength.

Advantages:

- Anterior teeth can be replaced at their original position (esthetic level) even in cases with residual ridge resorption.
- Restores the contour of the edentulous ridge.
- Brings out the normal contours of the lips and cheeks.
- Can be relined.

Disadvantages:

- They should rest on a large area for adequate stress distribution.
- Since acrylic denture base should be thick to withstand the occlusal forces, the amount of space available for the placement of artificial teeth is reduced. This becomes more problematic in cases with reduced inter-arch distance.
- May break on usage
- Tend to distort by the release of internal strains
- Tend to accumulate mucous deposits. This leads to calculus formation and soft tissue irritation.

Metal denture bases

Metal denture bases are mainly used for tooth supported partial dentures.

Advantages:

- Accurate soft tissue adaptation leads to better retention and restoration of facial contours.
- Permanent maintenance of form within the oral cavity without any distortion, the resin denture bases which tend to distort by the release of internal strains.
- Easy to clean and mucous deposits do not accumulate under metal bases as the metal base can be highly polished.
- Stronger than acrylic even in thin sections.
- Thinner metal bases can be given for cases with severe ridge resorption.
- They produce less interference with the tongue
- They transfer the thermal changes in the oral cavity to the underlying soft tissues producing a physiologic stimulation. This eliminates the feeling of a foreign object (denture) within the mouth.
- Better soft tissue response. This is because these materials have high density and they are also bacteriostatic.

Disadvantages:

- Difficult to trim and adjust.
- Over-extension can injure the soft tissues
- Under-extension can lead to ridge resorption, as the stresses are concentrated within a smaller area (Fig. 18.223).
- Poor aesthetics
- Difficult to reline or rebase.

Fig. 18.223: Metal denture bases with insufficient extension tend to concentrate the masticatory force over a small portion of the ridge

Tooth Replacements

The term tooth replacement refers to the artificial teeth placed in a denture. These artificial teeth are attached to the denture base in the following methods.

- Acrylic teeth fused with the denture base acrylic resin.
- Porcelain or acrylic tube teeth are usually cemented to the metal base
- Resin teeth processed directly over the metal base. The strength of the metal teeth junction is determined by the microscopic interlocking.

- Metal teeth are cast along with the framework
- Chemical bonding of acrylic with the metal base

There are different types of tooth replacements available commercially. Each one has its own advantages, disadvantages, requisites and indications. Based on the teeth selected for the patient, the design of the denture will vary considerably. A more detailed discussion about partial denture tooth replacements has been given in Chapter 21 under teeth selection.

Anterior Teeth Replacements

Here, aesthetics is the primary factor of concern. We shall discuss about the common materials available and their pros and cons. Refer Chapter 21 for more details.

Acrylic teeth

They are the most commonly used type of artificial tooth replacements. They easily crosslink with the denture base resin, have superior aesthetics and good retention. These teeth cannot be rebased and they have poor wear resistance.

Porcelain teeth

Porcelain teeth have better hardness and abrasion resistance than plastic teeth. They are mechanically retained. They have very high wear resistance and they can maintain the vertical dimension of the patient for a longer period. They have the best aesthetic appeal.

When opposed by natural teeth, porcelain produces extensive wear of enamel, but they have poor fracture resistance. They have to be trimmed to conform to the edentulous space and the metal framework underneath. This weakens the porcelain tooth.

They are used only when the partial denture has an opposing complete denture and when there is sufficient inter-occlusal clearance.

The porcelain tooth is mechanically retained to the acrylic denture base with the help of its retentive pins. The denture base acrylic is attached to the metal minor connectors with the help of:

- Nail head
- Diagonal spurs
- Retention loops

Plastic teeth

They have high impact strength but poor wear resistance compared to porcelain. They have adequate strength even in smaller dimensions. Their aesthetic reproduction is adequate for most cases.

Advantages:

- Most aesthetic
- Wider stress distribution
- Easy to reline
- Can restore the lost ridge contour

Disadvantages:

- Difficult for single tooth replacements
- Needs more bulk to achieve adequate strength

Metal teeth with facing

They have higher strength; hence, they are used in patients with reduced occlusal clearance. The facing must be well adapted to the ridge to achieve a natural look. Broad well-healed ridges are essential for fabricating these teeth.

The facings are easy to fabricate and can be interchanged whenever needed. But they are aesthetically inferior because the metal backings tend to show through the acrylic or porcelain facings.

In cases with deep bite, the natural teeth occlude with the metal backing leading to rapid tooth wear. Relining is not possible when these teeth are used.

Tube teeth

It is defined as, *"Artificial teeth with an internal, vertical, cylindrical aperture extending from the center of the base upward into the body of the tooth, into which a pin may be placed or cast for the attachment of the tooth to a denture (fixed or removable) base"*-GPT.

It is mainly used for single tooth replacements. It is nothing but a plastic or porcelain denture tooth with a channel prepared on the ridge lap surface of the tooth. A metallic post is fabricated along with the metal framework by waxing the channels of these teeth during pattern fabrication (Fig. 18.224).

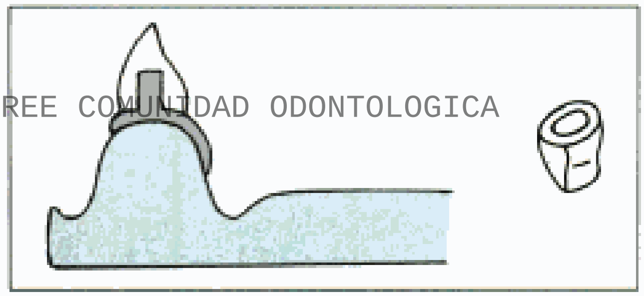


Fig. 18.224: Tube teeth

Advantages:
- As the post is covered by acrylic or porcelain all around, it has better aesthetics.
- Opposing teeth occlude against resin instead of metal.
- Reduced processing time.
- Can also be used for replacing a premolar.

Limitations:
- Adequate mesiodistal and occlusal space is needed.
- A broad, well-healed ridge is needed, as the teeth must adapt to the soft tissues to attain better aesthetics.
- Cannot be used for multiple tooth replacements.

Reinforced acrylic pontics (RAP)

It is a combination of teeth with facings and tube teeth. The teeth have metal projections or loop on the gingival half of the lingual surface. These loops provide better retention and strength. The facial and incisal portions are made of acrylic (aesthetics and shade matching) and are processed alongwith the framework (Fig. 18.225).

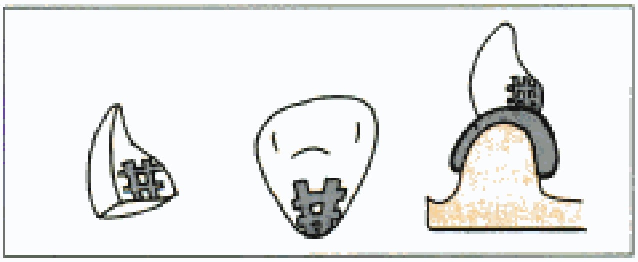


Fig. 18.225: Reinforced acrylic pontics

Advantages:
- High strength
- Better aesthetics
- Lower teeth occludes only with the acrylic portion
- Can be used in limited edentulous spaces

Limitations:
- No support from the ridge
- Cannot be used in unhealed or resorbed ridges
- Relining is not possible

Posterior Teeth Replacement

There are totally six different types of posterior teeth replacements commonly used. We shall read about them in detail. Refer chapter 21 for more details.

Plastic teeth

They have reduced wear resistance and tend to flatten under mastication. This leads to loss of vertical dimension and inefficient mastication. Hence, the patients must be frequently reviewed to detect occlusal wear.

Porcelain teeth

They are used only when the opposing tooth is also a tooth replacement like acrylic or porcelain. These teeth are retained by acrylic resin by their diatoric holes (Fig. 18.226).

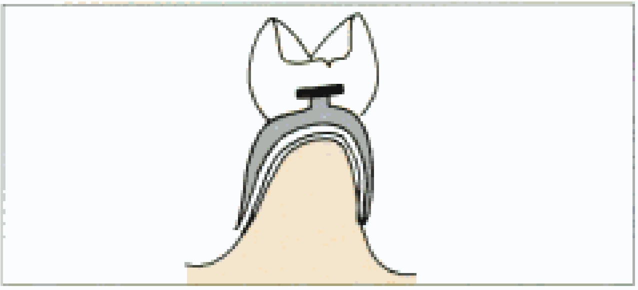


Fig. 18.226: Posterior porcelain teeth with diatoric retentive holes in gingival surface

Metal pontics

It may be a full-metal crown or metal crown with a tooth-coloured veneer. They are given in cases where acrylic or porcelain teeth cannot be given. Example—When there is reduced occlusal clearance or when there is limited inter-dental space.

It is made up of gold or chrome alloy. Chrome alloy abrades the natural teeth very quickly. Hence, the occlusal surface should be covered with tooth coloured resin. Gold is preferred as it has adequate strength and restores occlusion to the maximum limit.

Metal pontics with acrylic windows

In cases with reduced space and aesthetic requirement, the buccal surface of the pontic is removed and tooth coloured acrylic is packed into the buccal surface.

Tube teeth

It is mostly used for posterior tooth replacements especially for maxillary premolars. They are not used for distal extension prosthesis.

Reinforced acrylic pontics (RAP)

These are nothing but acrylic teeth reinforced with metallic loops extending into the gingival half of the lingual surface. The acrylic is processed around the metal projections. The metal projections give strength to the teeth.

Advantages:

- Excellent strength and aesthetics.
- Can be designed such that the opposing teeth contact only the acrylic.
- Strong even in small sizes. Hence, it can be used in cases with reduced inter-arch space.

Disadvantages:

- Contraindicated for cases with unhealed or excessively resorbed ridges.
- Little support can be obtained from the ridge.
- Cannot be relined.

Bonding between the Teeth and the Denture Base

The mechanism of bonding varies according to the type of denture base and tooth replacement used. Denture base-teeth bonding can be broadly grouped into:

- *Mechanical*
- *Chemical*
- *Chemicomechanical*
- *Acid etching (Microretention)*
- *Silanation (Tribo-chemical method).* This is a combination of acid etching and chemical bonding.

PRINCIPLES OF A REMOVABLE PARTIAL DENTURE

A denture should be designed to obtain a balance between both the mechanical and biological factors. A.H.Schmidt in 1956 stated the following five principles to be considered during the fabrication of a removable partial denture. They are:

- The dentist must have a thorough knowledge of both the mechanical and biologic factors involved in removable partial denture design. He must know about the various forces acting on the denture and soft tissues and their response to these forces.
- The treatment plan must be based on a complete examination and diagnosis of the individual patient. Any negligence in the appropriate diagnosis will lead to failure of the prosthesis.
- The dentist must correlate the pertinent factors and determine a proper plan of treatment. He must examine the existing oral condition and do the necessary modifications before designing a removable partial denture.
- A removable partial denture should restore form and function without injury to the remaining oral structure. It should produce adequate aesthetics and function without compromising on the health of the soft tissues.
- A removable partial denture is a form of treatment and not a cure. Even after insertion, the patient should be recalled and reviewed to ensure success of the treatment.

The Various Principles Involved in the Functioning of a Removable Partial Denture

- Different forces acting on a denture in the mouth.
- The response of the denture to the forces acting on it.
- Design methods, which help to limit the effects of these harmful forces.

In this section, we will discuss about the forces acting on a denture, the response of the denture to these forces and the methods of modifying the response of the denture (designing the denture to reduce the stress developed within it).

Different Forces Acting on the Denture Inside the Oral Cavity

The oral cavity is a complex structure enclosed within a lot of muscles. The forces acting on the denture arise from different sources in different directions. The various forces and their origin are:

Occlusal force It acts on the occlusal surface of the denture. It is of very high magnitude. This force pushes the denture on to the tissues on the edentulous ridge. Excessive occlusal forces can produce residual ridge resorption (Fig. 18.227).

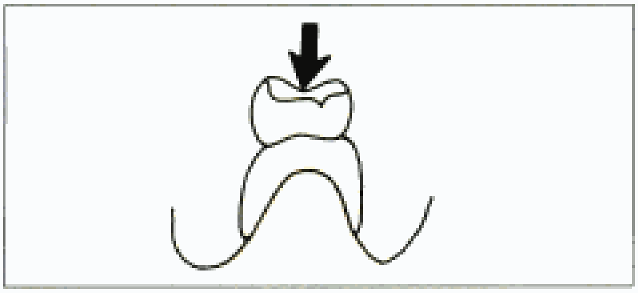


Fig. 18.227: Tissue supported partial dentures transfer most of the forces acting on them to the residual ridge and produce resorption

Forces from the tongue The tongue tends to push the denture buccally and labially. Excessive force from the tongue can displace the denture frequently during function.

Forces from the surrounding musculature (lip and cheek muscles) These forces compensate the forces of the tongue. Excessive forces tend to displace the denture (Fig. 18.228).

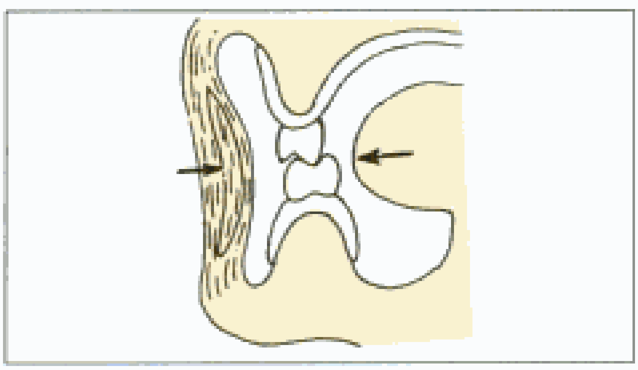


Fig. 18.228: The forces of the tongue and the cheek are neutralized in the neutral zone. Artificial teeth should be arranged in this zone to obtain best stability

A balance is usually maintained between the buccinator and the tongue. This balance results in a 'dead zone of nil force'. This zone is called *neutral zone* or *zone of minimal conflict* or *zone of equilibrium* (Fig. 18.228). Artificial teeth on the denture should be placed on this zone to achieve good stability for the denture.

Response of the Denture to Various Forces Acting on it

Generally tissue supported partial dentures respond like a lever or like an inclined plane when a force is applied on them. Tooth supported partial dentures (Kennedy's Class III) are not supported by resilient structures, and they transmit all the forces acting on the prosthesis along the long axis of the abutment tooth. A tooth supported partial denture is rarely subjected to induced stresses because.

- Leverage type of forces are not involved.
- There is no fulcrum line around which the partial denture can rotate.

Kennedy's Class I, II and IV (long span) removable partial dentures take support both from the teeth and the soft tissues. Hence, the forces acting on the denture are shared between the tooth and the soft tissues. Since two tissues of different resiliency support the denture, stress is precipitated within the denture due to uneven settlement during occlusal loading (Fig. 18.229). The following design principles aid to control the effect of the various forces:

- Maximum coverage of soft tissue
- Efficient use of the direct retainer
- Proper placement of the components in their most favorable position.

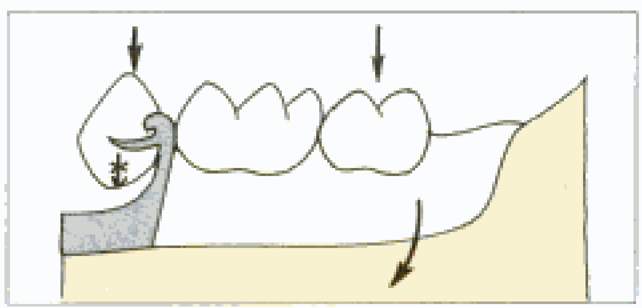


Fig. 18.229a: Tooth tissue supported dentures are subjected to leverage forces due to the difference in the compressability of the supporting structures (periodontal ligament of abutments is less resilient compared to the mucosa overlying the residual ridge hence the denture will settle more in the tissue support areas)

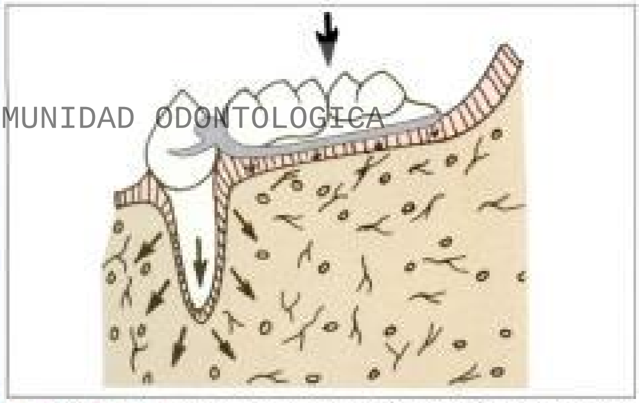


Fig. 18.229b: Schematic representation showing the pattern of force distribution and compressability of the supporting structures

The response of an object to any force is called *stress*. Forces acting on the removable partial denture develop internal stresses within the denture, which ultimately lead to *lever* and/or *inclined plane* action. It may also act like a *wedge* but this action is not common.

Lever *"A lever is a long bar with a single support around which it rotates when a load is applied to any one of its ends."* The support around which the lever rotates is called as the fulcrum.

Levers can be of three types namely:

- Ist - order levers
- IInd - order levers
- IIIrd - order levers

Each lever modifies the intensity of the force acting on the denture to a different degree.

Ist order lever: In this lever the fulcrum is in the center, resistance is at one end and effort (force) is at the other (Fig. 18.230).These levers are more efficient and easily controlled. This type of lever can occur in patients with distal extension partial dentures. The direct retainer will be the fulcrum, effort end lies on the point where the denture takes up the occlusal load (area where the artificial teeth are located) the load is the region of the anterior end of the major connector

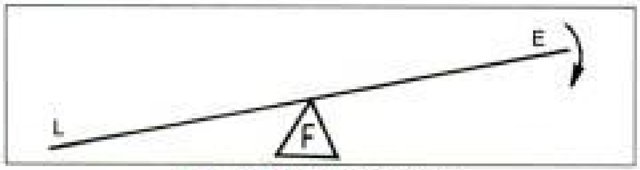


Fig. 18.230: Ist order lever
E = Effort, F = Fulcrum, L = Load

(Fig. 18.231a). Using an additional rest (indirect retainer) to shift the fulcrum line prevents lever action in these dentures (Fig. 18.231b).

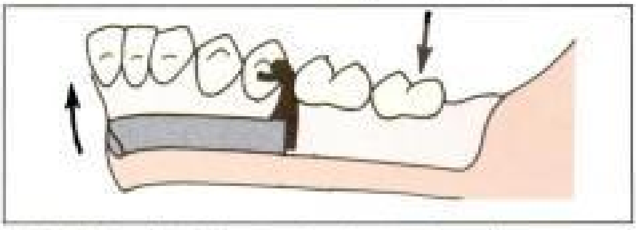


Fig. 18.231a: A distal extension denture base is an example for a Ist order lever where in the masticatory force (E) lift the anterior part of the denture (L) using the direct retainer as the fulcrum (F)

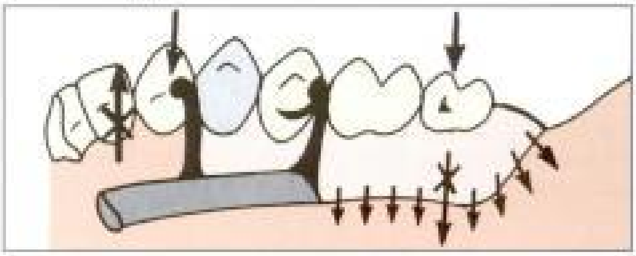


Fig. 18.231b: Adding an auxiliary rest anterior to the fulcrum prevents the lever action by acting as an indirect retainer. When an indirect retainer is given, the 1st order lever is converted to a IInd order lever which is more beneficial for the prosthesis

IInd order lever: In this lever, the fulcrum is at one end, effort is at the opposite end and resistance or load is the center (Fig. 18.232). This type of lever action occurs in indirect retention of a removable partial denture. When a displacing force tends to lift a denture from one end (*effort*), the anterior most point of the major connector will act as the axis of rotation (*fulcrum*), the intermediate zone of the denture, which is lifted by the force, will form the resistance (*load*) of the lever (Fig. 18.233).

IIIrd order lever: In this lever, the fulcrum is at one end, resistance is at the opposite end and

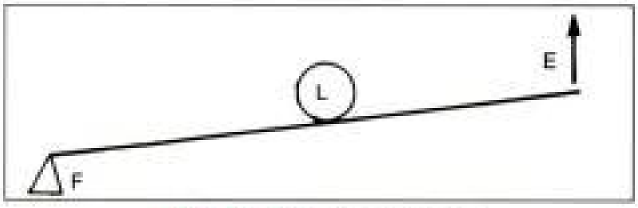


Fig. 18.232: IInd order lever
F = fulcrum, L = load, E = effort

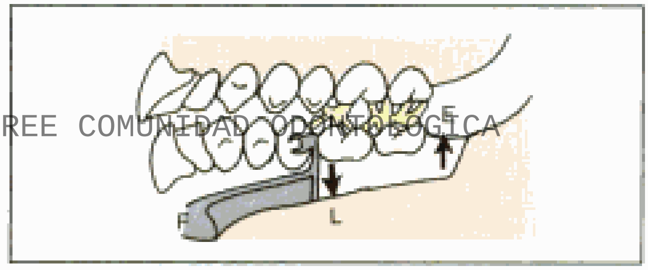


Fig. 18.233: Distal extension bases behave as second order levers when the denture is pulled by sticky foods (E). The anterior part of the major connector acts as the fulcrum (F) and the body of the denture is the load (L)

effort is at the center (Fig. 18.234) e.g. tweezers. This type of lever action does not occur in partial dentures.

Fig. 18.234a: IIIrd order lever
F: fulcrum, E: effort, L = load

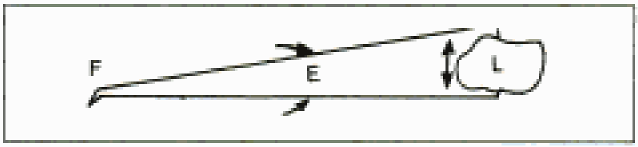


Fig. 18.234b: A tweezer is a typical example for IIIrd order levers

Lever action in a Kennedy's Class I prosthesis: In a distal extension partial denture rotation occurs around 3 principal fulcrums. They are:

Horizontal fulcrum line passing between two principal abutment teeth: It acts along the *x-axis* of the denture. This controls the rotational motion of the denture towards or away from the supporting soft tissues. Forces across this lever produce the most deleterious effect on the supporting tissues and the abutment teeth (Fig. 18.235).

Second rotational fulcrum line (Sagittal): It extends posteriorly from the occlusal rest of the terminal abutment. It passes along the alveolar crest till the posterior extent of the residual ridge on the same side. It acts along the *z-axis* of the denture. This fulcrum controls rocking or side-to-side movement of the denture that takes place over the crest of the residual ridge (Fig. 18.236).

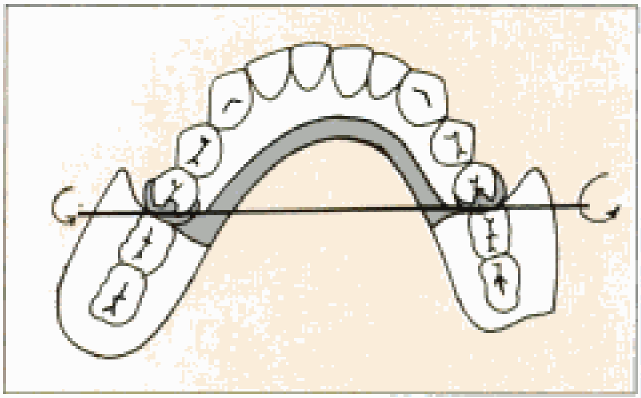


Fig. 18.235: Horizontal fulcrum line passing through the terminal abutment axis in a Kennedy's class I partial denture

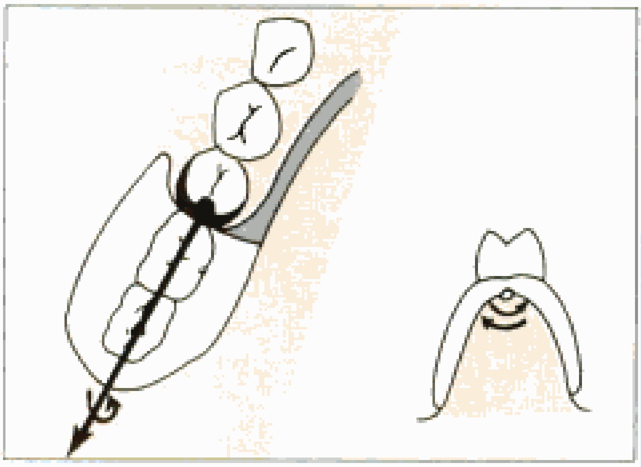


Fig. 18.236: Second rotational fulcrum line passing through the 'Z' axis

In a Class I condition, there are two such fulcrums extending posteriorly from each primary abutment to the respective retromolar pads (Fig. 18.237). These forces also have severe effects on the soft tissues.

Third fulcrum line (Vertical): It is vertical and is located on the midline, lingual to the anterior teeth. It acts along the *y-axis* of the denture. It controls the movement of the denture around the y-axis (Fig. 18.238).

When the forces acting on the denture are vertical, most of the periodontal ligament fibres are activated which provides good resistance to the force. If the forces acting on the denture are not vertical, only a part of the periodontal fibres are activated. This can produce damage to the abutment tooth (Fig. 18.239).

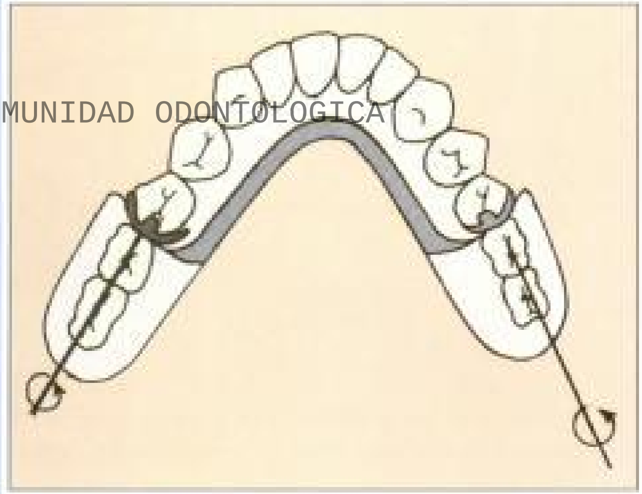


Fig. 18.237: Anteroposterior fulcrum lines on either side of a Kennedy's class I partial denture

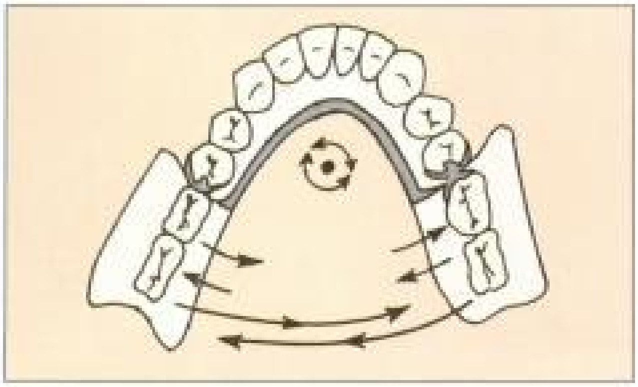


Fig. 18.238: Third rotational fulcrum line passing through the Y-axis or vertical axis of the partial denture

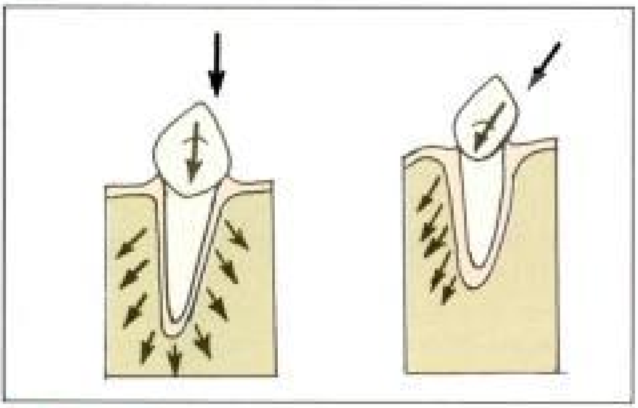
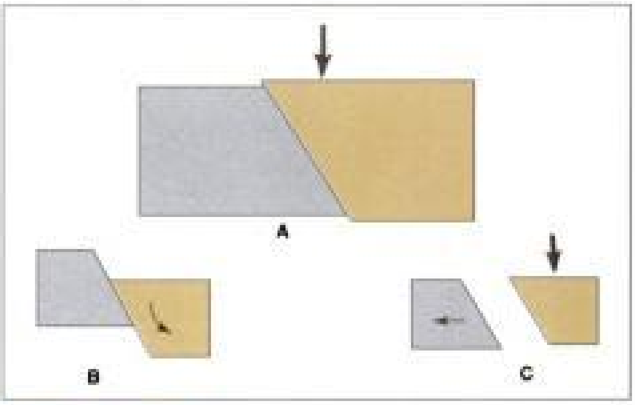


Fig. 18.239: Vertical forces are well distributed all across the pericemental area of the supporting tooth whereas oblique forces are partially distributed producing damage to the periodontium

Inclined plane (Fig. 18.240) Inclined plane is nothing but two inclined surfaces in close alignment to one another. The direct retainers and the minor connectors slide along the guide planes of the teeth and can act as inclined planes if not prepared correctly. When a force is applied against an inclined plane it may produce two actions:

- Deflection of the object, which is applying the force (Denture).
- Movement of the inclined plane itself (tooth). These results should be prevented to avoid damage to the abutment teeth.



Figs 18.240a to c: Response of an inclined plane to vertical forces (a) Vertical force applied by an object on an inclined plane (b) Deflection of the object applying the force (c) Movement of the inclined plane away from the object

Designing a RPD to Limit the Effects of Harmful Forces

In order to get a complete understanding about the various design concepts available, to limit the effects of harmful forces on the denture, we must have a thorough knowledge about the various factors that affect the magnitude of these forces.

Factors influencing magnitude of stresses transmitted to abutment teeth The various factors that control the amount of stress transmitted to the abutment are:

1. Length of the edentulous span.
2. Quality of support of the ridge.
3. Response of oral structures to previous stress.
4. Occlusal relationship of the remaining teeth and orientation of the occlusal plane.

5. Qualities of a clasp
6. Clasp design
7. Length of the clasp
8. Material used in clasp construction
9. Abutment tooth surface

1. Length of the edentulous span:
The longer the edentulous span, the longer will be the denture base and the greater will be the force transmitted to the abutment tooth. Posterior teeth should be preserved as far as possible to reduce the length of the edentulous span (Fig. 18.241).

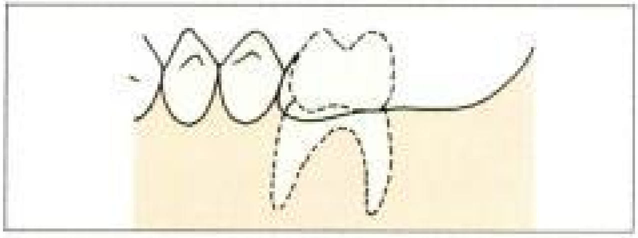


Fig. 18.241: Longer edentulous spans have poor prognosis

2. Quality of support of the ridge (Fig. 18.242).

- Large, well-formed ridges are capable of absorbing greater amounts of stress than small, thin, or knife edged ridges.
- Broad ridges with parallel sides permit the use of longer flanges on the denture base, which helps to stabilize the denture against lateral forces.
- A mucoperiosteum, which is approximately 1 mm thick, gives good support compared to a thin atrophic mucosa.

3. Response of oral structures to previous stress
The periodontal condition of the remaining teeth, need for splinting and the amount of abutment support remaining, are all a result of the previous stress subjected on the oral tissues. These factors affect the prognosis of the new prosthesis too.

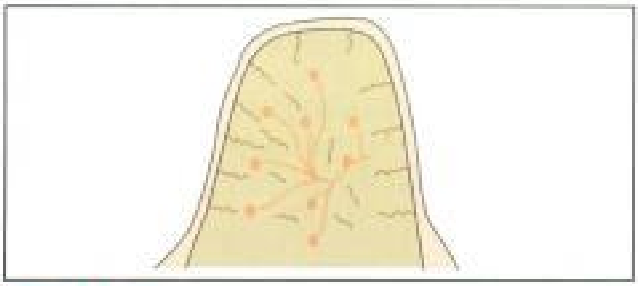


Fig. 18.242: Tall broad ridges with a thick mucoperiosteum offer superior support to the prosthesis

4. Occlusal relationship of the remaining teeth and orientation of the occlusal plane Improper occlusal relationship and a steep occlusal plane tend to increase the amount of force acting on the denture. The force applied on natural teeth is 300 pounds and the force acting on artificial teeth is about 30 pounds. Poor occlusal relationship can lead to supra-eruption of the opposing natural teeth.

The denture base area against which the occlusal load is applied determines the amount of stress transmitted to the abutment and the edentulous ridge. The occlusal load should be applied on the center of the denture bearing area both anteroposteriorly and buccolingually (the second premolar and the first molar region). Artificial teeth should be arranged so that the bulk of the masticatory forces are concentrated here (Fig. 18.243).

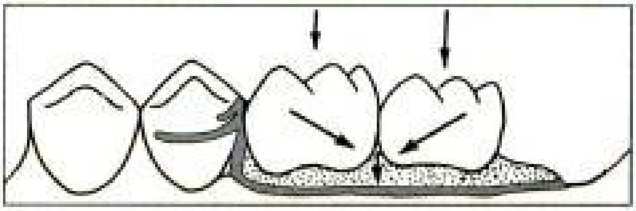


Fig. 18.243: Partial dentures should be designed such that forces acting on them are concentrated to the centre of the denture base both buccolingually and mesiodistally

5. Qualities of a clasp A flexible retentive clasp arm decreases the stress that will be transmitted to the abutment tooth. Example: A wrought wire clasp is more flexible than a vertical projection clasp, hence it decreases the forces acting on the abutment tooth and increases the forces transferred to the edentulous ridge. But it provides less horizontal stability.

6. Clasp design A clasp should be passive when it is completely seated on an abutment tooth. The passive clasps will exert less stress on the teeth. If a clasp is active throughout the period of denture wear, it will produce injury to the abutment.

When the framework is completely seated, the retentive clasp arms should become passive.

Disclosing wax can be used to test the proper placement of a framework.

A clasp should be designed so that the reciprocal arm contacts the tooth before the retentive tip passes over the greatest bulge of the tooth during insertion and it should be the last component to lose tooth contact during removal of the prosthesis.

7. Length of the clasp The flexibility of a clasp depends on its length. Doubling the length increases the flexibility by five times. This decreases the stress on the abutment tooth. Using a curved rather than a straight clasp on an abutment tooth will aid to increase the clasp length (Fig. 18.244).

Fig. 18.244: Longer clasp arms offer greater flexibility hence, retentive arms can be looped to increase their length

8. Material used in clasp construction A clasp constructed of chrome alloy will exert more stress on the abutment tooth than a gold clasp because of its greater rigidity. To decrease the stress, the chrome alloy clasps are constructed with a smaller diameter.

9. Abutment tooth surface The surface of a gold crown or restoration will offer more functional resistance to the movement of a clasp arm than enamel. Therefore, more stress is exerted on the tooth restored with gold than on the tooth with intact enamel.

Controlling Stress by Design Considerations

A removable partial denture will always have a destructive effect within the oral cavity. The best we can do is minimizing these destructive effects. The following factors can be modified to reduce the stresses developed within a denture.

1. Direct retention The retentive clasp arm is responsible for transmitting the destructive forces to the abutment teeth. A removable partial denture should be designed in such a way that the retention obtained from the clasp is just enough to provide adequate retention to prevent dislodgement of the denture. It should also be remembered that the retentive clasp should be designed such that it is active only during insertion and removal.

2. Forces of adhesion and cohesion Adhesion is defined as *"The physical attraction of unlike molecules for one another"* - GPT. Here, adhesion refers to the attraction of saliva to the denture and the tissues. Cohesion is defined as *"The physical attraction of like molecules for one another"* - GPT. Here, cohesion refers to the internal attraction of the molecules of saliva for each other.

Forces of adhesion and cohesion can be increased by:

- Recording an accurate impression so that the denture base fits accurately to the supporting tissues.
- Increasing the denture bearing area.

Atmospheric pressure may also contribute to retention. Generally, major connectors are beaded at their margins so that a tight valve seal is obtained.

3. Frictional control: Partial dentures should be designed to have maximum number of guide planes. Guide planes are flat surfaces on the teeth that are created such that they are parallel to one another and also to the path of insertion. As the name suggests, guide planes help to guide the denture during insertion. Various parts of the partial denture slide along the guide planes during insertion.

Preparation of guide planes on the proximal surfaces of teeth adjacent to edentulous spaces will increase the retention by frictional contact. These planes may be created on the enamel surface of the teeth or on the surface of the restorations placed on the teeth. During displacement, the components of the denture produce frictional retention along the surface of the guide planes (Fig. 18.245).

4. Neuromuscular control The action of lips, cheeks and tongue can be a major factor in the

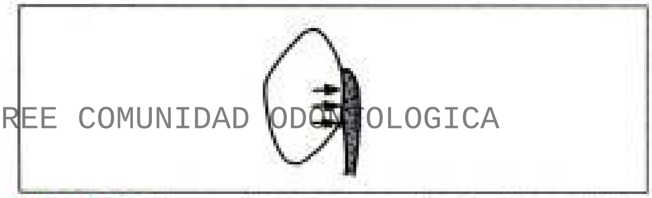


Fig. 18.245: The proximal plates associated with the guiding planes produce tensofrictional resistance to displacement against the path of insertion

retention of the denture. A properly contoured denture base can aid to improve the patient's neuromuscular control of the prosthesis. An overextended denture will get constantly displaced due to the neuromuscular action. Frequent displacement of these dentures will lead to excessive stress on the abutment.

5. *Clasp position* Position of the retentive clasp in relation to the height of contour is more important in retention and in controlling stress than the number of clasps present in the entire prosthesis.

Consider the following example: It is easier to pullout a pole immersed in sand from its tip than at a point just above the level of the sand (Fig. 18.246). Similarly, a clasp located deep in the undercut will be more difficult to remove.

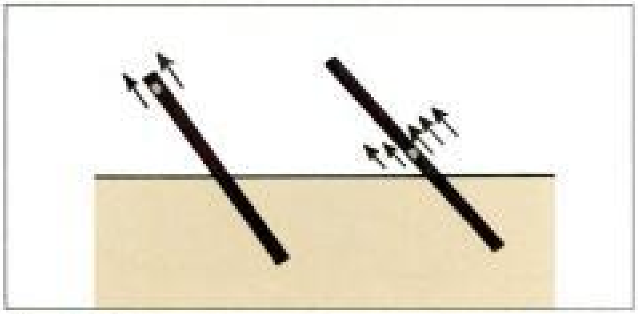


Fig. 18.246: Removing a stick submerged in sand using its tip requires less force (fewer arrows) compared to doing so from a point just above the level of sand (more arrows)

6. *Number and placement of clasps* The number of clasps used and their placement determine the type of stress developed within a denture. Removable partial dentures with four clasps are described to have a quadrilateral configuration. Similarly removable partial dentures with three and two clasps are described to have a tripod and bilateral configuration respectively. Quadrilateral configuration is the most efficient in controlling the stress developed within a denture.

Additional clasps are usually added to increase the stability and force distribution of the partial dentures with few clasps.

Quadrilateral configuration This design involves the use of four clasps. It is used commonly for Kennedy's class III arches particularly when there is a modification space on the opposite side of the arch. A retentive clasp should be positioned on each abutment tooth adjacent to the edentulous spaces (Fig. 18.247).

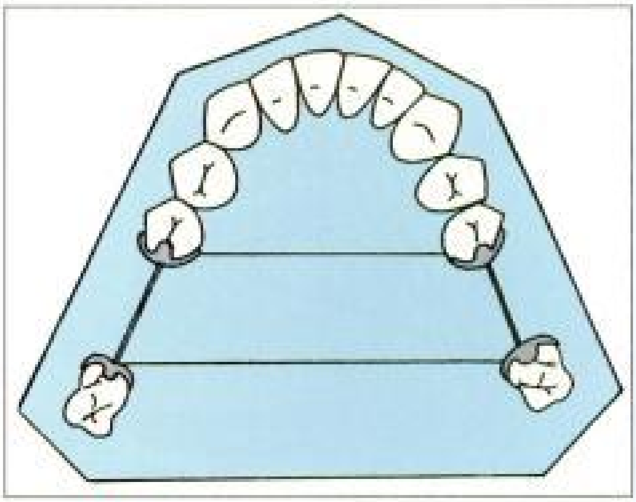


Fig. 18.247: Quadrilateral configuration is ideal to distribute occlusal forces

In a Kennedy's class III arch with no modification, one clasp is placed as far posterior on the dentulous side as possible and the other is placed as far anterior as possible depending on the availability of space and aesthetics. This retains the quadrilateral concept and is effective in controlling the stress.

When occlusal load is applied on these dentures, the forces are distributed to both sides of the arch and transmitted along all the abutment teeth. Usually occlusal loads do not produce any deflective (non vertical) movement of dentures with this configuration.

Tripod configuration This design involves the use of three clasps. It is used for Kennedy's class

II arches. In class II cases, rotational forces act on the prosthesis producing stress over the terminal abutment tooth. Adding two abutments on the opposite side helps to stabilize and distribute the forces.

One clasp is placed on the posterior most abutment of the edentulous space, and the other two are placed on the anterior and posterior ends of the dentulous quadrant. If a modification space is present, the anterior and posterior teeth adjacent to the modification space are clasped. If a modification space is not present, the posterior clasp is placed as posterior as possible. The placement of the anterior clasp is determined by the availability of interocclusal space and aesthetics (Fig. 18.248).

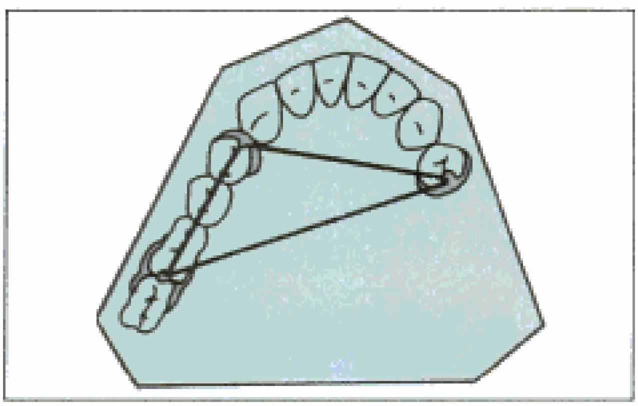


Fig. 18.248: Tripod configuration seen commonly in Kennedy's class II partial dentures

Bilateral configuration: This design is used for a Kennedy's class I partially edentulous arch. The terminal abutment teeth are clasped. The clasps have a very minimal neutralizing effect on the stresses developed by leverage-induced forces on the denture base. These stresses should be controlled using other methods.

Additional clasps can be used at the anterior end to convert the design into a quadrilateral configuration (Fig. 18.249)

7. *Clasp design* The design of the clasp used in a prosthesis determine the stress developed by the abutment under occlusal load. Flexible clasps produce the least stress and rigid cast circumferential clasps produce the maximum stress in an abutment.

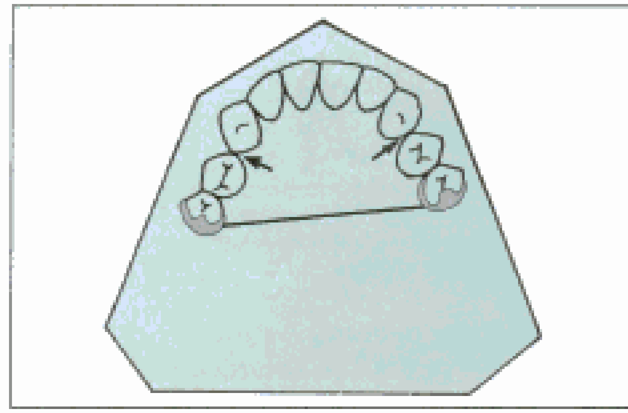


Fig. 18.249: Bilateral configuration of a Kennedy's class I partial denture. It should be converted into a quadrilateral configuration by adding clasps at the arrow points

Cast circumferential clasps In a Kennedy's class I condition, simple circlet clasps, which approach the mesiobuccal undercut, will produce severe torquing forces on the abutment. Reverse circlet clasps do not produce these forces but they do have some amount of wedging action on the abutment. If occlusal rests are placed on the adjacent teeth, wedging forces of a reverse circlet clap are avoided (Fig. 18.250).

Vertical projection or bar clasp It is used in distal extension cases where a distobuccal undercut is present on the terminal abutment tooth. The bar clasp functions similar to the reverse circumferential clasp, except that it does not produce

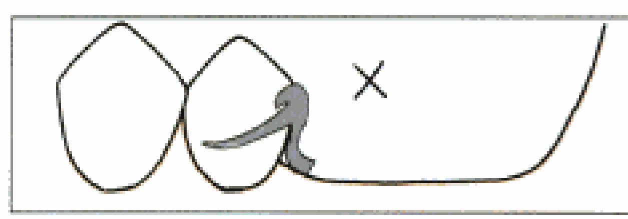


Fig. 18.250a: Simple circlet clasps are contraindicated for distal extension partial dentures as they may damage the abutment

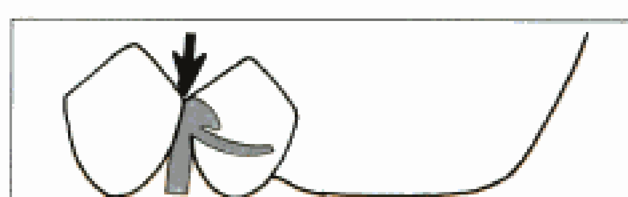


Fig. 18.250b: Reverse circlet clasps are preferred for distal extension dentures but they have a wedging action (arrow)

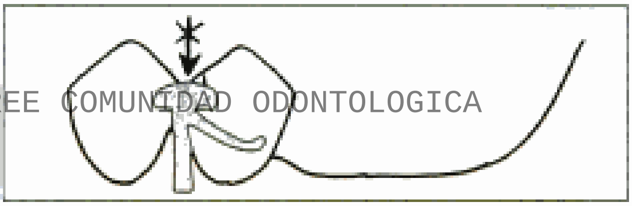


Fig. 18.250c: Wedging action of reverse circlet clasps can be avoided by adding a rest to the adjoining tooth

wedging forces. This clasp relieves the torsional load on the abutment tooth by moving gingivally without disturbing the abutment under occlusal load. In some cases, the distal rest is replaced with a mesial one. But in such cases food impaction is more common (Fig. 18.251).

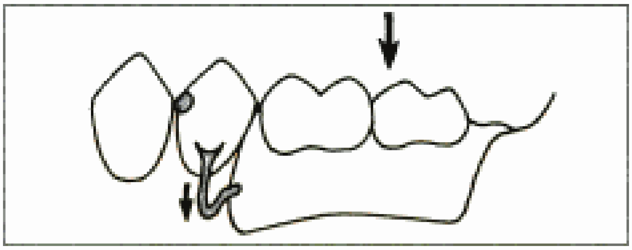


Fig. 18.251a: Bar clasps do not stress the abutment during occlusal loading

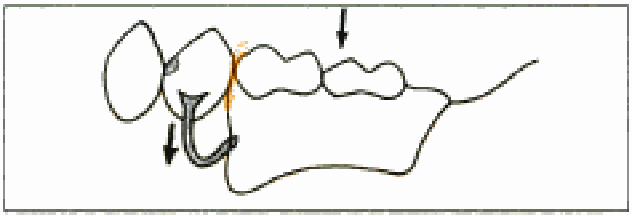


Fig. 18.251b: Bar clasps with mesial rests report to produce greater incidence of food impaction

Combination clasp The combination clasp is indicated in a mesiobuccal undercut, on the abutment tooth adjacent to a distal extension denture base. This clasp reduces the stress transmitted to the abutment tooth because the retentive terminal is made of wrought wire, which is more flexible.

8. Splinting the abutment teeth Weak abutment teeth should be splinted with the adjacent teeth for strength and stability. Splinting helps to share the stress produced in a weak abutment. Splinting stabilizes the weak teeth in the mesiodistal direction.

Usually splinting is done by fabricating full veneer crowns over the teeth to be splinted. Splinting using a clasp is done when no other approach is feasible. This is done by clasping more than one tooth on each side of the arch with numerous rests for additional support and stabilization.

Guide planes help to increase the horizontal stability of the denture. Hence, additional clasps can be used to increase the guide planes and also increase the cross arch stabilization.

Indications Splinting is indicated for the following clinical conditions.

- Abutments with a tapered or short root.
- Terminal abutments located on the edentulous side of a distal extension denture base.
- Fixed splinting is given if there is some loss of periodontal attachment, after a periodontal disease and therapy.

9. Indirect retention An indirect retainer is one, which helps the direct retainer to prevent displacement of the distal extension denture by resisting the rotational movement of the denture around the fulcrum line passing through the occlusal rests on the terminal abutment.

Indirect retention is based on the lever principle. Indirect retention is produced by moving the axis of rotation of the denture away from the point of application of force.

- In a class I arch, indirect retainers are necessary and they should be positioned as far anteriorly to the fulcrum line as possible (Fig. 18.252).
- In a class II arch, the fulcrum line runs through the most posterior abutment on the dentulous side and the terminal abutment on the distal extension side. Adding another rest per-

Fig. 18.252: Indirect retainers in the form of auxiliary rests can be placed anterior to the fulcrum line to control leverage forces on the denture

pendicular to this fulcrum line provides indirect retention (Fig. 18.253).

- In a class III arch, indirect retention is not required. In some case there is buccolingual rotation of the denture. This is prevented by placing a rest on the dentulous side (opposite side), perpendicular to the longitudinal axis of rotation of the denture.

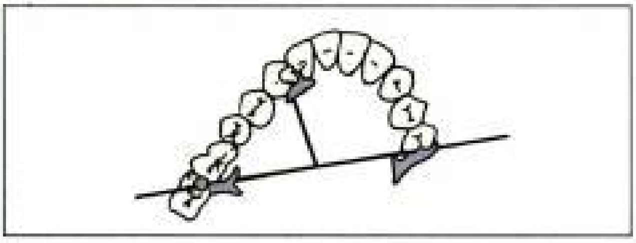


Fig. 18.253: For best efficiency indirect retainers should be placed on a point perpendicular to the midpoint of the terminal abutment axis

10. Denture base

- The denture base should be designed to cover the maximum amount of soft tissue available.
- The denture base should have long flanges in order to stabilize the denture against horizontal movements.
- Distal extension denture bases must always extend onto the retromolar pad area in the mandible and cover the entire tuberosity in the maxilla (Fig. 18.254).

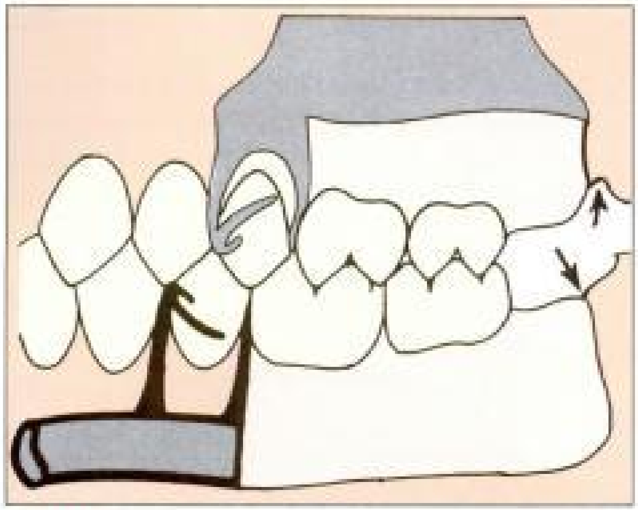


Fig. 18.254: Ideal extent of distal extension denture bases

- The denture base will displace the soft tissues on the ridge during functional occlusal load. Hence, a functional impression should be recorded to fabricate the denture in order to improve its adaptation and avoid excessive tissue displacement.

11. Major connector

The major connector of choice in the maxillary arch is the broad palatal major connector because it can distribute stress over a large area. In the mandibular arch, a lingual plate with rests can aid to distribute functional stress to the remaining teeth. Functions of the major connector include rigidity, retention, and stability.

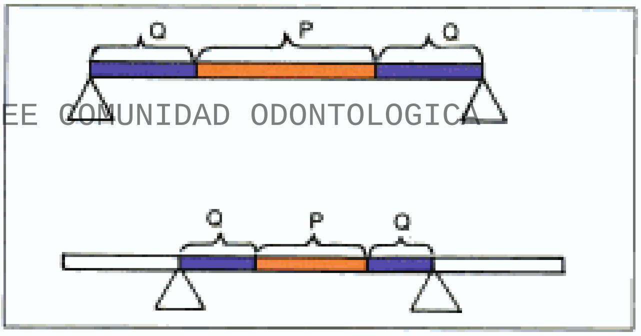
Major connectors should be selected to best suit the patient. It should distribute the occlusal load over a wide area and at the same time produce the least amount of stress. There are three important principles for design exclusively used for a major connector. They are:

- L-bar or L-beam principle.
- Circular configuration.
- Strut configuration.

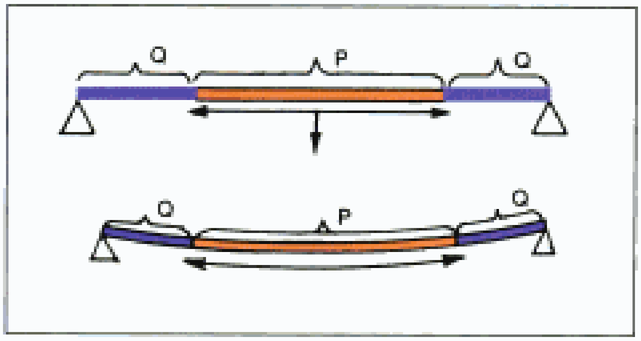
L-bar or L-beam principle The L-beam or L-bar or *Linear beam theory* states that the flexibility of a bar is directly proportional to the length of the bar and inversely proportional to its thickness. When a load is placed on the bar or beam supported at its ends, maximum stress is present in the centre and zero stress at the supported ends.

A bar supported at both its ends can be divided into two parts namely the parabolic and quartic parts. The parabolic part forms the middle 2/4th of the distance between the supports and the remaining 1/4th on either sides of the bar form the quartic part (Fig. 18.255). The parabolic part shows maximum stress concentration and the quartic part shows minimum or zero stress concentration.

Hence, if we design a bar such that it has a smaller parabolic part and a larger quartic part it will be less flexible. The material becomes more rigid (less flexible) without adding bulk to the bar. The next question is how do we do this? The answer is very simple. If we bend the bar on either side, the length of the bar lying in the quartic part will increase (Fig. 18.256).



Figs18.255a and b: According to the L beam theory, a bar supported by two supports will have various zones of stress concentration and those zones depend on the distance between the supports and **NOT** the length of the bar (b) When the distance between the supports decreases, the size of the quartic and parabolic zones also decrease



Figs 18.256a and b: Since the quartic zone is free of stress, flexion of the bar will occur only in the stressed parabolic part. In a straight bar supported at it's ends, the quartic zones form the outer 50% of the length (25% on either side) and the parabolic zone forms the middle 50%. In other words, the middle 50% of the length is subjected to flexural stress

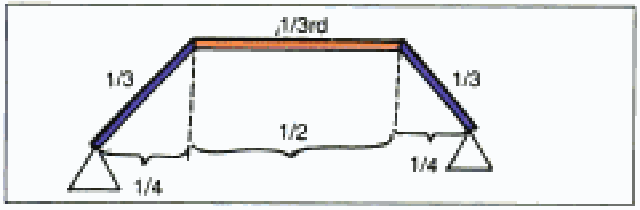


Fig. 18.256c: Consider the same bar is bent in 3 sides such that 33% is flat and the remaining 66% slopes on either side. Now when this bar is supported at it's ends, the solpes will form the quartic zone and the horizontal part will form the parabolic zone. Though the length of the bar is unaltered, more thatn 65% of the length comes under the 0-stress or quartic zone. Only the remaining 35% comes under the parabolic zone and is available for flexion. Hence the entire bar becomes less flexible

Now apply this concept in the design of a major connector. The palate has a flat vault and two lateral slopes. If the slopes are shallow, the quartic part of the major connector also decreases leading to increased flexibility of the prosthesis under occlusal load. The major connector should be located and designed such that it lies over the steeper slopes in the palate.

Hence, broad palatal major connectors, palatal strap major connectors can be fabricated with lesser bulk of material (but with adequate rigidity) because it extends in three planes (one central vault and two lateral slopes) with the length of the quartic part (the two lateral slopes) being greater than the parabolic part.

Circular configuration The advantage of a circle is that it is a continuous unit without an end. Any force acting on a circular bar can be easily distributed all along the circumference (Fig. 18.257). Hence, a circular bar is more rigid than a linear bar with the same area of cross section. This concept can be used to reduce the bulk of the major connector with a circular configuration (anteroposterior double palatal bar and closed horseshoe) (Fig. 18.258).

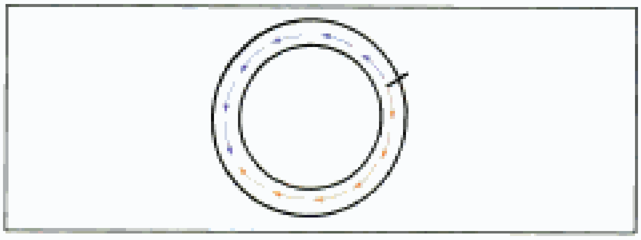


Fig. 18.257: Circular concept of infinite force transfer and even force distribution

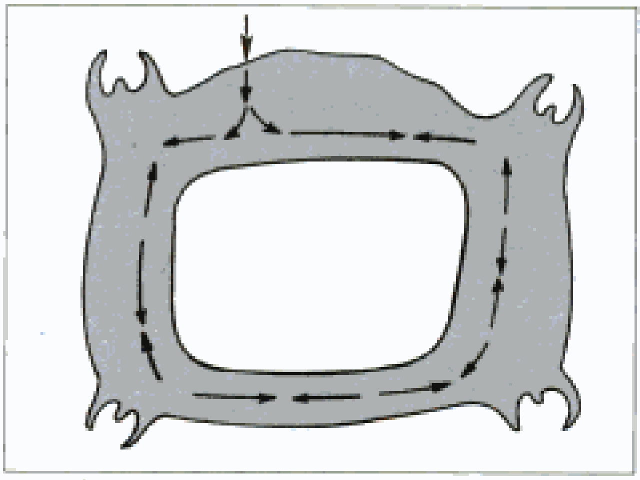


Fig. 18.258: Circular concept in maxillary major connectors

Strut configuration: According to this configuration, a straight bar bent at its ends near the support is more rigid because, the bent slopes of the bar aid to transfer the load acting on the horizontal portion (Fig. 18.259). This is similar to the linear bar theory (L-beam discusses stress concentration but struts discuss stress distribution). The major connector on a narrow vault is more rigid than a major connector extending over a shallow vault. In other words, the major connector extending in two different planes has more rigidity. This concept is seen in the anterior plate of the double palatal bar, where the slope of the rugae area acts as an additional strut (Fig. 18.260).

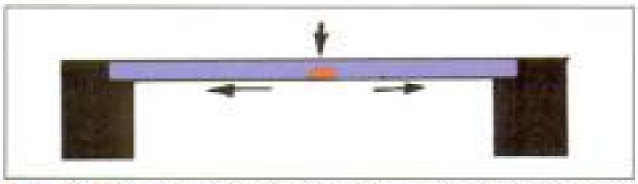


Fig. 18.259a: A bar supported only at its ends is subjected to greater stress and poor force distribution. Red Zone is the stressed area

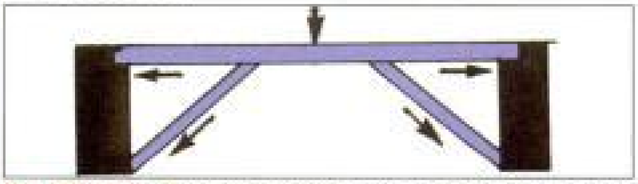


Fig. 18.259b: Same bar additionally supported by struts is stronger and more efficient in force distribution

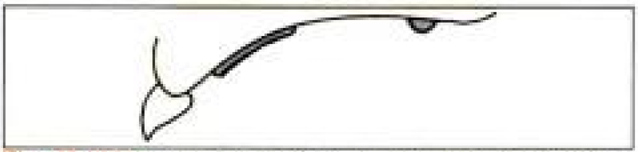


Fig. 18.260a: Anteroposterior struts seen in double palatal bars

Fig. 18.260b: Lateral struts seen in most maxillary major connectors

12. Minor connector The minor connector joins the major connector to the clasp assembly and the guiding planes located on the abutment tooth surface. The minor connector should be designed such that it does not interfere with the placement of the artificial teeth, tongue etc. The minor connectors used for auxiliary rest aid in indirect retention. It has the following functions:
- It provides horizontal stability to the partial denture against lateral forces on the prosthesis.
- The abutment tooth receives stabilization against lateral forces by the contact of the minor connector.

13. Rests Rests help control stress by directing the forces acting on the denture to the long axis of the abutment teeth. The floor of the rest seat should be less than 90° to a tangent line drawn parallel to the long axis of the tooth. In class I and class II partial dentures, the rest seat preparation must be saucer shaped. Adding rests on additional teeth decrease the amount of occlusal load on each tooth and helps to distribute the occlusal load equally to all the abutment teeth.

PRINCIPLES OF DESIGN/OR PHILOSOPHY OF DESIGN

The various philosophies of design deal with the methods employed to design a denture such that it evenly distributes the forces acting on it across the hard and soft tissues of the oral cavity.

All design characteristics of a partial denture should be such that the supporting structures are not stressed beyond their physiological limits. Usually a tooth supported removable partial denture (Kennedy's class III) has a better soft tissue response than a tissue supported partial denture (Kennedy's class I and II).

There are four design concepts, which can be used to distribute the force evenly along the soft tissues and supporting tooth structure. They are:
- Conventional rigid design.
- Stress equalization.
- Physiologic basing.
- Broad stress distribution.

Conventional Rigid Design

The denture is designed with rigid components, which act like a raft foundation to evenly distribute the forces on the supporting tissues. This design is used in all general cases. The only flexible component of these dentures is their retentive terminal.

Advantages

- Easy to construct and economical.
- Equal distribution of stress between the abutment and the residual ridge.
- Reduced need for relining as the ridge and abutment share the load.
- Indirect retainers prevent rotational movement and also stabilize the denture during horizontal movements.
- Less susceptible to distortion.

Disadvantages

- Increased torquing forces on the abutment teeth.
- Rigid continuous clasping may damage the abutment teeth.
- Dovetail intracoronal retainers cannot be used in these cases as tipping forces from the denture base will be directly transmitted to the abutment teeth.
- Tapered wrought wire retentive arm (combination clasp) cannot be used, as it is difficult to construct.
- Relining is difficult and inappropriate relining leads to damage of the abutment teeth.

Stress Equalization or Stress Breaker or Stress Directing Concept

A stress breaker is defined as, *"A device which relieves the abutment teeth of all or part of the occlusal forces"* - GPT.

"A stress director is a device that allows movement between the denture base and the direct retainer which may be intracoronal or extracoronal".

Dentures with a stress breaker are also called as a *broken stress partial dentures* or *articulated prostheses*. We know that the soft tissues are more compressible than the abutment teeth. In a tooth-tissue supported partial denture, when an occlusal load is applied, the denture tends to rock due to the difference in the compressibility of the abutment teeth and the soft tissues (Fig. 18.261).

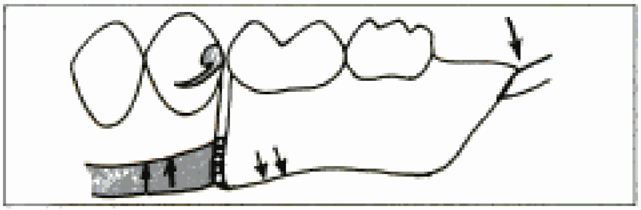


Fig. 18.261: Stress breakers can be added to the junction between the tooth supported portion and tissue supported portion of the denture to avoid leverage forces

As the tissues are more compressible, the amount of stress acting on the abutments is increased. This can produce harmful effects on the abutment teeth.

In order to protect the abutment from such conditions, stress breakers are incorporated in to a denture. A stress breaker is something like a hinge joint placed within the denture framework, which allows the two parts of the framework on either side of the joint to move freely. There are two types of stress breakers:

Type I

Here a movable joint is placed between the direct retainer and denture base. This joint may either be a hinge or a ball and socket or a sleeve and cylinder. Adding these stress breakers to the junction of the direct retainer and the denture base, allows the denture base to move independently (Fig. 18.262).

This decreases the amount of force acting on the abutment. The combined resiliency of the periodontal ligament and the stress director will be equal to the resiliency of the oral mucosa overlying the ridge. Examples for hinges include DALBO, CRISMANI, ASC 52 attachments.

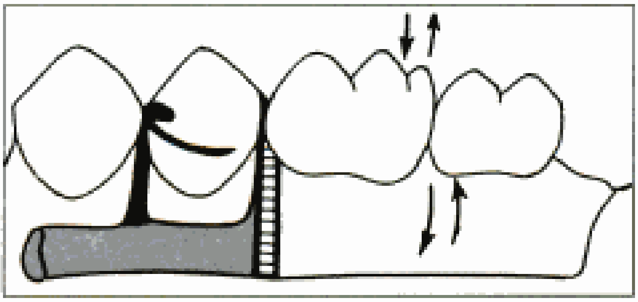


Fig. 18.262: The denture base shows independent movement with type I stress breakers

Type II

It has a flexible connection between the direct retainer and the denture base. It can be a wrought wire connector, divided or split major connector or a movable joint between two major connectors.

In a split major connector, the major connector is split by an incomplete cut parallel to the occlusal surface of the teeth into two units namely the upper unit (more near to the tooth) and the lower unit. The denture base is connected to the lower unit and the rests and direct retainers are connected to the upper unit (Fig. 18.263).

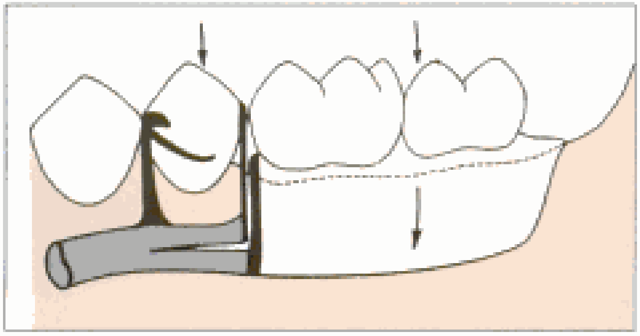


Fig. 18.263: Split major connector or type II stress breaker

Advantages

- The alveolar support of the abutment teeth is preserved as the stress acting on the abutment teeth are reduced.
- The stress on the residual ridge and the abutment teeth are balanced.
- Weak abutment teeth are well splinted even during the movement of the denture base.
- Abutment teeth are not damaged even if relining is not done appropriately (after the denture wears out).
- Minimal requirement of direct retention.
- Movement of the denture base produces a massaging effect on the soft tissues.
- This avoids the frequent need for relining and rebasing.

Disadvantages

- Design is complicated and expensive.
- The assembly is very weak and tends to fracture easily. Distorts to rough handling.
- It is difficult to repair.
- It can be used only to counter the vertical forces on the denture. Inability to counteract lateral stress acting on the ridge leads to ridge resorption.
- Reduced stability against horizontal forces.
- Both vertical and horizontal forces are concentrated on the ridge leading to resorption.
- Inappropriate relining leads to excessive ridge resorption.
- Reduced indirect retention.
- The split major connector tends to collect food debris at the area of split.

Physiologic Basing

This technique distributes the occlusal load between the abutment teeth and the soft tissues by fabricating a denture based on a functional record. Functional record is obtained by recording the tissues under occlusal load or by relining the denture under functional stress. This technique involves making an impression of the soft tissues in a compressed state.

The denture fabricated using a functional impression has one major disadvantage. That is the denture tends to compress the soft tissues even at rest. This can lead to excess ridge resorption (Fig. 18.264).

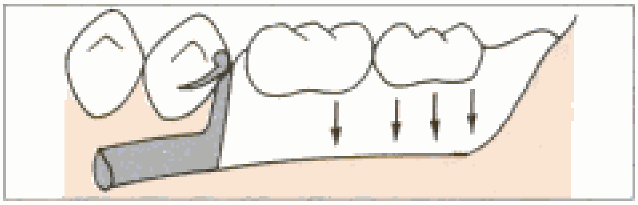


Fig. 18.264: Physiologically based dentures compress tissues even at rest. Hence, during occlusal loading, the tissues cannot be compressed further. The already compressed tissues offer greater resistance to compression equivalent to that of the periodontal ligament thereby preventing stresses within the denture

Since the denture is fabricated using a functional record (compressed tissues), the soft tissues offer more resistance to further compression. This increased resistance to compression provided by the oral mucosa equates to that of the periodontal ligament of the abutment tooth. In this manner, the abutment tooth is protected from excessive forces and the denture can distribute occlusal load evenly to the teeth and tissues.

Requirements for Physiological Basing

- A rigid metal framework
- Functional occlusal rests
- Indirect retainers to provide additional stability.
- Well-adapted, broad coverage denture bases.

Advantages

- Good adaptation of the denture base.
- Simple design and economical.
- Minimal direct retention decreases the functional stress on the abutment tooth.

Disadvantages

- Decrease in the number of retentive components provides less stability.
- The denture tends to lift at rest. This leads to premature contacts.
- Indirect retention is decreased due to vertical movement of the denture due to tissue rebounce at rest.

Broad Stress Distribution

According to this philosophy of design, the occlusal load acting on the denture should be distributed over a wider soft tissue area and maximum number of teeth. This is achieved by increasing the number of direct retainers, indirect retainers, and rests and by increasing the area of the denture base.

Advantages

- This design with multiple clasps acts as a form of removable splinting.
- It increases the health of the abutment teeth (due to splinting action).
- Easier to construct and economical.

Disadvantages

- Less comfortable
- Difficult to maintain adequate oral hygiene.

ESSENTIALS OF DESIGN

In this section, we will discuss about the key factors to be considered while designing a partial denture for common clinical situations.

Design Considerations for Kennedy's Class I and II Cases

Direct Retention

It is very important. Close adaptation of the denture base, restoration of form and function and preservation of soft tissue are the key concerns. The position of the undercut is very critical as it determines the type of clasp.

Clasp

Its design should be simple and fulfill all the necessary requirements of a clasp. For a class I case two clasps on each terminal abutment are needed. For a class II case three retentive clasps are required. One clasp is placed on the edentulous side and two clasps are placed on the dentulous side. The type of the clasp is determined by the type of the undercut (refer retention).

Rest

The rest seat should be prepared on the tooth with the maximum support. It should have an ideal configuration (refer rest). The rest should be placed adjacent to the edentulous space.

Indirect Retention

It should have all the ideal requisites (refer indirect retainers). For a class I case two indirect retainers are needed. For a class II case one indirect retainer on the dentulous side is adequate. Lingual plate may be given.

Major Connector and Minor Connector

It should fulfil all the ideal requisites (refer major and minor connectors).

Occlusion

The occlusion of the denture should coincide with the centric relation of the patient. There should not be any premature contacts. It should be in harmony with the remaining natural teeth. The artificial teeth should be selected and positioned on the denture base so that the stress is minimized.

Denture Base

A broad coverage without any functional interference is required. A selective pressure impression technique (discussed later) is needed.

Design Consideration for Kennedy's Class III Case

Direct Retention

The damage to the abutment teeth is very less compared to other cases. The position of the undercut is not critical.

Clasp

Four clasps should be placed to obtain a quadrilateral design. It should fulfil all the ideal requirements.

Indirect Retention

It is usually not needed. But if a clasp is not placed on the posterior tooth, indirect retention should be provided as in class I and class II cases.

Rest, Major Connector, Minor Connector and Occlusion

Similar to that of class I or II designs.

Denture Base

A functional impression is not required. It should fulfil all the ideal requirements discussed previously.

Design Consideration for Kennedy's Class IV Case

The stress pattern on the abutment teeth is unique to this case. The anterior teeth are placed anterior to the crest of the ridge for aesthetic reasons. This leads to the formation of tilting or lever forces against the abutment teeth. These forces can be minimized by:

- Retaining the natural teeth as an intermediate abutment or as an over denture abutment.
- Shorter the edentulous area, the lesser are the tipping forces.
- Preservation of the labial alveolar bone.

Four clasps should be placed to obtain a quadrilateral design. The major connector should be rigid and have a broad coverage. The indirect retainer should be placed posterior to the fulcrum line. A functional impression is needed for a large edentulous span.

LABORATORY DESIGN PROCEDURE

Step-by-Step Sequence

It is assured that the reader is aware of the different components of a partial denture to make meaningful decisions during designing.

Armamentarium Required

- Surveyor and accessories
- Articulator (Galetti-Luongo type)
  - It does not utilize plaster to hold casts in position. It is an excellent diagnostic tool.
  - Casts are held with the help of clamps only.
  - When the clamps are released, the casts can move independently in 3 dimensions.
- *Pencils for colour coding:* Red, blue, brown or green crayon and black lead pencil (2H or 3H). The most commonly used colour code key for laboratory design is as follows:
  - Red (solid): for rest seats
  - Red (outline only): for tooth surfaces that are to be contoured and prepared
  - Blue: for acrylic resin portions
  - Brown: for metallic portions. (Green can also be used here)
  - Black: for survey lines, tripod marks, soft tissue undercuts, type of tooth, use of wrought wire clasps.

Procedure

- The proposed rest areas are marked on the base of the cast just below the tooth (Fig. 18.265)
- Next the occlusal rest areas are marked by drawing a (solid) red area (Fig. 18.266).

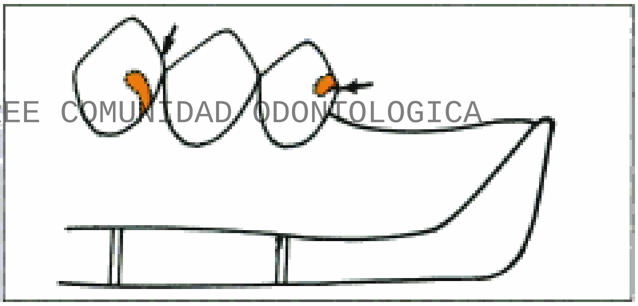


Fig. 18.265

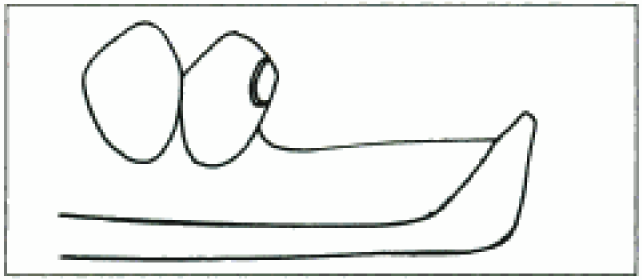


Fig. 18.267

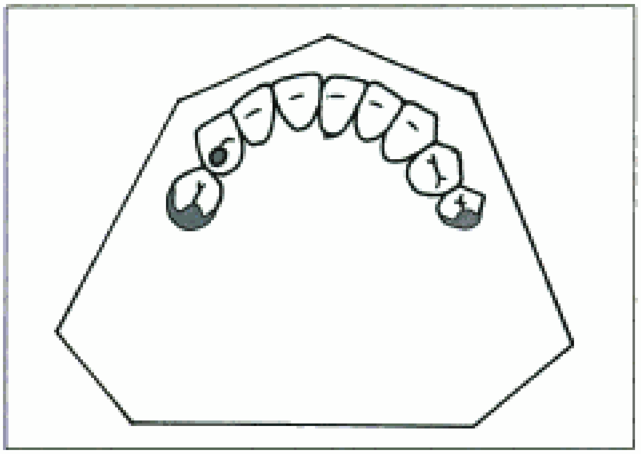


Fig. 18.266

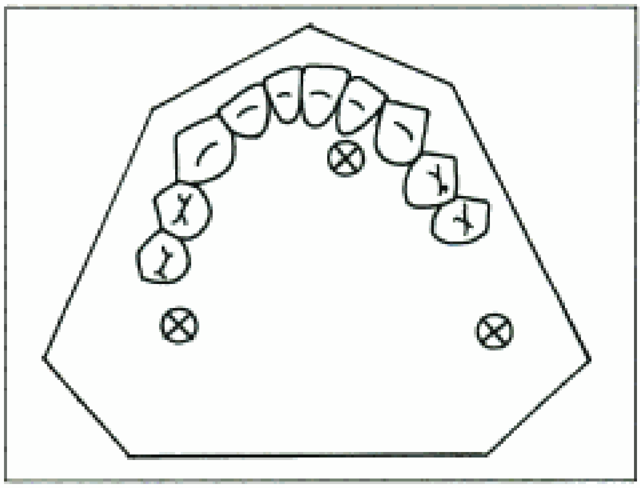


Fig. 18.268

- The type of tooth to be replaced is written on the base of the cast.
  - Tube tooth: T
  - Facing: F
  - Metal pontic: M
  - Reinforced Acrylic Pontic: RAP
  - Denture teeth: No symbol
  - Next the cast should be placed on the cast holder horizontally. The teeth should be examined for retentive under cuts. Soft tissue undercuts should also be examined.
- Based on the aesthetics and the location of favourable retentive undercuts, the tilt of the cast is determined. This is the path of insertion for the prosthesis.
- A red outline is given for areas that require re-contouring (Fig. 18.267).
- Once the tilt is determined, the cast is tripoded. The tripod points should be marked as the intersection of two 4 to 5mm lines within a circle (Fig. 18.268). Tripoding helps in repositioning any casts of the same patient in the same tilt, that is, the same path of insertion is maintained throughout treatment.
- The survey lines are scribed (drawn) against abutment teeth using a carbon marker. This is done by rotating the cast (on the holder) against the side of the carbon marker (Fig. 18.269). Area below this line will be the undercut to that path of insertion.
- The extent of the denture base is outlined using a blue (for acrylic resin) or brown pencil (for metal base) (Fig. 18.270).
- The framework outline is drawn with brown pencil. Other structures like major connector, indirect retainer, minor connector etc are designed and marked / drawn along with this step (Fig. 18.271).
- The carbon marker is removed and an undercut gauge is placed on the surveying arm. For chrome cobalt alloy 0.010" gauge is adequate, 0.015" gauge is required for a gold

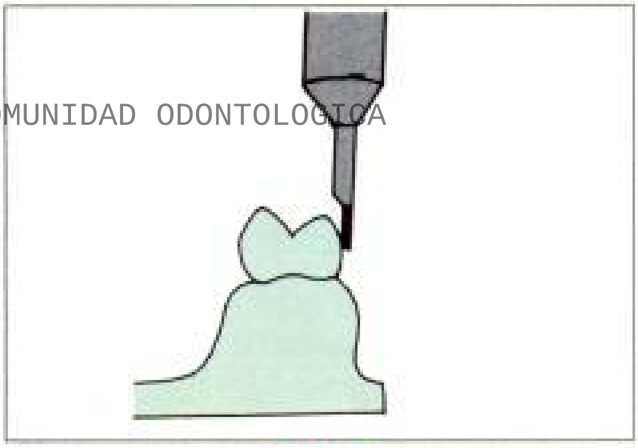


Fig. 18.269

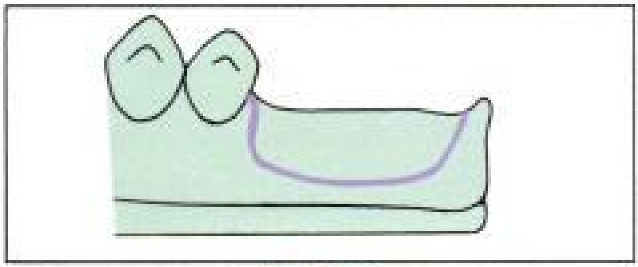


Fig. 18.270

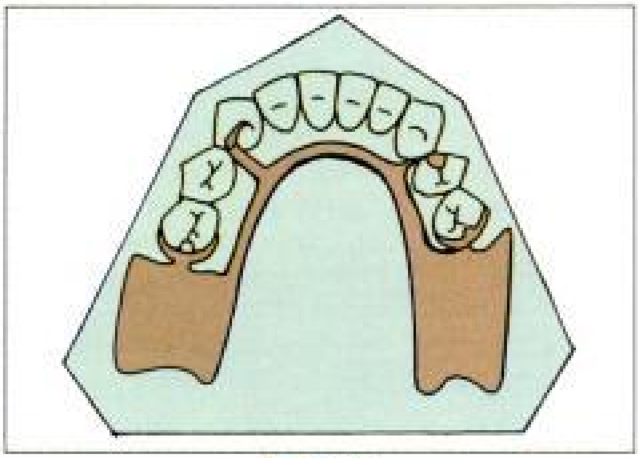


Fig. 18.271

alloy and 0.020" gauge is required for a wrought wire clasp.

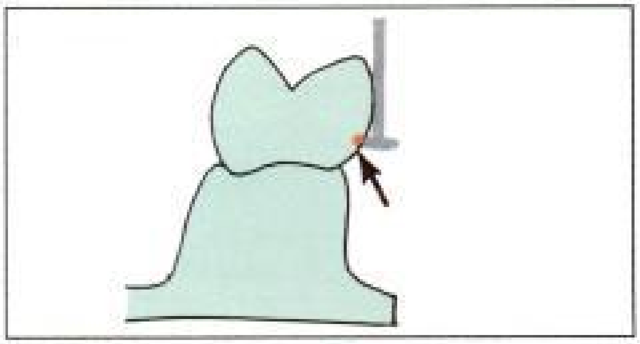


Fig. 18.272

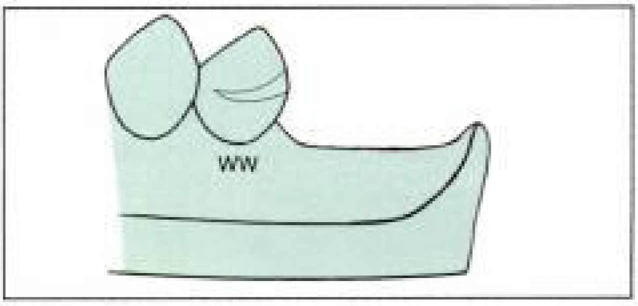


Fig. 18.273

The bead and shank of the gauge should contact the tooth simultaneously against which it is held. The area where the bead contacts is marked with red pencil (Fig. 18.272). The gingival edge of the retentive clasp tip should be placed against this mark (the clasp should be drawn accordingly). This mark should be placed at the line angle of the tooth and not at the center of the facial or lingual surface.

- Clasp areas are drawn to actual shape, size and location using brown pencil. If wrought wire clasps are used, a symbol WW is placed on the soft tissue area of the cast below the tooth (Fig. 18.273).
- The outline of all the components are joined to complete the design. One should always remember that the outline of the component parts are drawn separately and then unified. The process of joining all the outlines is known as *unification*.

Chapter 19
Prosthetic Mouth Preparation

19

Prosthetic Mouth Preparation

INTRODUCTION

Prosthetic mouth preparation forms the phase V of partial denture treatment. In this phase the oral structures are prepared to favour the placement of a denture. Remember, pre-prosthetic mouth preparation is done to prepare unwanted oral structures that interfere with the placement of a prosthesis. Whereas prosthetic mouth preparation is done to modify the existing structures to further enhance the placement of a prosthesis.

In design, we learned that certain parts of the RPD like rests, proximal plates, etc. require alteration in the oral structures for their placement. If such structures are included in the design of a partial denture, prosthetic mouth preparation is carried out.

In this section we will learn about all the mouth preparation procedures done after designing a RPD (required by the design of the RPD) prior to making the master impression.

Prosthetic mouth preparation can be broadly classified into:

- Preparation of retentive undercuts.
- Preparation of guiding planes.
- Preparation of rest seats.

PREPARATION OF RETENTIVE UNDERCUTS

We know that retentive undercuts are required to engage the retentive arm of the clasp and provide retention. Generally, all teeth have convex surfaces with natural undercuts below the height of contour. Some teeth get abraded and have a straight surface without any undercut. In such teeth artificial retentive undercuts are prepared to produce retention for the prosthesis.

There are four common methods used to prepare a retentive undercut, namely:

- Crowns
- Cast restorations (other than crowns)
- Dimpling (Enameloplasty)
- Tilting the cast.

Crowns

- Full veneer crowns are used to restore the contour of abraded, attrited and submerged teeth (Fig. 19.1).

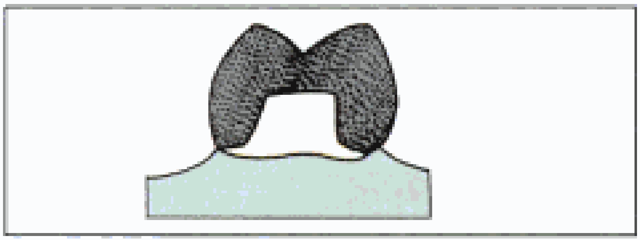


Fig. 19.1: A crown prepared to recontour the abutment

- Tooth reduction is done and the crown is fabricated as usual. But, before casting, the wax pattern of the restoration is surveyed with an analysing rod (Fig. 19.2).

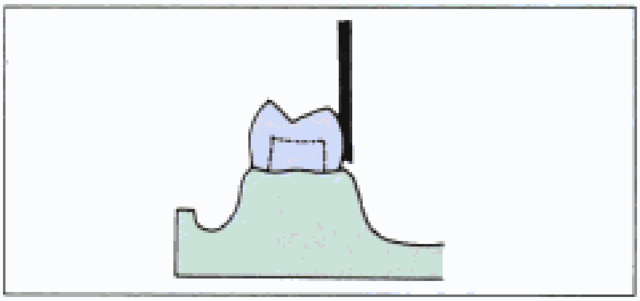


Fig. 19.2: The wax pattern of the crown should be analysed and surveyed for undercuts before casting

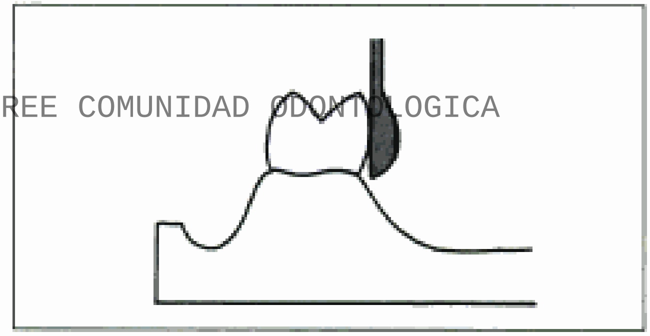


Fig.19.3: The crown wax pattern should be recontoured using a surveying wax carver to establish the guiding planes

- After analysing the pattern the guide planes are prepared using a wax carver tool of the surveyor (Fig. 19.3).
- After contouring the guide planes on the wax pattern, the undercuts are checked. If there is no favourable retentive undercut, it is contoured directly on the wax pattern being surveyed (Fig. 19.4).

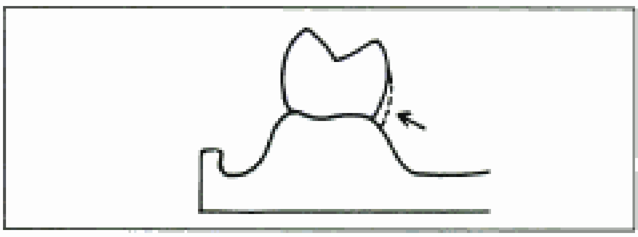


Fig. 19.4: Required favourable undercuts should also be contoured on the wax pattern

- The wax pattern is invested and cast. The resulting prosthesis with proper contour is cemented to the tooth. Consecutively, the partial denture treatment is continued.

Cast Restorations: (Other than Crowns)

A cast restoration (e.g. onlays) is placed instead of full veneer crowns when adequate tooth structure is present. The procedure for the preparation of an undercut on a cast restoration is similar to the procedure described for a full veneer crown (Fig. 19.5). Care shold be taken to ensure that the retentive terminal engages the undercut **on sound enamel** than on the cast restoration. A cast restoration can be contoured such that the tooth surface below it becomes an undercut.

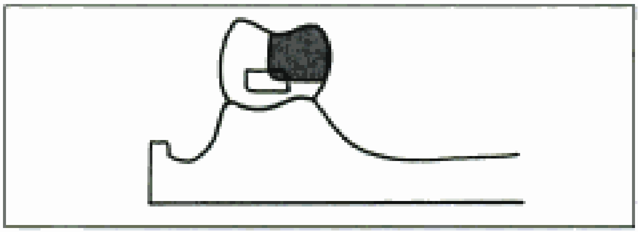


Fig. 19.5: Undercuts prepared on cast restorations. It is preferable to place undercuts on the sound tooth structure

Dimpling (Enameloplasty)

Enameloplasty is defined as, *"The intentional alteration of the occlusal surface of the teeth to change their form"* - GPT. The enameloplastic procedure done to produce a retentive undercut is known as *dimpling*. The preparation made on the tooth by dimpling is known as a *dimple*.

A dimple is nothing but a gentle depression created on the enamel surface of the abutment teeth to provide a retentive undercut. It is done when the abutment tooth does not provide any surface undercut, that can be utilised by some form of clasp. It can also be done to modify an existing undercut on the tooth surface and also on an existing cast restoration without a favourable undercut.

Design

- It is a gentle depression, not a pit or hole (Fig. 19.6).

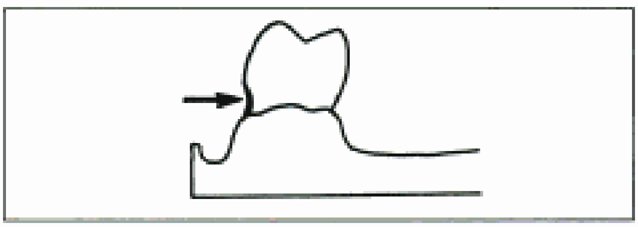


Fig. 19.6: Dimple

- It is prepared close to and parallel to the gingival margin (Fig. 19.7).
- It should be 0.010 inch deep when measured from a tangent parallel to the path of insertion extending over the surface of the tooth above the preparation (Fig. 19.8).
- The preparation should be atleast 2mm occlusogingivally and 4 mm mesiodistally (Fig. 19.9).

Fig. 19.7: The dimple should follow the horizontal axial contour of the tooth

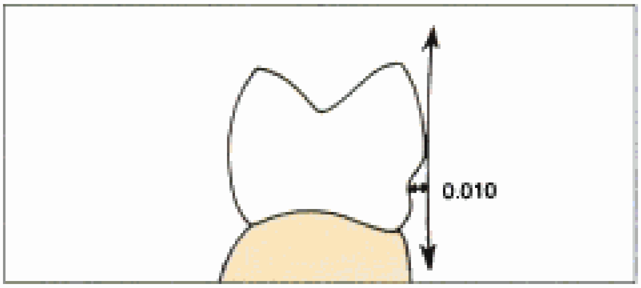


Fig. 19.8: The depth of the dimple is verified with a tangent drawn to the height of contour of the tooth. Ideally a dimple should be 0.010" deep

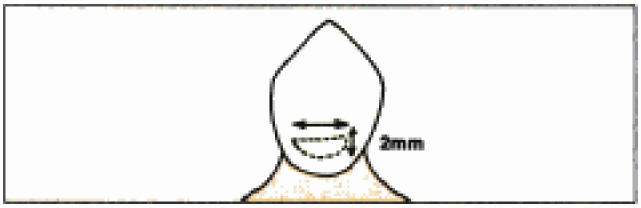


Fig. 19.9: Ideally a dimple should be 4 mm mesiodistally and 2 mm occlusogingivally

- The surface of a dimple should be highly polished.

Indications

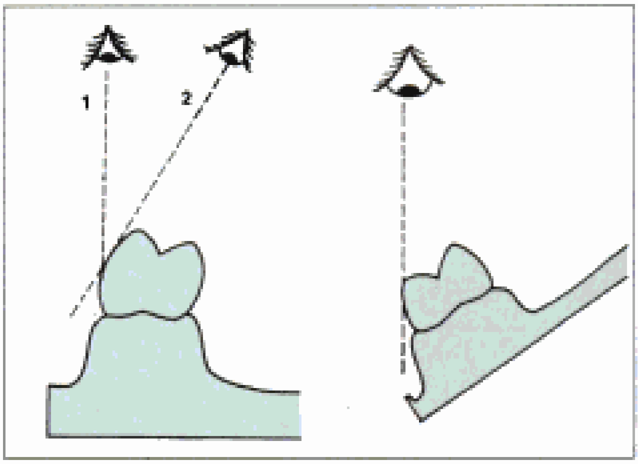
- Small non-retentive undercuts that require modification.
- Teeth with nearly vertical buccal and lingual surfaces.

Procedure

- A small round ended tapered diamond stone is used.
- The bur should be moved in the antero-posterior direction near the line angle where the undercut is to be prepared.
- The depression should be very gradual and not steep.

Tilting the Cast and Altering the Path of Insertion

Some areas of the tooth may form an undercut only when viewed in a different angle. In such cases, the cast can be tilted on a surveyor so that the path of insertion of the denture is altered and the undercuts are present in relation to the new path of insertion (Fig. 19.10).



Figs 19.10a and b: (a) Some teeth may not have undercuts when viewed vertically (1) but when viewed at an angle (2), a favourable undercut may be present (b) The path of insertion of the denture can be altered such that favourable undercuts are engaged

The cast can be tilted only to a maximum of 10°, beyond which it is not advisable because the patient will require excessive mouth opening for insertion and removal. Generally, tilting the cast to obtain a retentive undercut is the least sorted procedure and is not advisable in the presence of other alternatives.

GUIDE PLANE PREPARATION

They are prepared by selective grinding of teeth (Enameloplasty) or by appropriate shaping of wax patterns of abutment crowns. The design position and purpose of a guide plane was discussed in detail in the previous chapter. In this section we shall read in detail about the procedure for preparing a guide plane.

Procedure

The procedure for the preparation of a guide plane varies according to its location. Here we have explained the guide plane preparation for the following conditions:

- Abutment teeth adjacent to tooth supported segments.
- Abutment teeth adjacent to distal extension edentulous space.
- Lingual surfaces of the abutment teeth.
- Anterior abutments.

Guide Plane Preparation for Abutment Teeth Adjacent to Tooth Supported Segments

- A surveyed diagnostic cast is needed during preparation.
- The hand piece with a cylindrical diamond point is positioned over the abutment tooth in the primary cast and the same relationship should be reproduced in the mouth. (*Note: the hand piece must be positioned on the cast using a surveyor before preparation to avoid errors*) (Fig. 19.11).

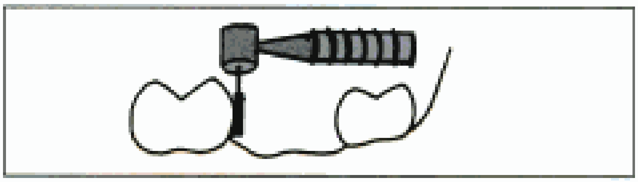


Fig. 19.11: The bur should be parallel to the path of insertion while preparing guide planes

- A mild, sweeping stroke is made starting from the buccal line angle to the lingual line angle.
- The preparation should be 2-4 mm high occlusogingivally (Fig. 19.12a).
- The preparation should be flat and also follow the contour of the proximal surface.

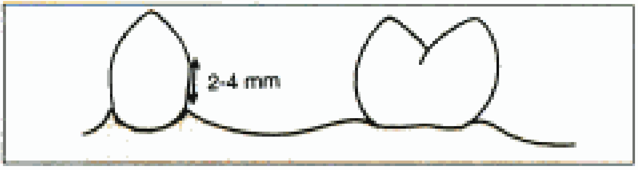


Fig. 19.12a: Guide planes should be 2-4 mm tall for tooth supported partial dentures to resist rotational forces of the denture

- The preparation should be finished and polished.

Guide Plane Preparation for Abutment Teeth Adjacent to Distal Extension Edentulous Space

It is similar to the procedure mentioned above except for the following changes.

- The guiding plane should be 1.5 - 2 mm high occlusogingivally. This permits rotation of the partial denture around the distal rest (Fig. 19.12b).

Fig. 19.12b: Guide planes should only be 1.5-2.0 mm tall for distal extension edentulous spaces to permit rotation of the denture around the distal rest

Guide Plane Preparation for Lingual Surfaces of the Abutment Teeth

- It is prepared on the middle third of the crown.
- The height of the preparation should be 2-4 mm.
- These planes provide maximum resistance to lateral stress and help in stabilization of the denture.

Guide Plane Preparation for Anterior Abutments

It is similar to the preparation mentioned above. It has the following advantages:

- Provides parallelism for stabilization.
- Reduces the wedging action between the teeth.
- Reduces the space between the abutment tooth and the denture.
- Increases retention.
- Improves the aesthetics (space between the abutment and the proximal plate of the denture is avoided because the denture totally adapts to the guiding plane).

REST SEAT PREPARATION

Rest seat preparation is done along with other mouth preparation procedures prior to making the master impression. The location position and extent of the rest seat is determined using a surveyor on a diagnostic cast. The procedure for rest seat preparation is different for enamel (natural tooth structure) and for restorations.

On Enamel

- A depth orientation groove is drawn along the desired outline form to create an island of enamel.
- The island of enamel is removed using the same bur used to make the depth orientation grooves (Fig. 19.13).

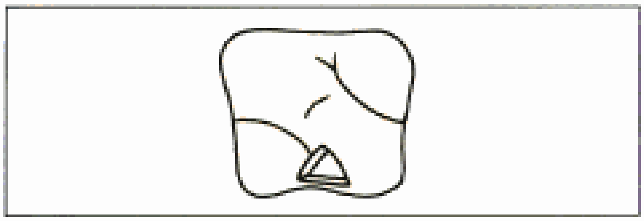


Fig. 19.13: Occlusal rest seat on enamel

- Undercuts should be avoided. The shape and design of the rest seat is verified with that marked on the primary cast.
- Red beading wax or utility wax can be used to check for occlusal clearance (Fig. 19.14).

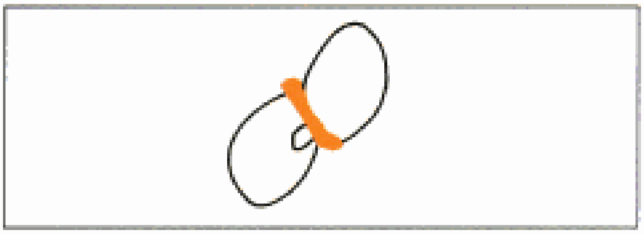


Fig. 19.14: Red utility wax should be used to check for sufficient occlusal clearance of the preparation

- Sharp line angles are rounded with a No.4 round steel bur.
- Margins are also relieved by removing unsupported enamel.
- The rest seat preparation must be highly polished.

On New Gold Restorations

The term new gold restoration denotes the preparation of a fresh restoration along with the rest.

- Sufficient occlusal clearance must be present to accommodate the rest seat and the gold restoration (Fig. 19.15).

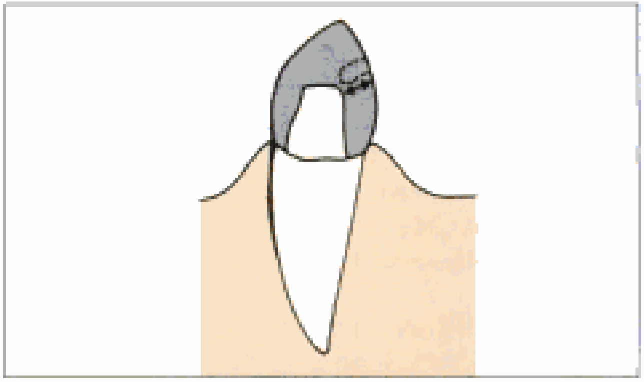


Fig. 19.15: Rest seat preparation for a new gold restoration

- After tooth preparation for the gold restoration, an additional depression is made on the prepared tooth surface (where the rest is to be placed) to allow sufficient thickness of metal below the rest seat (Fig. 19.16).

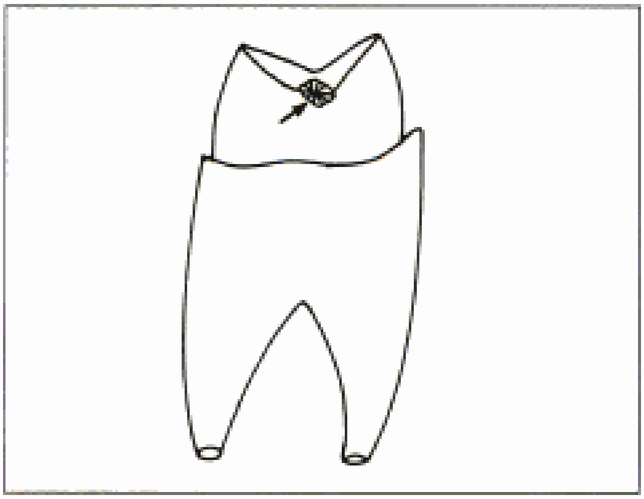


Fig 19.16: Additional tooth reduction can be done to strengthen the floor of the rest seat formed by the restoration

- The rest seat is prepared on the wax pattern after carving the guide planes.
- Rest seat preparation is done using a no.4 round steel bur in a slow speed hand piece with light pressure. This can also be done with discoid or cleoid excavators. Remember that the seat preparation is done on the wax pattern of the gold restoration.

- The rest seat preparation is polished using a small round finishing bur.
- Later the pattern is cast as usual.

On Existing Gold Restorations

- Here, the rest seats are directly prepared on existing gold restorations.
- Rest seats should not be prepared on restorations with poor marginal integrity and poor occlusal harmony.
- If the restoration is not thick enough to accommodate the rest, a new restoration should be made.
- Procedure is similar to the one described for enamel.

On Amalgam Restorations

- They are least preferred.
- Occlusal rests are not prepared on multi surface amalgam restorations. Amalgam tends to flow under constant pressure (creep).
- The junction between the proximal portion and isthmus of the restoration should not be weakened (made thin) as the restoration may fracture.
- No.4 round bur is used instead of diamond stone.
- Procedure is similar to that on enamel.
- Polishing is done with No.4 round bur in reverse revolutions.
- Regular amalgam polishing can also be done.

Rest Seat Preparation for Embrasure Clasp

Embrasure clasps are two clasps fused at the body to fit into a single embrasure (Fig. 19.17). Rest seats for such clasps should be prepared on the mesial and distal fossae of two approximating posterior teeth. The speciality of this preparation is that the marginal ridges are also reduced for better strength of the clasp.

Procedure

- A small round or cylindrical diamond stone is used. The two occlusal rest seats are prepared simultaneously as described for the rest seat preparation on enamel.

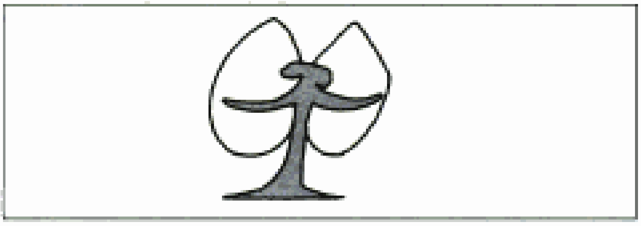


Fig. 19.17: Embrasure clasp

- Both the marginal ridges should be reduced equally (Fig. 19.18).

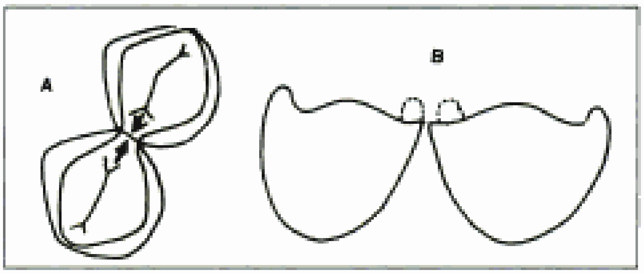


Fig. 19.18: Preparation for an embrasure clasp

- The contact point should not be broken (Fig. 19.18b).
- Buccal and lingual extensions should extend to the buccal and lingual embrasures.
- Finishing and polishing is done as usual with a No: 4 round steel bur.
- Sufficient occlusal clearance should be present so that there is no highpoint between the opposing teeth and the clasp even during occlusion. This is checked by keeping two 18-gauge wires, one beside the other in the embrasure area (Fig. 19.19). (*Note: Relieving the metal after casting will result in internal fracture of the rest, hence, the wax pattern itself should be carved properly so that the occlusal clearance is preserved*).

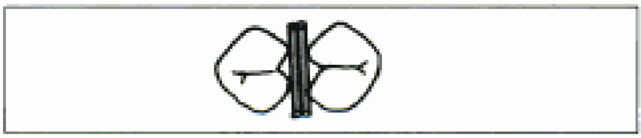


Fig. 19.19: Checking for occlusal clearance of an embrasure rest seat preparation using two 18 gauge stainless steel wires

- Biting on utility wax makes an impression of the area. The thickness of the rest is measured using a Boley's gauge.

Cingular Rest Seat Preparation

Similar to the occlusal rest preparation, the cingular rest seat preparation will vary depending on the surface over which they are prepared (Fig. 19.20).

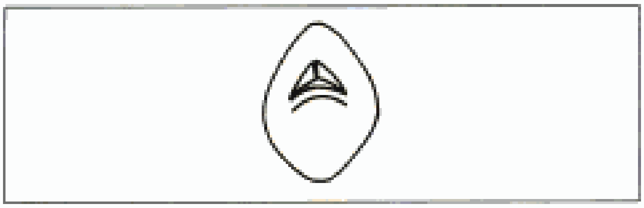


Fig. 19.20: Cingulum rest seat

Cingulum Rest Seat Preparation in Cast Restorations

- Cingulum rest seats on cast restorations can be used for all maxillary and mandibular anteriors.
- Rests seats prepared on cast restorations are preferred to those prepared on enamel.
- They are prepared on the wax pattern similar to the procedure for preparing occlusal rests on new gold restorations.

Lingual Rest Seat Preparation on Enamel

A lingual rest seat can be prepared on maxillary canines and certain mandibular incisors. Lingual rest seat preparation on the lower anteriors is done only when,

- The tooth is sound.
- The patient has good oral hygiene and a low caries index.
- A prominent cingulum must be present and the lingual surface must have a gradual slope.

Procedure

- The first step is to check for adequate occlusal clearance.
- The rest seat should be half-moon shaped located above the cingulum.
- The rest seat should be gingival to the contact point with the adjacent teeth (Fig. 19.21).

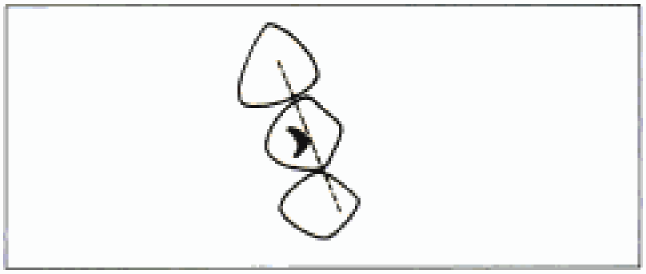
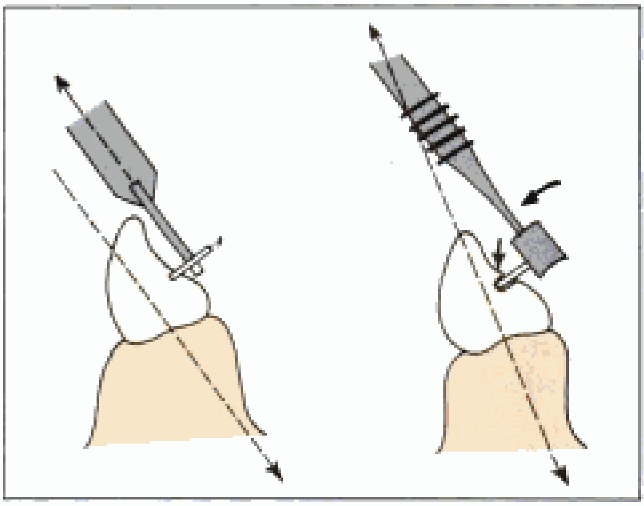


Fig. 19.21: The cingulum rest seat should be gingival to the point of contact (dotted line)

- A flat end, large diamond cylinder is usually used. A safe-sided 1/4-inch diamond disc can be used in cases, where the lateral incisor and the premolar are absent and sufficient space is available.
- The safe sided disc should be held parallel or slightly labial to the path of insertion, but the flat end diamond cylinder should be tilted slightly gingival to the path of insertion. Improper orientation of the disc will lead to the formation of undercuts (Fig. 19.22).
- The tooth reduction is started at one corner near the marginal ridge. The bur is moved incisally above the cingulum and then gingivally to reach the opposite marginal ridge (Fig. 19.23). This is done to obtain half moon shaped outline.
- The preparation is polished and finished.

Incisal Rest Seat Preparation

They are prepared on the distoincisal angle (when an Akers clasp is used) or on the mesioincisal



Figs 19.22a and b: (a) Tooth preparation using a safe sided disc (b) Tooth preparation using a cylindrical diamond (notice the bur is held gingival to the path of insertion)

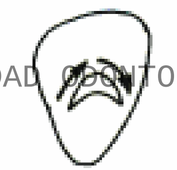


Fig. 19.23: Cingulum rest seats should be prepared from one corner moved incisally to the centre and continued gingivally to the other end. This helps to obtain a half moon configuration

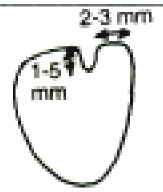


Fig. 19.24: Incisal rest seats should be prepared as a 1.5 to 2.0 mm deep notch 2-3 mm away from the proximo-incisal angle

angle (when a vertical projection clasp is used) (Fig. 19.24).

- A small safe-sided diamond disc or knife edged stone is used to carryout tooth reduction.
- The cutting instrument should be held parallel to the path of insertion.
- A vertical cut about 1.5 to 2.0 mm deep and 2 to 3 mm away from the proximal angle along the incisal edge is made (Fig. 19.24).
- The notches are rounded. Unsupported enamel proximal to the notch is slightly reduced. The enamel wall near the center of the tooth is rounded (to remove stress concentration).
- A flame-shaped diamond point is used for finishing.

CONCLUSION

As mentioned previously, prosthetic mouth preparation is done during phase V of treatment before making the secondary impression. These preparations should be recorded accurately in the secondary impression using which, the denture will be fabricated.

Chapter 20
Secondary Impression and Master Cast for RPD

- **Introduction**
- **Dual Impression Procedures**
- **Preparing the Master Cast**

20

Secondary Impression and Master Cast for RPD

INTRODUCTION

Now we enter the second part of phase V of treatment planning, i.e. fabricating the partial denture. And it is obvious that to fabricate a prosthesis, we require a master impression. Generally, impressions can be classified into anatomical and functional impressions.

Anatomical Impressions

'Anatomical form' is the surface contour of the ridge when it is not under any occlusal load (Fig. 20.1). This resting form is recorded with soft impression materials like zinc oxide eugenol, plaster of Paris, etc. Other impression materials like elastic putties tend to displace and distort the soft tissues due to their high viscosity.

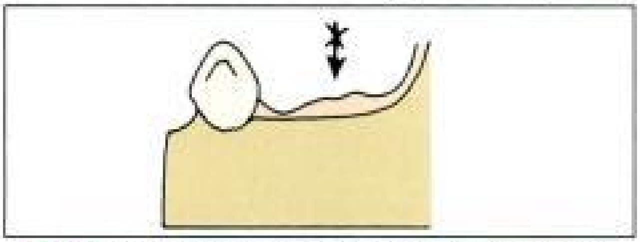


Fig. 20.1: An anatomic impression records the tissues without any displacement

Disadvantages

When the denture is at rest it will adapt well to the tissue surface. Under occlusal load, the rest in the direct retainer will prevent the tissueward movement of that part of the denture near the abutment tooth. However, the distal end of the denture will show tissueward movement and compress the tissues under occlusal load and produce lever action (Fig. 20.2). This will lead to

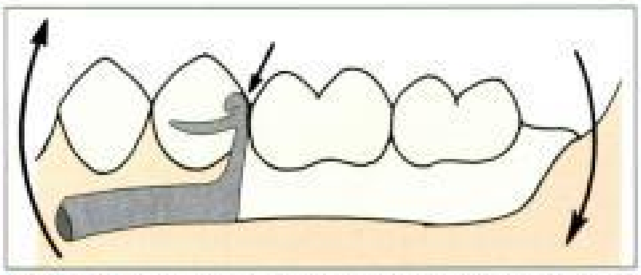


Fig. 20.2: Dentures prepared using anatomic impressions compress the tissues under occlusal load and rotate around the terminal abutment axis

weakening of the abutment due to torsional forces acting on it and residual ridge resorption.

Thus we understand that when an impression is made in the anatomical form, the deleterious forces of the denture are concentrated on the abutment teeth. The RPD should be designed with a stress breaker to avoid damage to the abutment teeth. This complicates the design of the prosthesis. Hence, anatomical impressions are avoided for tooth-tissue supported partial dentures (e.g. distal extension denture base).

Generally anatomic impressions are preferred for tooth supported partially edentulous arches (Kennedy's class III and class IV cases). Anatomical impressions are contraindicated for distal extension cases due to the reason explained above.

Functional Impressions

These impressions are recorded under functional load (pressure), that is, the tissue surface is recorded in the compressed form (Fig. 20.3). Since the soft tissues are recorded in the compressed form, the denture will not exert additional stress on the abutment teeth during functional loading. By this

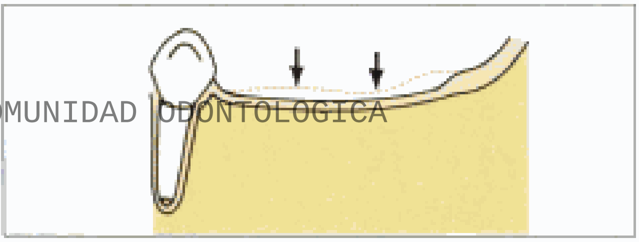


Fig. 20.3: Functional impressions record the tissue in a compressed form

procedure, the occlusal load can be evenly distributed between the soft tissues and the abutment teeth. This prevents the concentration of deleterious forces on the abutment teeth.

Functional impressions are required only to record edentulous saddles. The existing teeth do not change form under load and hence they do not require a functional impression. These impressions are indicated for tooth-tissue supported partial dentures.

Impression Making for Kennedy's Tooth Supported Partial Denture

Generally Kennedy's class III and class IV arches are considered as tooth supported partial denture. Since maximum support is obtained from the abutment teeth, it is not necessary to record a functional impression. Conventional anatomic impressions are made. The material of choice to make a master impression for these partial dentures is irreversible hydrocolloid. Elastomers are used when there are severe undercuts and for cases which use internal attachments for retention. Alginate is preferred for its ease of use, economic price.

The procedure for impression making is similar to the procedure described for making a diagnostic impression in Chapter 17. Additional care should be given to accurately record rest seats, guide planes, dimples, etc. prepared during prosthetic mouth preparation. A small quantity of alginate is spread over the prepared tooth surfaces before placing the tray material. This small quantity acts like a syringe material and records the finer details accurately.

After making the impression, it is gently washed under flowing tap water to clear the saliva and debris. The impression should be disinfected before pouring the cast. The cast should be poured within 12 minutes after impression making. Refer chapter 17 for more details about disinfecting, preserving the impression and pouring the cast.

Impression Making for Distal Extension Denture Bases

Before we go into the details about impression making for a distal extension denture base, we should discuss about the support for such a denture. Support is one of the most important principles of impression making.

A Few Words About the Support for the Partial Denture

Support for a distal extension denture is obtained from both the teeth and the tissues. Hence, we expect complex forces to act on the denture due to the difference in the settlement of the supporting tissues. For example, the teeth are less compressible and intrude little to the occlusal load compared to the supporting soft tissues. Compressibility depicts the shock absorbing capacity and sponginess of the periodontal ligament.

There are many factors that influence the support of a distal extension base, they are:

Quality of the soft tissues covering the edentulous ridge

- A firm, tightly attached mucosa of adequate thickness can provide the best support to the denture.
- If the soft tissues are flabby and mobile, the ridge cannot provide adequate support. Hence, the excess tissue should be removed surgically.

Alveolar architecture of the denture bearing area

- The residual ridge should have a cortical plate of adequate thickness to provide support by resisting the occlusal load.
- If the ridge is made up of cancellous bone, it cannot resist occlusal forces of higher magnitude and will undergo resorption. The rough margins of the cancellous bone can act as a source of chronic irritant leading to inflam-

mation. Hence, the crest of the ridge should not be considered for support.

Design of the partial denture

- The partial denture should be designed such that the forces acting on the edentulous ridge can be minimized.
- Additional components like minor connectors are added to the design to avoid the rotation of the denture around the terminal abutments.

Amount of tissue coverage of the denture base

- Based on broad stress distribution theory, wider tissue coverage distributes the occlusal load more evenly thereby protecting the soft tissues and the teeth from damage during function.
- The borders of the denture should not be overextended because the overextended margins can produce discomfort, soft tissue ulcerations, etc.

Amount of occlusal force

- The occlusal load can affect the support of the denture.
- The residual ridge should be covered to its maximum physiological extent.
- The occlusal table of the artificial teeth can be narrowed to reduce the occlusal load.
- Adding supplemental grooves on the occlusal surface can increase the efficiency of the artificial teeth. This reduces the biting force thereby reducing the occlusal load.

Nature of the denture bearing area

- Stress bearing areas should be identified in the maxillary and the mandibular arch to derive support.
- In the maxillary arch, the buccal slopes of the ridge can resist lateral forces. The hard palate can act as a secondary stress-bearing area. The crest of the ridge provides the maximum support to the denture.
- In the mandibular arch, the buccal shelf area acts as a primary stress-bearing area. It has a thick cortical plate covered with a firm mucosa. It is also placed almost perpendicular to the occlusal stress. The slopes of the ridge can act as secondary stress-bearing areas and they resist horizontal stress.

Fit of the denture

The fit of the denture should be such that the forces can be transmitted to the stress-bearing areas without any hindrance. This can increase the life of the prosthesis.

Type of impression registration

The soft tissues can be recorded in their anatomical form. They can also be recorded in functional form (displaced under occlusal load). Sometimes, a part can be recorded in the functional form and the remaining areas can be recorded in the anatomical form.

DUAL IMPRESSION PROCEDURES

One of the most common problems affecting the success of distal extension dentures is that the tissues get compressed during function leading to the vertical displacement of the denture. This type of tissueward movement of the denture will produce rotation of the prosthesis around its terminal abutment axis (Fig. 20.4). This should be avoided, as it may weaken the abutment due to excessive stress.

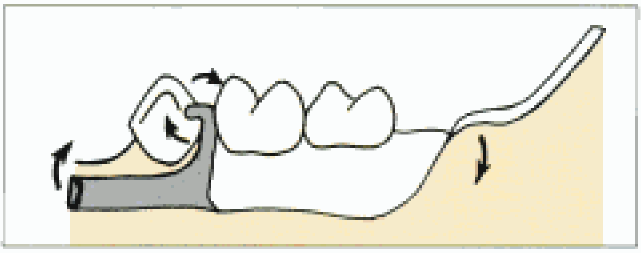


Fig. 20.4: Rotation of the denture around the distal abutment permitted by compressable soft tissues

We can prevent tissueward movement of the denture by recording a functional impression. That is, the tissues are recorded in a compressed form (under pressure). Hence, the denture fabricated from this impression will seat and compress the tissues even during rest and there will be no additional tissueward movement (tissue compression) during function (occlusion, chewing, etc) (Fig. 20.5).

Generally, functional impressions require a special tray to closely adapt to the tissues and

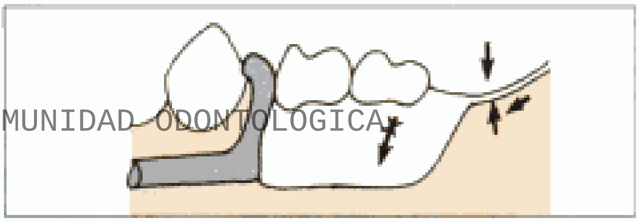


Fig. 20.5: Denture fabricated using functional impressions do not move vertically during occlusal loading. Since the tissues are already compressed, they resist further compression and they obtain a resiliency equivalent to that of the periodontal ligament of the remaining teeth. This facilitates even distribution of load between teeth and tissues.

provide adequate space for even thickness of the material. As we do not require a functional impression of the dentulous area, we prefer to limit the functional impression to the saddle area. The remaining areas are recorded with an anatomic impression using a stock tray.

One other advantage of recording functional impression is that the resulting denture will be a physiologically based one. Refer principles of design (design philosophies) in Chapter 18.

Since we record the ridge using two impressions, i.e. one portion in the functional form and the other in the anatomical form, these impressions are known as *dual impressions*. It should be remembered that both these impressions (anatomical and physiological) made in a dual impression technique are master impressions.

Dual impressions are indicated for all tooth-tissue supported partial dentures. We know that Kennedy's class I and class II cases directly fall into this category. There are various dual impression techniques available to record a distal extension denture base.

Though there are different techniques, the basic principle is similar. An anatomical impression is used to record the teeth and a functional impression is used to record the edentulous ridge. The two impressions are used together to fabricate the denture. The greatest challenge is to fabricate a denture using both these impressions. It is over come with the help of the following procedures:

- The functional and anatomical impressions are fused together (Pick-up impression).
- A cast is poured from the anatomical impression and later altered according to the functional impression (Altered-cast technique).

Dual impressions can be broadly classified as:

- Physiological or functional dual impressions.
- Selective pressure functional dual impression technique.

Physiological or Functional Dual Impressions

Here, one anatomical impression is made of the entire ridge and one physiological or functional impression is made only on the edentulous portion. The functional impression is made by applying occlusal load on the impression tray while making the impression (Fig. 20.6). Thus the tissues are displaced during impression making. The common techniques employed to record a physiological dual impression are:

- McLean's technique
- Hindle's modification of McLean's technique
- Functional relining method
- Fluid wax.

Fig. 20.6: Functional impressions are made by applying pressure on the special tray as the impression material sets

Now we shall discuss in detail about the procedure, advantages and disadvantages for each of these techniques.

McLean's Physiologic Impression

Principle

Two impressions are made in this procedure. A functional impression of the edentulous ridge is made. The second impression is made **over** the functional impression and it records the structures in their anatomic form. The second impression is also known as the *pick up* impression because it covers, and picks up the functional impression (first impression) alongwith itself.

Procedure

- A custom-made impression tray is fabricated over the edentulous areas of the preliminary cast. A spacer is not adapted because we intend to record only the supporting tissues with this tray (we do not record any relieving tissues with the tray) (Fig. 20.7).

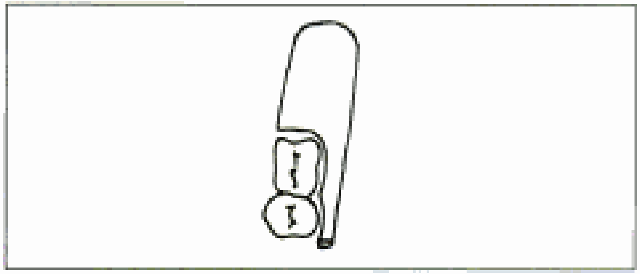


Fig. 20.7: Special tray confined to the edentulous spaces prepared for McLean's physiologic dual impressions

- Occlusal rims are made on the custom tray. Occlusal rims are required for the patient to close (bite) on while making the impression.
- The tray loaded with the impression material is inserted into the patient's mouth and the patient is asked to close on the occlusal rims built over the tray. When the patient closes on the occlusal rim, the tissues under the tray are compressed and the impression is recorded in this relation (Fig. 20.8).

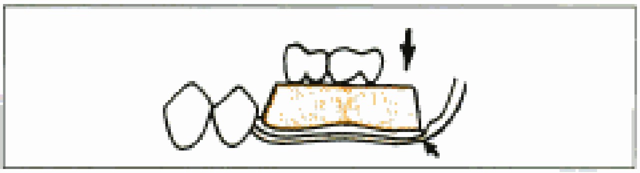


Fig. 20.8: The patient is asked to close on the special tray with the occlusal rim to apply pressure while making the impression

- After making the impression, the custom tray should not be removed from the mouth.
- An alginate **over-impression** (this impression is made over the existing impression) is made using a large stock tray (Fig. 20.9).
- When the overimpression is removed, the functional master impression comes along with it. Since the alginate over impression carries the functional impression along with it, it is called a **pick up impression** (Fig. 20.10).

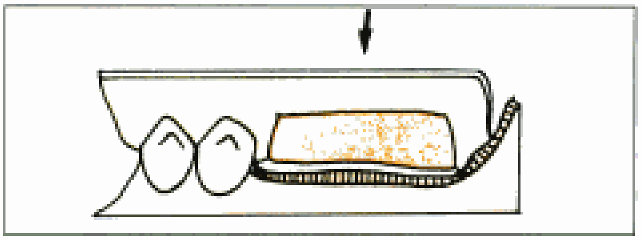


Fig 20.9: Alginate 'pick-up' over impression made over the special tray with the functional impression

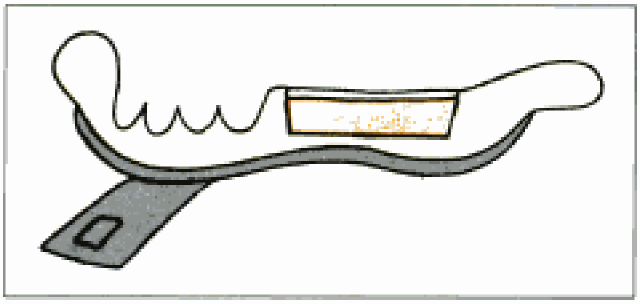


Fig. 20.10: Inverted 'pick-up' impression

- While making the over-impression, finger pressure should be applied on the stock tray so that the custom tray under it is pushed towards the tissues while making the over-impression (Fig. 20.11).

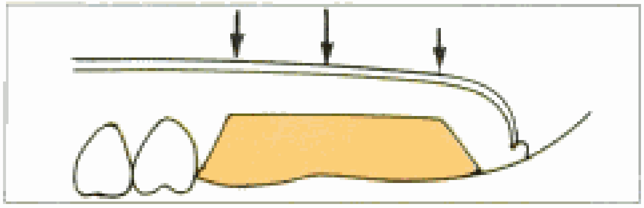


Fig. 20.11: Pressure should be applied over the stock tray while making the pick-up impression

- A cast is poured into the impression. This cast will reproduce the teeth in the anatomical form and the tissues in the functional form.

Disadvantage

Finger pressure used to settle the functional impression while making the over impression is not equal to the biting force used while making the functional impression. Hence, the supporting tissues may not be as compressed as they were while making the functional impression. This can lead to errors.

Secondly, there will be a small quantity of alginate between the occlusal rim of the custom tray and the over-impression stock tray. This alginate may act like a buffer and prevent the transfer of the entire load (finger pressure) applied on the stock tray to the special tray (Fig. 20.12).

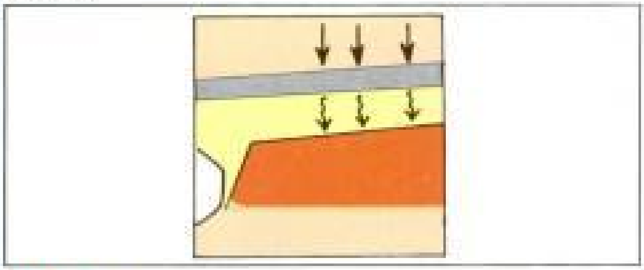


Fig. 20.12: Buffering of forces applied on the stock tray by the 'pick-up' impression material

Modification by Hindle

Principle

It is similar to McLean's technique. Hindle modified McLean's technique to overcome the disadvantages mentioned before.

Method

- A special tray with an occlusal rim is fabricated using the primary cast. The special tray should have stoppers to avoid excessive pressure on the tissues. The stoppers should be placed on the tray extending over the stress-bearing areas.
- The special tray is used to record the supporting tissues under *rest* (anatomical impression).
- The special tray with the impression is left untouched in the patient's mouth.
- A special stock tray with large holes is used to make the over impression. While making the over-impression, the clinician should place his finger into the holes of the stock tray and apply steady constant pressure on the occlusal rim built on the special tray. Pressure should be held till the alginate sets completely (Fig. 20.13).
- The finger pressure pushes the special tray against the edentulous ridge to give a pseudo-functional stress (similar to the functional load). The over-impression is a *functional impression*.

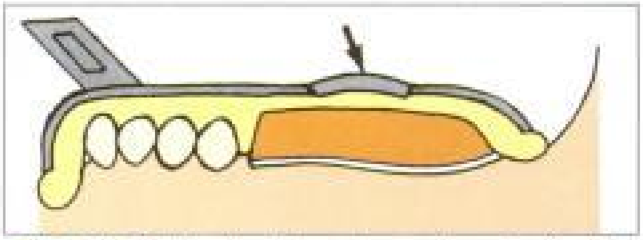


Fig. 20.13: Making the pick up impression using Hindle's modified stock tray

- The stoppers present on the tissue side of the custom tray help to avoid excessive tissue compression.

Ill-effects Produced by McLean and Hindle's Methods

- The denture is fabricated using an impression made over compressed tissues. But the tissues in the oral cavity are not always in a state of compression. The retentive components will try to retain the denture as it was fabricated. This gives the denture an inherent property to constantly compress the tissues even when there is no occlusal load (Fig. 20.14).

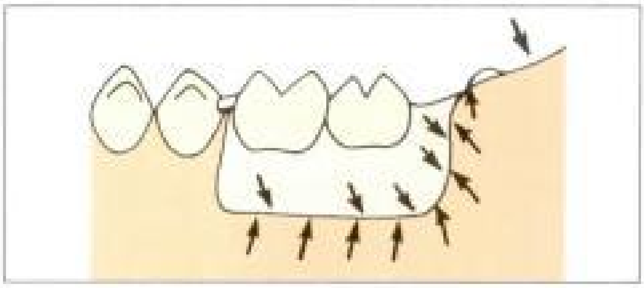


Fig. 20.14: Dentures made using functional impressions will constantly pressurise the soft tissues

- Since the tissues are constantly compressed there will be excessive bone resorption. Bone resorption occurs due to two reasons:
  - Constant pressure stimulates the osteoprogenitor cells to form osteoclasts. Osteoclasts resorb bone. (Fig. 20.15).
  - Constant pressure decreases the blood supply to the bone which again through a series of chemical mediators stimulate osteoclasts (Fig. 20.16).
- If retentive clasps do not hold the denture base properly, the partial denture will be slightly occlusal to the normal position (pushed away

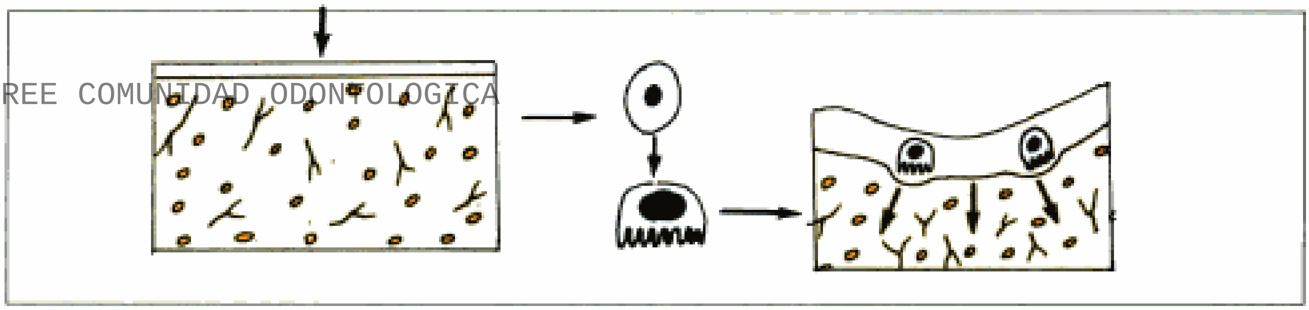


Fig. 20.15: Constant pressure from the denture will stimulate osteoprogenitor cells to form osteoclast which resorb bone

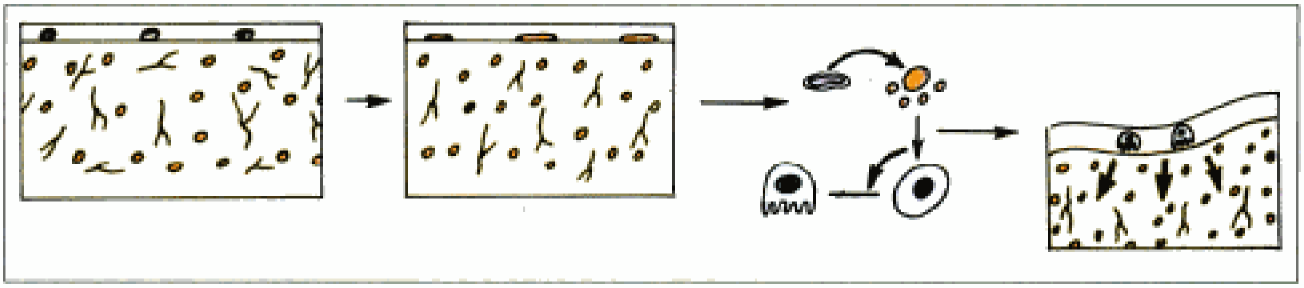


Fig. 20.16: Constant pressure from the denture can produce ischemia. Ischemia can produce bone resorption via various chemical mediators that stimulate osteoclasts

due to tissue rebounce). Since the dentures are occlusally displaced, they will be the first to contact the opposing teeth during occlusion. This will produce premature contacts (Fig. 20.17).

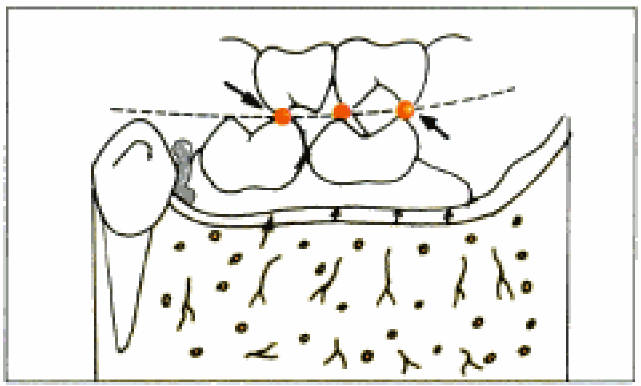


Fig. 20.17: Dentures made using functional impressions get occlusally displaced at rest due to tissue rebounce. This may lead to premature contacts. (Notice the occlusal rest elevated away from it's seat)

Functional Relining Method

Principle

In this method, an anatomical master impression of all the oral structures is made. Two casts are made from this anatomical impression, one is the **master cast** and the other is the **refractory cast** (The refractory cast is made by duplicating the master cast). The framework of the partial denture is fabricated using the refractory cast.

This framework is verified in the patient's mouth and is directly used to record the functional impression. The master cast made from the anatomical impression is altered according to the functional impression made on the tissue surface of the framework.

Advantages

- It improves the fit of the denture after bone resorption.
- The tissue surface of the metal framework can be relined after insertion.

Disadvantages

- It is difficult to maintain the relationship of the framework to the abutment teeth while making the impression.
- Occlusion is usually affected due to the addition of a new layer to the tissue surface of the denture base.

Procedure

- The partial denture framework is constructed on the cast made from a single anatomic impression (usually made with alginate). This is the first master impression.
- A master cast is made from the anatomical impression. The master cast is duplicated and a refractory cast is made.
- A framework is fabricated using the refractory cast.
- Ash No.7 soft metal spacer is adapted on the cast before constructing the framework to provide space for the impression material. The spacer should be removed before making the impression.
- Next the framework is tried in the patient's mouth. Once the fit of the framework is verified, a functional impression is made on the tissue surface of the framework. This functional impression is the second master impression. Hence this technique is categorised as a dual impression.
- The functional impression is made with low fusing modelling plastic. The material is added in a flowing consistency onto the tissue surface of the framework. It is tempered and placed within the mouth (Fig. 20.18).

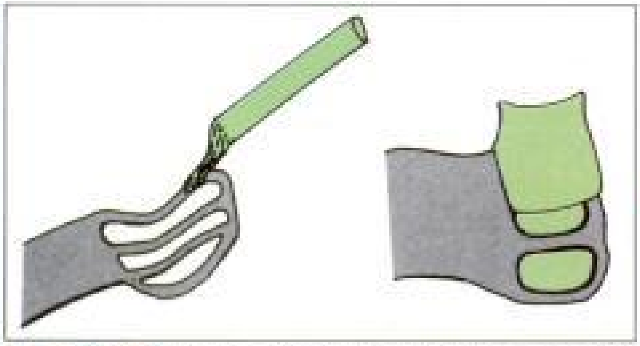


Fig. 20.18: Modelling plastic (greenstick compound) is melted and adapted as a receptacle over the framework to act as a special tray

- Sufficient pressure is applied during impression making to ensure compression of the tissues.
- The function of the modelling plastic is to act like a tray or receptacle to make the final impression with zinc oxide eugenol impression paste.
- The modelling plastic at the borders of the framework are re-softened to do border moulding. Border moulding is done by manipulating the cheeks and tongue.
- After recording the tissues with modelling plastic, it is trimmed to provide space for zinc oxide eugenol impression paste.

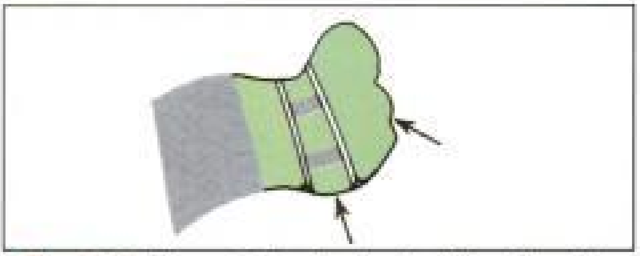


Fig. 20.19: The modelling plastic should be relieved to allow space for the impression material

- The modelling plastic at the borders are reduced by 1 mm and the modelling plastic at the crest of the ridge is removed to its entire thickness. (Fig. 20.19).

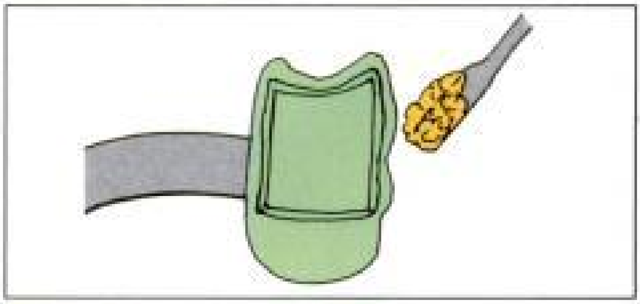


Fig. 20.20: After border moulding, a secondary impression is made using zinc oxide eugenol impression paste

- After reducing the modelling plastic, the final impression is made with zinc oxide eugenol impression paste. If undercuts are present, light bodied polysulfide or silicone rubber can be used (Fig. 20.20).
- The amount of relief given to the modelling plastic controls the amount of soft tissue displacement.
- Patient should keep his mouth in a partially opened position during impression making because:

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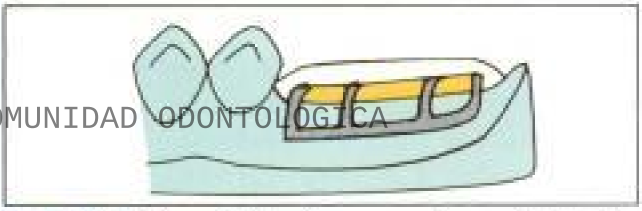


Fig. 20.23: After adapting the spacer, the partial denture framework is seated in position and auto-polymerising resin dough is adapted over it

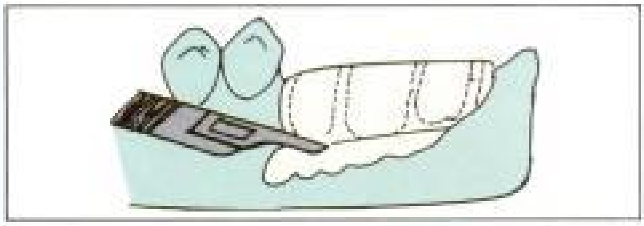


Fig. 20.24: Excess dough material is trimmed away

- The borders of the cured resin tray should be trimmed according to the outline.
- The borders of the tray should not be more than 2mm short of movable tissues because the fluid wax used to make the impression does not have sufficient strength to support itself.
- Relief holes can be prepared along the crest of the ridge (on the temporary denture base) and the retromolar pad to allow the escape of excess impression material (Fig. 20.25).

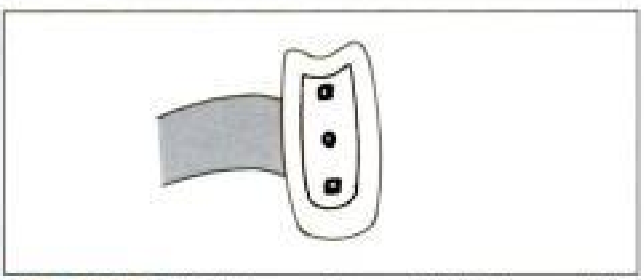
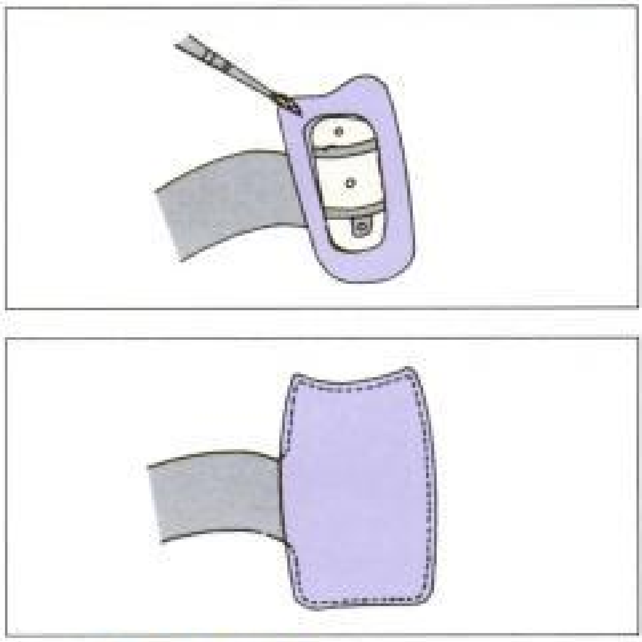


Fig. 20.25: Relief holes may be provided in the special tray to allow escapement of excess impression material

Impression making

- Wax is softened in a water bath at 51-54°C (125° – 130°F).
- The softened wax is painted evenly on the tissue surface of the impression tray with a brush. The wax is painted in layers till the sufficient thickness is obtained (Fig. 20.26a). The wax should be painted in excess near the borders to record the suclus (*remember that the borders are about 2mm short of the sulcus so the wax should be in excess at the borders*) (Fig. 20.26b).



Figs 20.26a and b: Fluid wax is painted in layers over the special tray

- The tray is seated and held in position with three fingers. Two are placed posteriorly over the primary abutments and the other one is placed on the tray (major connector) anteriorly.
- After seating the tray, the cheeks are pulled over the borders of the tray to record the buccal vestibule. The patient is asked to force his/her tongue against the cheeks to record the sub-lingual borders and against the anterior teeth to record the distolingual extensions. The patient is also asked to open the mouth widely to record the distal limit of the impression.
- The patient should keep his mouth half open for at least 5 minutes to ensure cooling and hardening of the wax.
- The framework special tray is removed and the impression is examined.
- The wax surface that contacted the tissues appear glossy and the other areas that did not contact the tissues will appear dull (Fig. 20.27). *(This is exactly opposite of low fusing modelling*

Fig. 20.27: Wax should be painted in excess over the borders

plastic wherein the material that contacts the tissue will appear dull after impression making).

- Additional wax is painted over the dull areas and the procedure is repeated until glossy borders are obtained. Hard wax can be applied to increase the thickness of the wax in the borders.
- Each time the wax impression is inserted into the mouth, the operator must wait for atleast 5 minutes before removing the impression.
- The impression should be placed in the mouth finally for 12 minutes. The cast is then poured using altered cast technique.
- It is a very accurate technique but the procedure is laborious and time consuming.

Selective Pressure Functional Dual ImpressionTechnique

In this technique one anatomical impression and one selective pressure functional impression is made. A master cast is prepared from the anatomical impression and is later altered according to the selective pressure functional impression. This technique differs from the previous techniques in that the second functional master impression is a selective pressure functional impression.

The selective pressure functional impression made in this technique is similar to the one described for complete dentures. Here the tissue surface of the special tray lying over the relieving areas is reduced. Reduction is done such that adequate space is available for the impression material to not exert any pressure in those areas.

Thus the impression tray contacts the tissues only over the areas that were not reduced (stress-bearing areas). Since the tray contacts only the stress-bearing areas during impression making, only these areas are compressed (recorded functionally) while making the impression. This concept wherein pressure is applied to selected areas while making the functional impression is known as selective pressure impression technique.

Advantage

It equalizes the stress acting on the abutment teeth and the soft tissues. The rate of ridge resorption is reduced because relieving areas that cannot withstand any load are not stressed.

Procedure

- The special tray is fabricated on the master cast made from an anatomical impression. The tray is fabricated without a wax spacer.
- The tissue surface of the special tray is trimmed with burs to provide adequate relief. (About 1mm of acrylic is trimmed along the crest of the ridge and the stress-bearing areas in the tray are left untouched) (Fig. 20.28).
- The impression material (preferably zinc oxide eugenol) is loaded on the prepared special tray and inserted into the patient's mouth.

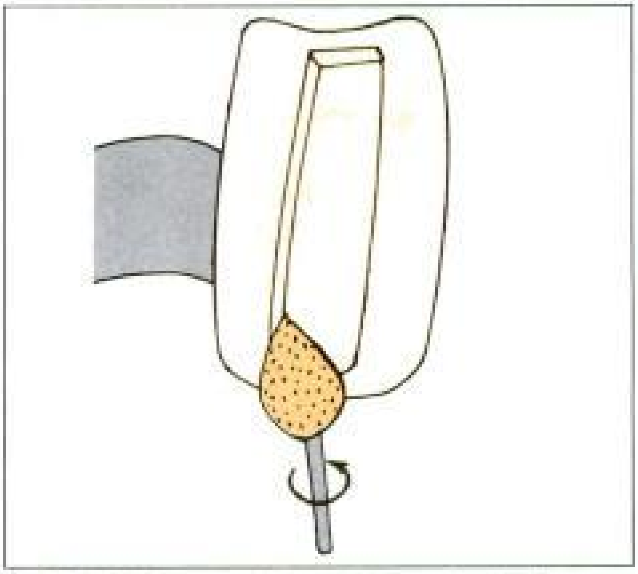


Fig. 20.28: The special tray is trimmed on the tissue surface to relive the non-stress-bearing areas

- The patient is advised to keep his mouth open. The impression is recorded under finger pressure. Only the stress-bearing areas will be compressed during impression making.

PREPARING THE MASTER CAST

Preparing the master cast includes pouring the master cast, altering the anatomical master cast if required, correcting the master cast and finally trimming and finishing the master cast.

Pouring the Master Cast

The technique is similar to the one explained in chapter 3 for a diagnostic cast for a complete denture. Any way I will summarise the procedure here.

- Minimal expansion dendrite dental stone is used.
- The cast is poured with two-pour technique.
- The cast should be poured within 12 minutes after making the impression.
- Stone mix is made under vacuum and the first pour is made.
- The thickness of the first pour should be atleast 6 mm (Fig. 20.29).

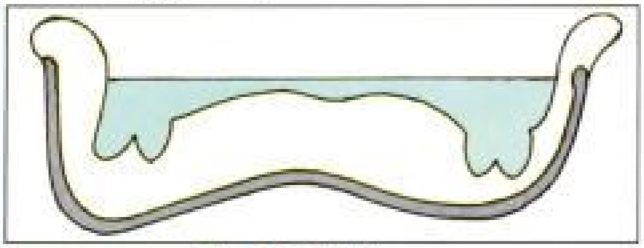


Fig. 20.29: First pour

- After 10 to 12 minutes, slurry water is applied over the first pour.
- The impression is inverted over a mix of stone (second pour) and the base is shaped (Fig. 20.30).
- The impression and the cast should be separated only after 45 to 60 minutes.

Correcting the Master Cast

This is done when the lingual surface of mandibular ridge is not recorded properly due to various reasons like entrapment of the sublingual salivary gland in the lingual sulcus etc.

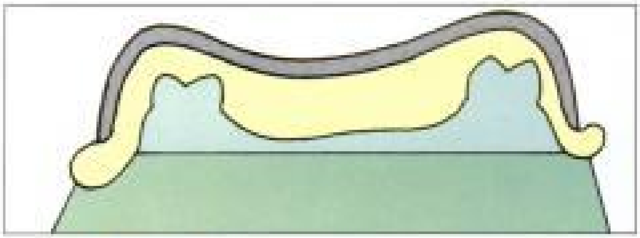


Fig. 20.30: Contoured second or base pour

The master cast can be corrected using three methods:

1. The area that was not recorded properly is arbitrarily reduced in the cast with the help of the clinician's perspective (Fig. 20.31).

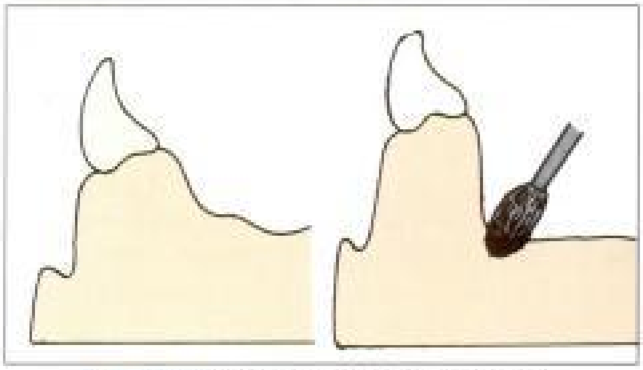


Fig. 20.31: Arbitrarily trimmed master cast

2. Utility wax can be attached to the border of the stock tray to increase the height of the tray border and to displace the tissues during impression making (Fig. 20.32).

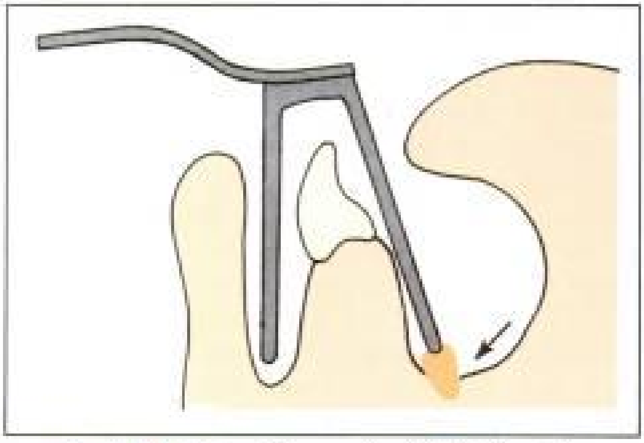
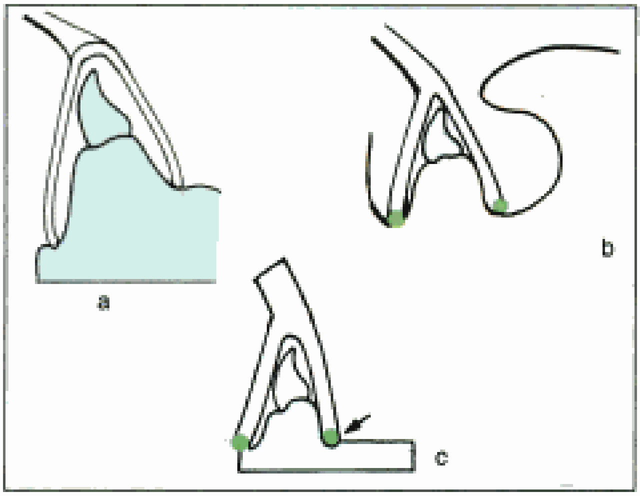
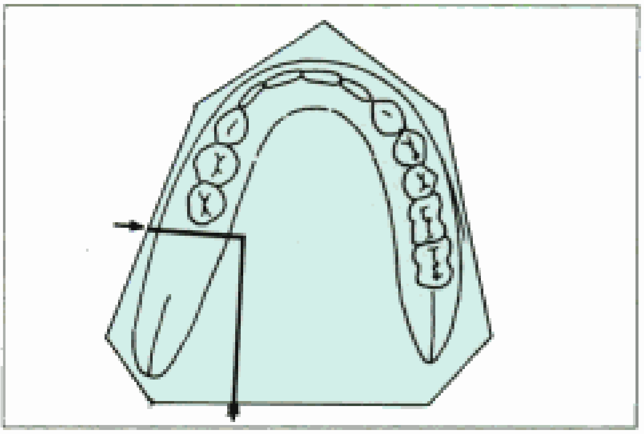


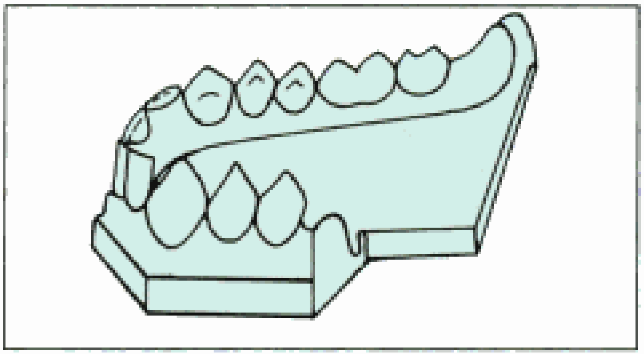
Fig. 20.32: Using utility wax (red) to displace the soft tissues

3. A special tray is fabricated over the cast. Border moulding is done using this special tray to record the lingual sulcus in the affected area and the suclus area in the cast is trimmed till the border moulded tray seats on the cast (Fig. 20.33).



Figs 20.33a to c: Sectional border moulding with a special tray and using it as a guide to trim the cast





Figs 20.34a and b: Slicing away the edentulous area (a) occlusal view (b) diagonal view

Altering the Master Cast

This is done for functional reline, fluid wax and functional selective pressure dual impression techniques. In all these techniques, the master cast is made using the anatomical impression (first impression). This anatomical master cast is altered according to the functional impression, which is made later (second impression). Remember, all the following procedures are made after making the functional impression.

Procedure

- The edentulous area in the anatomical master cast is cut away with a saw. The cast is sliced using two cuts one buccolingual and one anteroposterior (Fig. 20.34).
- The buccolingual cut is made 1 mm behind the terminal abutment across the edentulous ridge (Fig. 20.35).
- The anteroposterior cut is made 1 mm lingual or medial to the lingual suclus. Note: the lingual sulcus should be cut away alongwith the edentulous ridge (Fig. 20.35).

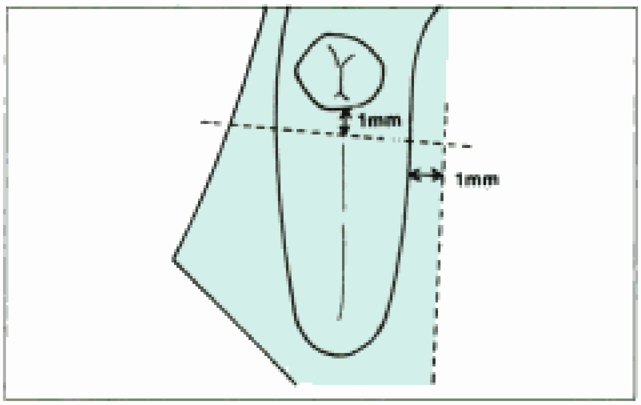


Fig. 20.35: The buccolingual cut should be placed 1 mm away from the primary abutment. The anteroposterior cut should be placed 1 mm lingual to the lingual sulcus

- Vertical grooves are prepared on the cut walls of the cast (Fig. 20.36).
- The framework along with the functional impression is placed over the cut anatomical master cast. Since the edentulous areas are cut away from the cast, the edentulous areas of

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Fig. 20.39b: Beading and boxing the impression in continuity with the remaining cast: diagonal view

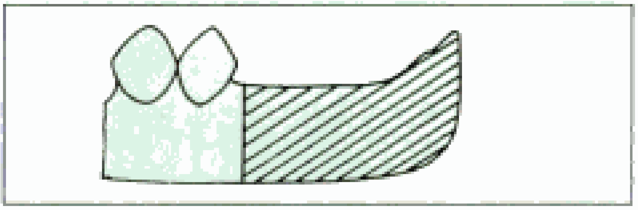


Fig. 20.40: Altered master cast

Trimming the Cast

The technique is similar to the one explained in Chapter 17 for a diagnostic cast. Anyway I have summarised the procedure here.

- Minimum thickness of base (at the thinnest portion)
- 10 mm at the center of hard palate in the Maxilla. (Fig. 20.41a).

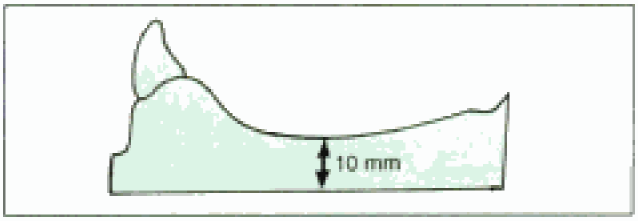


Fig. 20.41a: The maxillary cast should be atleast 10 mm high at its' thinnest portion

- 10 mm at the depth of lingual sulcus in the mandible (Fig. 20.41b).
- Posterior surface of the cast must be perpendicular to the base (Fig. 20.42).
- The sides of the cast are trimmed so that they are parallel to the buccal surface of the teeth (Fig. 20.43).

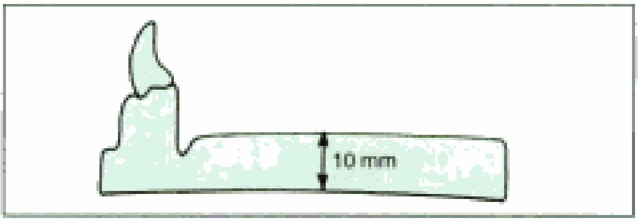


Fig. 20.41b

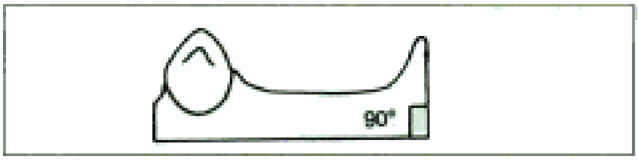


Fig. 20.42: The posterior wall should be perpendicular to the base

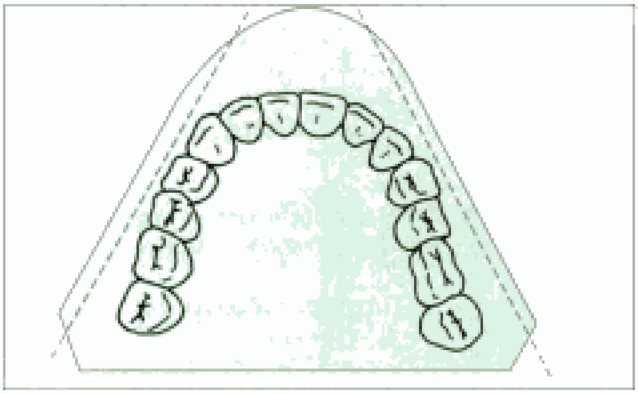


Fig. 20.43a: The sides of the cast should be trimmed parallel to the buccal surface of the remaining teeth

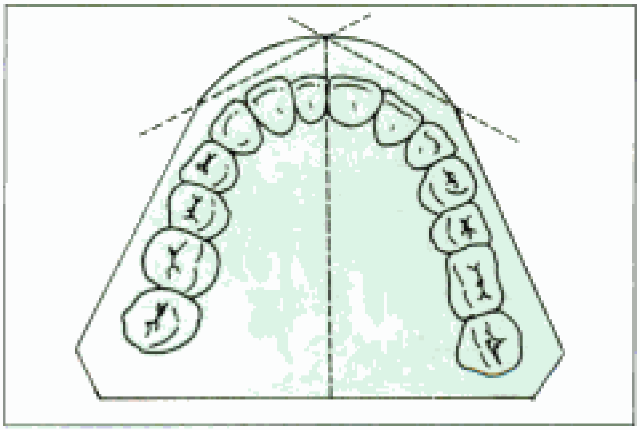


Fig. 20.43b: The anterior portion of the base of the maxillary cast should be trimmed to two surfaces that meet at the midline

- Land area/periphery should be 3 mm wide all around the cast (Fig. 20.44).

Chapter 21
Fabrication of A Removable Partial Denture

- Framework Fabrication
- Framework Try-in
- Fabrication of the Temporary Denture Base and Occlusal Rims
- Jaw Relation
- Mounting the Casts
- Denture Base Selection
- Teeth Selection
- Arranging the Artificial Teeth
- Processing
- Insertion

21 Fabrication of a Removable Partial Denture

Fabrication of a partial denture comes under phase V of treatment planning. The chapter is extremely condensed because these procedures are not very important in the undergraduate syllabus.

FRAMEWORK FABRICATION

After recording the master impression, the framework is fabricated for a cast partial denture. The framework is essential for other procedures like preparing occlusal rims, jaw relation, etc. Framework fabrication involves the following steps:

- Wax-up
- Duplication and preparation of refractory casts
- Waxing
- Investing
- Burn out
- Casting
- Finishing and polishing.

Wax Up Procedure

It deals with all the procedures done to the master cast prior to duplication. We know that the master cast is duplicated to produce the refractory cast, which is used to cast the framework. The refractory cast will not resemble the master cast because the contours of the master cast are altered by various wax up procedures before duplication. Wax up includes design transfer, block out, relief and beading of the master cast.

Design Transfer

Design transfer is defined as, *"Conveying the outline of the proposed prosthesis from the diagnostic cast to the master cast"*—GPT. The outline of the proposed partial denture is drawn on the primary cast during design. This out line is transferred to the master cast with the help of a surveyor. The colour codes used in the primary cast should be followed in the master cast also.

Design transfer includes the following steps:

- Marking the height of contour
- Measuring the undercut
- Drawing the clasps
- Drawing the connectors.

Marking the height of the contour The tripod marks of the primary cast are transferred to the master cast. The master cast can be repositioned on the surveyor using these tripod marks. After positioning the master cast, the survey lines are drawn on the abutment teeth with reference to the survey lines marked in the diagnostic cast (Fig. 21.1).

Fig. 21.1: As a first step in design transfer, the height of contour is marked on the master cast using the primary cast as the guide

Measuring the undercut The undercut gauge is attached to the survey arm and the undercut areas are marked and measured. The procedure is as described in Chapter 18.

Drawing the clasps The clasp should be drawn so that the retentive terminal descends gracefully into the infrabulge (undercut) area of the tooth. The clasps are drawn in reference to the primary cast. The shape of the clasp should be similar in both primary and master cast (Fig. 21.2).

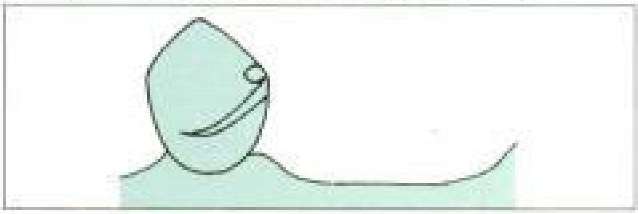


Fig. 21.2: The clasp components are drawn on the master cast

Drawing the connectors The major connector including the lattice work is drawn using brown colour pencils. The minor connectors are drawn such that they unite the clasp with the major connector. The area to be occupied by the denture base may be drawn finally (Fig. 21.3).

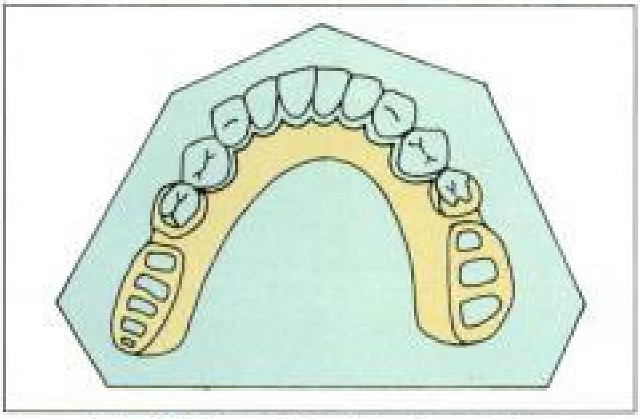


Fig. 21.3: The outline of the framework is drawn on the cast

Completed transfer of metal outline on the refractory cast should be similar to the design on the master cast.

Blockout or Wax Out

Blockout is defined as, "*Elimination of undesirable under cut areas on the cast to be used in the fabrication of the removable partial denture*".

It is the process by which the undesirable undercuts on the master cast are eliminated using wax. Since the undercuts are filled with wax, the refractory cast duplicated from the master cast will not have these undercuts.

Before block out, the master cast is coated with a sealer (a special liquid sealer or bees wax is used) so that it forms a protective film over the cast (Fig. 21.4). Based on the purpose, blockout can be classified into three types namely *parallel blockout*, *arbitrary blockout* and *formed blockout*.

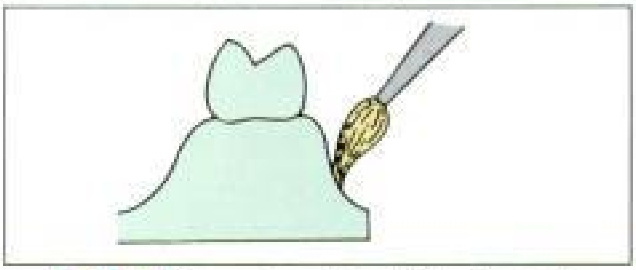


Fig. 21.4: The master cast is painted with a sealer before blockout

Parallel blockout This is the procedure by which, undercuts below the height of contour of the existing teeth are eliminated in relation to that path of insertion. The master cast is surveyed and the undercuts in relation to the determined path of insertion are marked. Blockout wax is filled into the infra-bulge (undercut) area of the tooth and trimmed such that its surface is parallel to the path of insertion. Trimming the excess blockout wax is done using a parallel or tapered wax carving blade attached to the surveying arm (Fig. 21.5).

Arbitrary blockout This procedure involves filling the soft tissues and other unwanted undercuts in

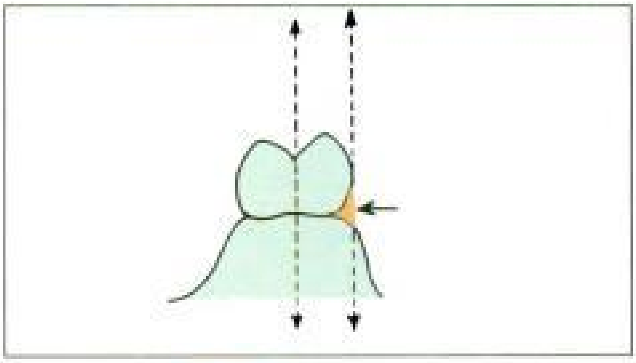


Fig. 21.5: Parallel blockout

the cast with blockout wax. The purpose of this procedure is to eliminate the unwanted undercuts (ridge, soft tissue), which may interfere with the path of insertion. It is termed arbitrary blockout because the surface of the block out wax need not be parallel to the path of insertion (Fig. 21.6).

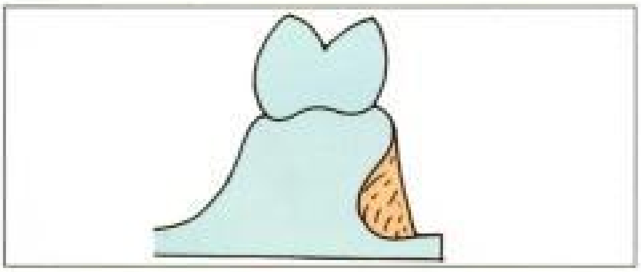


Fig. 21.6: Arbitrary blockout

Formed or shaped blockout This procedure is very special because it has a totally different purpose. It is done in the undercut of the primary abutment along the lower border of the proposed retentive arm. The blockout wax is not trimmed to flush with the tooth surface. Instead it is filled in excess, i.e. the surface of the block out wax will be projecting from the surface of the teeth. The excess wax will form a ledge on the occlusal surface. This ledge will follow the lower border of the proposed retentive arm drawn on the master cast. This blockout will be reproduced as a ledge in the refractory cast duplicated from the master cast. This ledge guides the fabrication of the wax pattern for the retentive arm (Fig. 21.7).

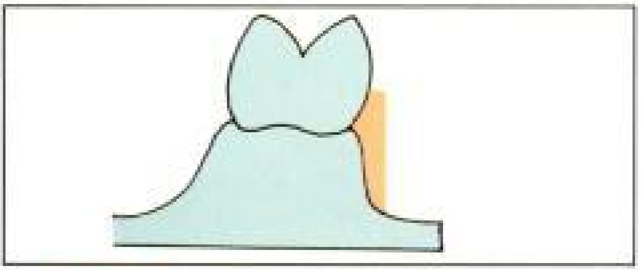


Fig. 21.7a: Formed blockout (Cross-sectional view)

Relief

It is defined as, *"The procedure of placing a sheet of wax in strategic areas on the master cast to be duplicated so that a refractory cast can be made"*.

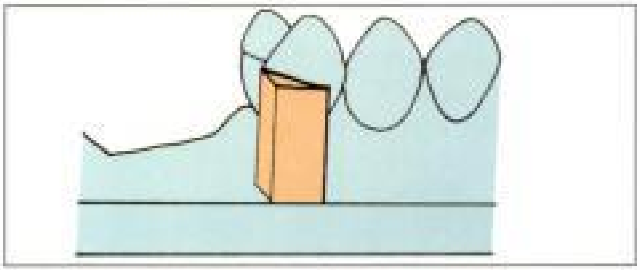


Fig. 21.7b: Formed blockout

The purpose of relieving the master cast with wax is to provide space between certain components of the framework and the adjacent oral structures such as the minor connector to which the denture base will be attached. The relieved areas on the master cast will be produced as elevations on the refractory cast. Hence, the framework fabricated over the refractory cast will not contact the tissues to be relieved in the mouth (Fig. 21.8).

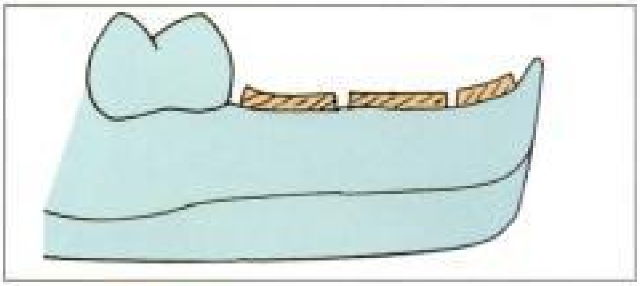


Fig. 21.8a: Adapting spaces for relief

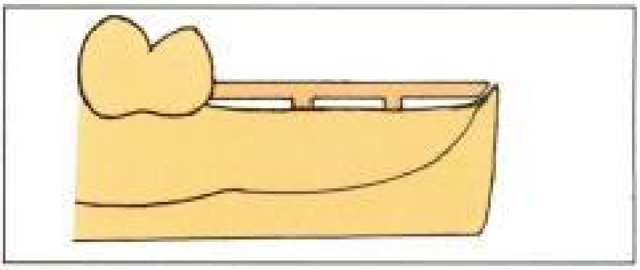


Fig. 21.8b: When the master cast is duplicated, the area where the relief wax was adapted will be a elevation. Hence, when a framework is fabricated it will be elevated from the ridge of the master cast

Relief should be provided in the form of a spacer on the tissue surface of the denture base minor connector meshwork to provide space for the resin to flow under the meshwork.

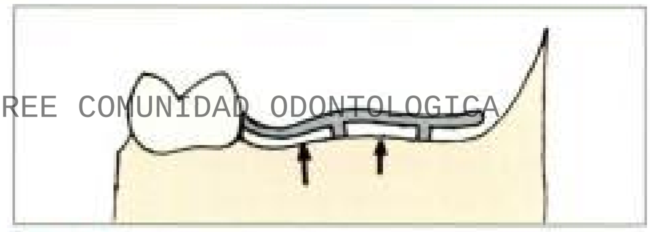


Fig. 21.8c: When a framework is fabricated over the refractory cast, a space will be formed between the tissue surface and the framework. This space will be packed with denture base material later

Areas to be relieved In the maxilla the relief areas include, facial surface of the edentulous ridge and the tuberosity. In the mandible the retromolar pad and the crest of the alveolar ridge are relieved. The free gingival margins of all the teeth should be relieved.

Procedure A sheet of wax equivalent to the thickness of the base plate is adapted over the ridge. This relief wax also provides the internal finish line. A square of 2 mm is cut on the spacer or relief wax to allow placement of a tissue stop (Fig. 21.9). The gingival margins are relieved by adapting a thin strip of wax over the gingival margins on the cast (Fig. 21.10).

Beading

It is defined as, "*Scoring a cast with a sharp instrument or Bur in any desired area to provide a seal between the finished prosthesis and the soft tissue*".

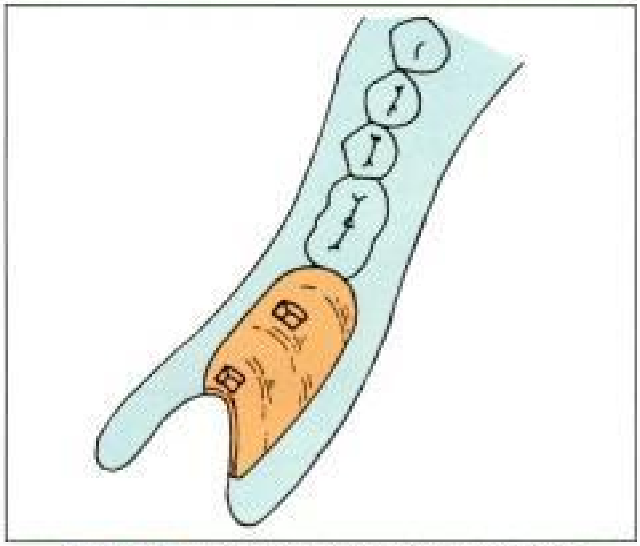


Fig. 21.9: Stopper holes should be created over the relief wax

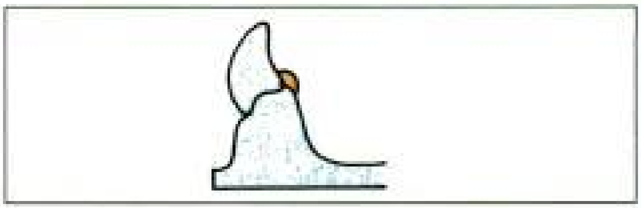
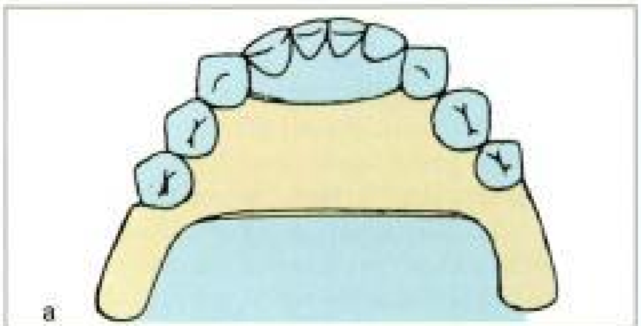


Fig. 21.10: Relief wax should be adapted over the free gingival margin like a thin bead

Beading is nothing but a depression created along the borders of the framework drawn on the cast so that the resultant framework will have an elevation at its borders. This is done only for the maxillary cast to get a good seal (Fig. 21.11).



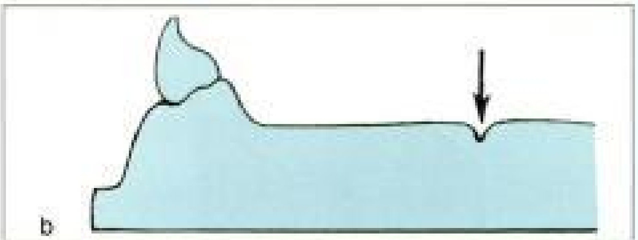


Fig. 21.11: Beading done near the posterior border of the major connector (a) occlusal view (b) Cross-sectional view

A spoon excavator is used to produce beading. The depth of the bead should not extend more than 1 mm and it should thin down near the gingiva.

Duplication and Preparation of Refractory Casts

Either alginate or agar can be used to duplicate the master cast. Agar is the duplicating medium of choice. The blocked, relieved and beaded master cast should be duplicated so that the resultant refractory cast, is ideal to fabricate the framework.

A Few Words on Duplicators and Duplicating Flasks

Duplicators A duplicator is a machine designed to prepare and load the duplicating material into the duplicating flask. The apparatus resembles an Italian softy ice cream vending machine.

There is an upper reservoir compartment or storage unit where the duplicating material is heated and constantly mixed to improve homogeneity and prevent graininess. The duplicating material is maintained in a particular constant temperature with the help of a thermostat inbuilt within the system. The reservoir has a dispensing nozzle to dispense the material. The duplicating flask should be placed below the dispensing nozzle of the duplicator during duplication procedure. The duplicator has a horizontal table to hold the duplicating flask. The horizontal table is perforated and a fan is present below the table to cool the duplicating flask. Sophisticated duplicators, which help to pour the duplicating medium in a vacuum chamber, are also available. Vacuum based duplicators prevent porosity in the duplicating material (Fig. 21.12).

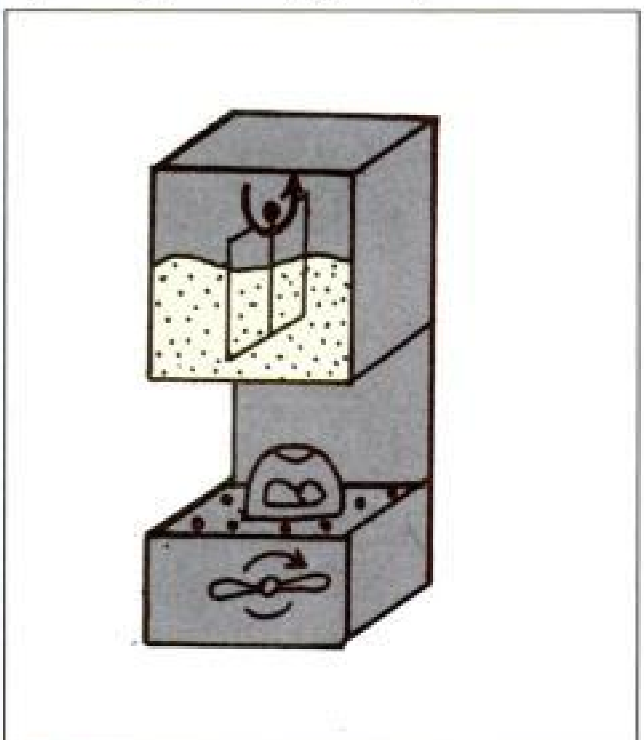


Fig. 21.12: Agar duplicator (Schematic representation)

Duplicating flasks The duplicating flask has two parts namely, the body and a reservoir ring or counter. The body of the duplicating flask forms the base of the flask where the cast to be duplicated is positioned. The reservoir ring is a dome shaped structure with vent holes through which the duplicating material can be poured in. The reservoir ring is designed such that the flange extension of the dome seats on the body of the flask (Fig. 21.13). The vent hole present on the upper surface of the counter should be aligned with the dispensing nozzle of the duplicator during duplication procedures.

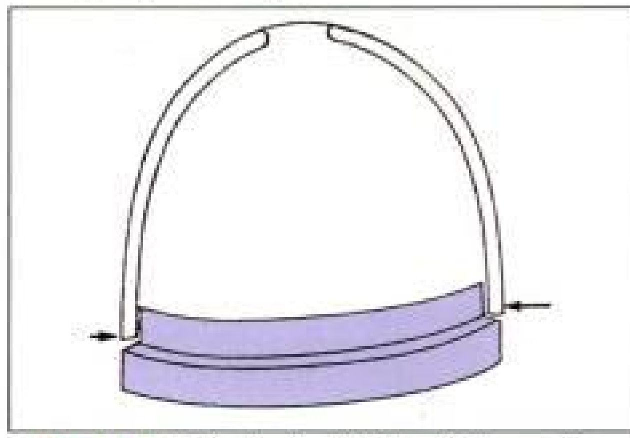


Fig. 21.13: Duplicating flask. Notice the flange of the dome sleeving over the base

Procedure

- The master cast should be soaked in slurry water for atleast 5 minutes before duplication.
- The soaked cast is positioned on the base of the duplicating flask such that there is at least 1/4th inch clearance all around the cast.
- The cast is secured in place on the base of the duplicating flask with the help of modelling clay (Fig. 21.14).

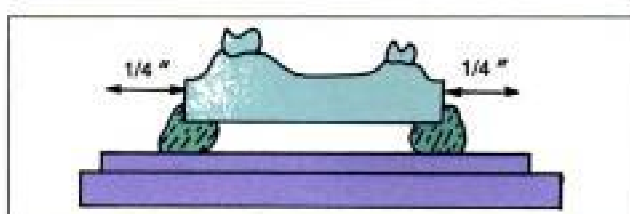


Fig. 21.14: The master cast should be positioned using modelling clay

- The reservoir ring is positioned to fit in the body of flask.
- The duplicating flask with the positioned cast is placed in the duplicating unit. The vent holes of the flask should be aligned below the dispensing nozzle of the duplicating unit (Fig. 21.15).

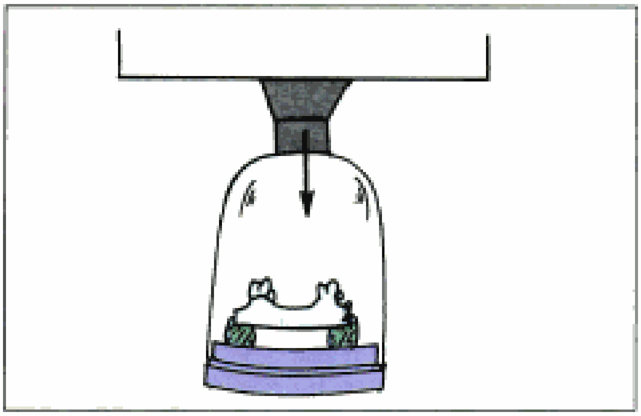


Fig. 21.15: Duplicating material can be filled by aligning the nozzle with the vent holes of the flask

- The nozzle is opened till the agar from the storage unit fills the entire reservoir ring of the flask.
- When the agar completely fills the reservoir ring it will flow out through the other vents present in it (Fig. 21.16). (Vacuum is created at this stage when a vacuum based unit is used).
- The agar is allowed to cool in the duplicating unit with the help of the fan placed below the perforated table holding the flask in the unit.

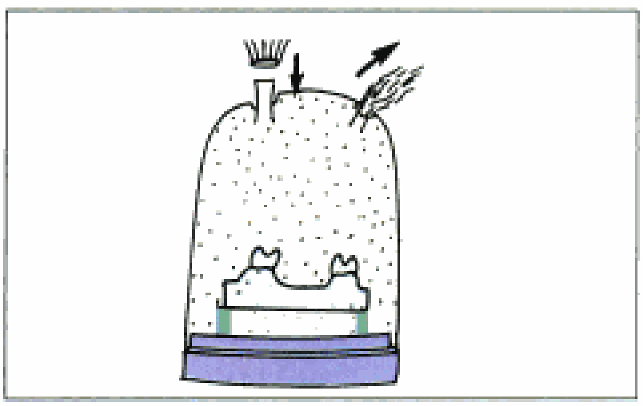


Fig. 21.16: Material is filled till it escapes out through the other vent holes

- After the agar cools, the base of the duplicating cast is gently removed. The clay used for stabilization is removed.
- A jet of cold air can be blown at the junction of the cast for the set duplicating material to loosen and remove the cast embedded in the duplicating medium (Fig. 21.17).

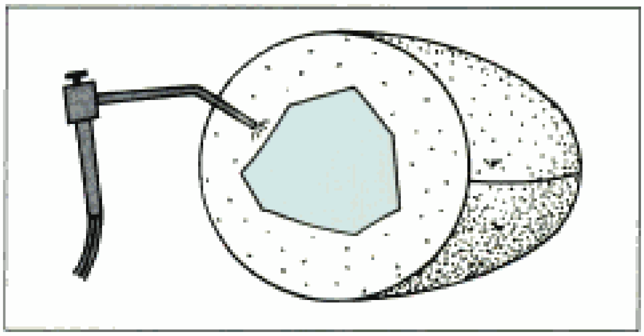


Fig. 21.17: After the agar cools, the master cast can be separated by applying a jet of air spray

- Refractory investment (used to make the refractory cast) is poured into the impression of the master cast present in the duplicating material (Fig. 21.18). The cast is dried in an oven and treated.

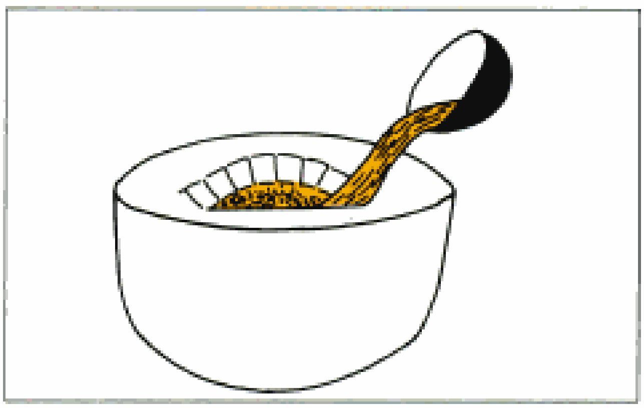


Fig. 21.18: Refractory cast poured using refractory material

A Few Words about the Refractory Cast

After blockout and relief, the master cast is duplicated to form the refractory cast. As mentioned before the refractory cast will not be similar to the master cast. It will have the following characteristics:

- All the blocked out undercuts will be invisible in the refractory cast (Fig. 21.19).

Fig. 21.19: All infrabulge undercuts will be blocked out on the refractory cast

- The spacer relief will appear as an elevation on the edentulous ridge (Fig. 21.20).

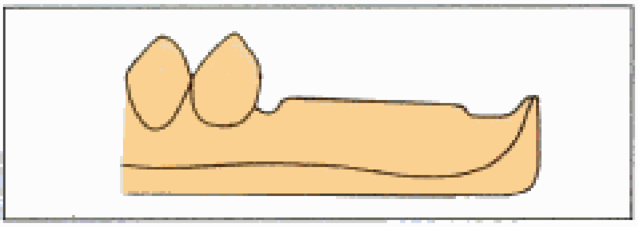


Fig. 21.20: The spacer area will be an elevation on the duplicated cast

- The stopper holes on the spacer will appear as depression on the elevated saddle area (Fig. 21.21).

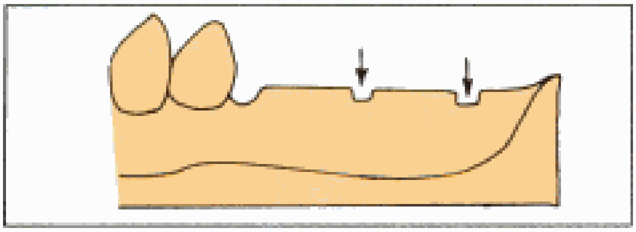


Fig. 21.21: Stopper holes in the spacer will be replicated as depressions within the elevated zone on the refractory cast

- The gingival relief will appear as an elevated band on the refractory cast (Fig. 21.22).

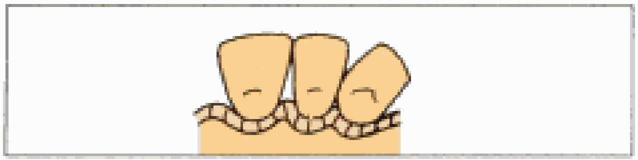


Fig. 21.22: Gingival relief will be an elevated band on the refractory cast

Waxing

Waxing is nothing but fabricating the wax pattern for the framework. Commercially available wax or plastic patterns can be used to fabricate the framework pattern. Wax patterns for Cobalt-chromium alloy frameworks should be waxed slightly heavier (thicker) than those for gold frameworks. Commercial wax and plastic patterns are available in a wide variety of shapes and gauges (thickness). Commonly used pattern gauges include:

- Full Palate: 26 gauge
- Palatal strap: 22 gauge
- Horseshoe and Double palatal bar: 24 gauge
- Lingual plate: The portion of the plate extending over the teeth is fabricated using a 6 gauge pattern, whereas the lower border is made half-pear shape by reinforcing the 6 gauge pattern with a 28 gauge pattern over it. The superior margins are made knife-edged while adapting over the teeth (on the refractory cast).
- Lingual bar: It is also 6 gauge at the upper border; the lower border is made half-pear shape by adapting a 28-gauge pattern over it.

Gauged pattern wax sheets are also available with adhesive backs and various colours, e.g. green (soft, non-adhesive), yellow (Soft, adhesive) and pink (hard).

Procedure

- A sheet of the pattern material (plastic or wax) is roughly cut according to the shape of the outline of the major connector and gently adapted over the refractory cast (Fig. 21.23).
- If the major connector is designed to extend over the lingual surface of the teeth, the pattern should be extended on to the lingual

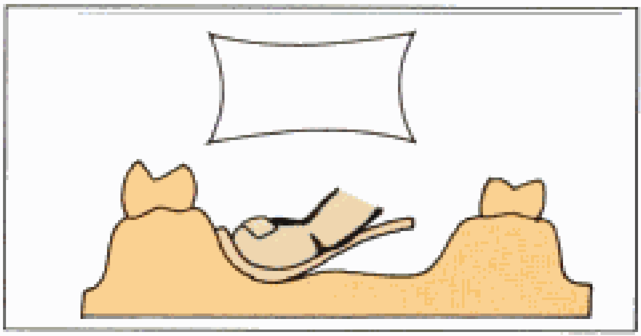
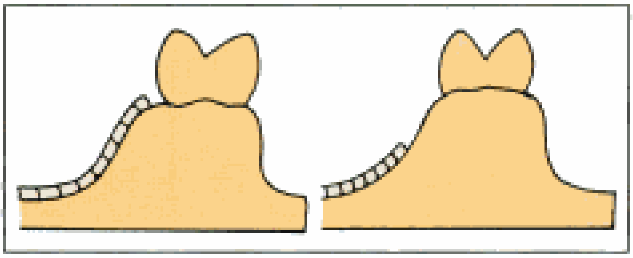


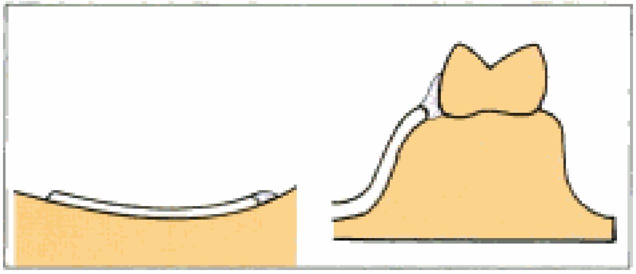
Fig. 21.23: Pattern wax is cut to an approximate shape and adapted over the refractory cast

surface of the teeth stopping just short of the cervical edge line of the tooth (Fig. 21.24).



Figs 21.24a and b

- A Blue casting wax is poured over the edge to seal it to the cast (Fig. 21.25).



Figs 21.25a and b

- The bead groove created during wax up should be filled with blue wax (Fig. 21.26).

Fig. 21.26

- A thin layer of wax is then applied to cover the entire contour of adapted pattern.
- Wax is finished to a thin edge in the area where it contacts the tooth and is slightly rounded at the borders (Fig. 21.27).

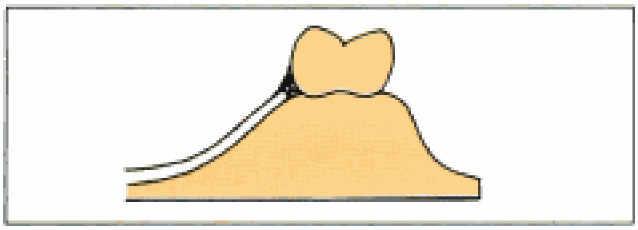


Fig. 21.27

- A 12-14-gauge half round pattern wax is used to adapt the outer strut around the edentulous ridge (Fig. 21.28). (Refer denture base minor connectors).

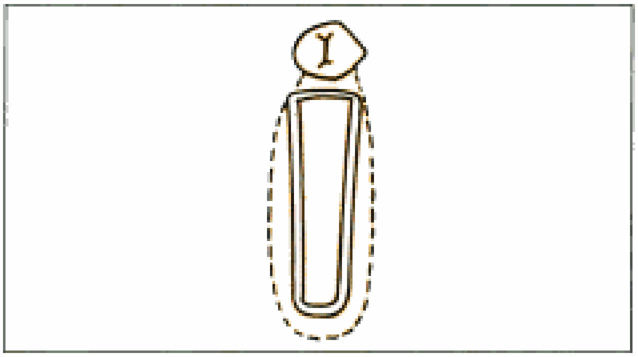


Fig. 21.28

- Depending on the type of minor connectors either cross struts may be used to make a meshwork or nail beads created on the saddle area (Fig. 21.29).
- Finally the pattern is polished.

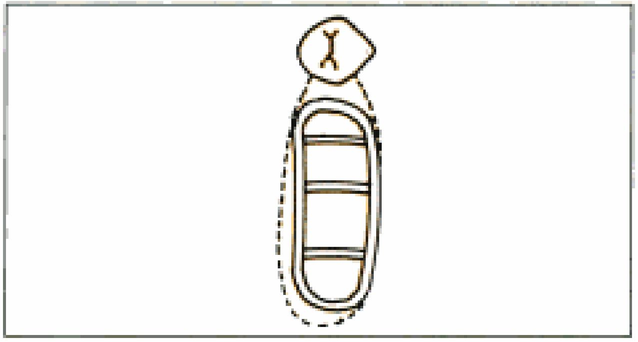


Fig. 21.29

Investing

After fabricating and finishing the framework pattern, it should be invested and cast to obtain a metal framework. Investing is defined as, "*The process of covering or enveloping, wholly or in part, an object such as a denture, tooth, wax form, crown, etc. with a suitable investment material before processing, soldering or* casting" – GPT.

Investing is done by placing the pattern with the cast in an investing ring. The pattern is surrounded by the investing medium. Sprues are attached to the wax pattern in order to create a path for the molten metal to reach the wax pat-

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- *Expand the mould to compensate for solidification shrinkage of the metal*: The mould is heated at 1000F (538°C) for 1 hour to complete mould expansion.
- *Eliminate the pattern plastics and waxes by melting and vapourization*: The mould is heated at 1250 to 1300F (675°C to and 710°C) for 1 to 2 hours to eliminate and vapourize the traces of wax.

Casting

The mould is ready for casting after complete burnout. The casting ring is placed and locked in position within the casting machine. The centrifugal casting machine is prepared and locked. The required amount of metal is placed on the crucible in front of the sprue way of the casting ring.

The tip of the blue flame is used to heat the metal pellets. Powdered flux is added when the pellets begin to fuse. The casting machine is released by unlocking the spring. The casting ring is bench cooled for 12 minutes before quenching in water.

Recovery

Casting recovery is nothing but removing the adherent investment away from the cast metal.

In case of phosphate bonded investment the casting is recovered grossly (i.e. remnant investment not adherent to the casting) and then the adhered investment removed by sand blasting with aluminium oxide (Fig. 21.38). Hydraulic devesting machines can be used for gross recovery.

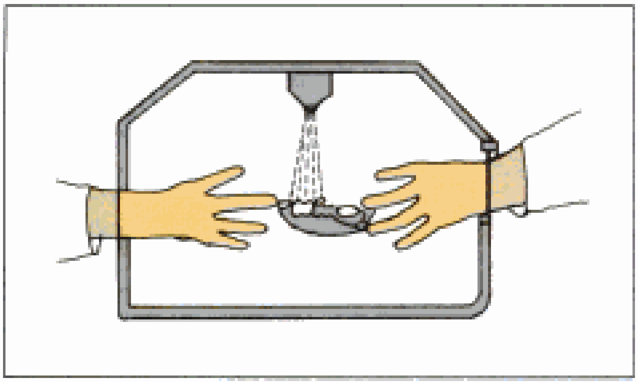

Fig. 21.38: Sand blasting

Finishing and Polishing

The sprues are cut using carborundum discs. Surface irregularities are removed with the help of a tungsten carbide (TC) bur. The casting is trimmed and finished using a mounted stone. Polishing is done using rouge, which is coated on the polishing buff.

The portions of framework, which are difficult to access, are polished using rubber abrasive wheels and points. The clasp arms and other parts of framework that contact teeth are maximally finished to avoid surface decalcification of the abutment.

FRAMEWORK TRY-IN

After finishing, the framework is tried in the patient's mouth. The fit of the framework is tried first. Wrought wire clasps can be adjusted/adapted at this stage. Even cast clasp arms can be altered to a certain extent. Pressure indicating paste (calcium carbonate + chloroform) should be coated on the tissue surface of the framework before insertion.

The pressure indicating paste indicates premature contacts in the framework. The framework is tried-in until all the premature contacts are eliminated. After try-in the framework is forwarded to the laboratory for the fabrication of the temporary denture base and occlusal rims.

Problems in Framework Try-in

The framework typically will fit the stone cast very tightly and may be quite difficult to remove from it. But the same framework may not seat in the patient's mouth. Reasons for such problems include:

- Inaccurate impression
- Improperly poured cast
- The cast modified for dual impression is not altered properly.
- Change in position of the natural teeth after impression making.

Adjusting the Framework

The framework can be adjusted only if the discrepancies are minimal. Gross structural discrepancies cannot be corrected. In such cases, the framework should be fabricated again. In other words, all the procedures should be started from scratch.

Fitting the Teeth to the Framework

The framework is fitted onto the teeth by inserting it along the determined path of insertion. Finger pressure should be applied in a direction parallel to the path of insertion to seat the clasps and rests in position.

Adjusting the Clasp

The clasp arm should be adjusted if it produces any obstruction to the insertion of the framework. Special contouring pliers like *smooth beak pliers* can be used to alter the clasp arms. Gold alloys are more pliable compared to cobalt-chromium alloys. Cobalt chromium alloy clasps can be modified by making a series of minute bends till the desired configuration is obtained (Fig. 21.39).

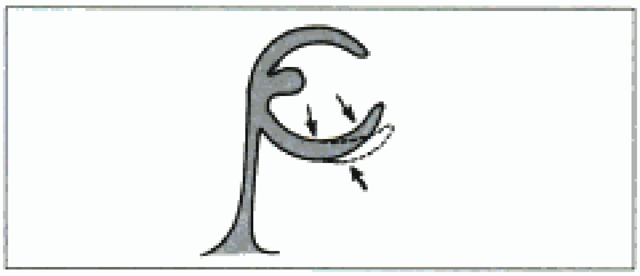

Fig. 21.39: Adjusting a cast circumferential clasp

FABRICATION OF THE TEMPORARY DENTURE BASE AND OCCLUSAL RIMS

Fabricating the Temporary Denture Base

The temporary denture base is fabricated using the metal framework. The denture base is fabricated only over the saddle area of the prosthesis. The material of choice to fabricate a temporary denture base is acrylic. The framework is placed in position on the master cast and the outline of the denture base is marked around the framework (Fig. 21.40).

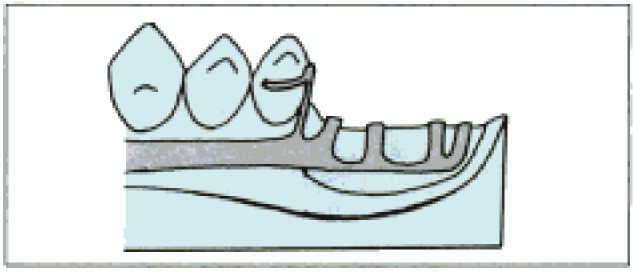

Fig. 21.40: Seating the framework on the master cast

A tin foil substitute is applied over the cast. Auto polymerizing resin is made into a dough and placed over the framework. The resin should flow in-between the framework and the tissue surface of the cast. The excess resin extending beyond the required borders are trimmed using a Le Cron's carver (wax carver) before the resin polymerizes (Fig. 21.41). The cast with the resin is placed in a pressure pot for complete polymerization and to avoid porosities. The polymerized resin is trimmed and smoothened using an acrylic trimmer.

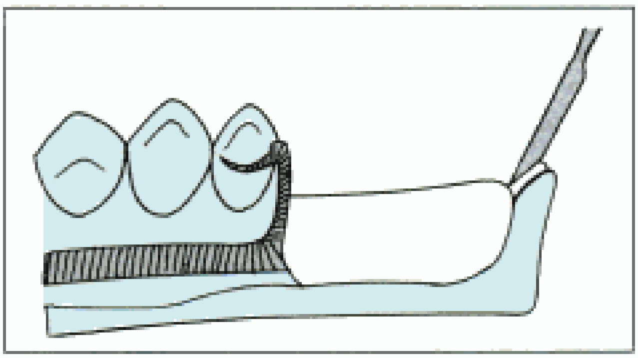

Fig. 21.41: Fabricating an acrylic temporary denture base

The fabricated base plates (temporary denture bases) can be used to make functional secondary impressions (as a part of dual impressions), fabricate occlusal rims and set artificial teeth for aesthetic try-in.

Preparing Occlusal Rims

Base plate wax is adapted over the resin retention minor connector in the framework to form a base plate. Modelling wax is folded to form an occlusal rim and is fused to the base plate (Fig. 21.42). (Refer Chapter 8 *for detailed information about occlusal rims*).

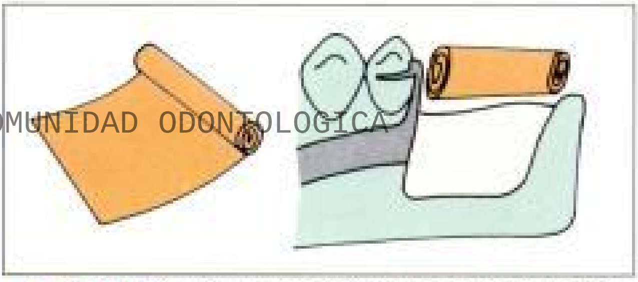

Fig. 21.42: Occlusal rims are fabricated by rolling and adapting modelling wax over the temporary denture base

JAW RELATION

After fabricating the occlusal rims, jaw relations are recorded . A brief description of the procedure is as follows:

- The base plates with the occlusal rims are inserted into the patient's mouth.
- The patient is asked to close on the occlusal rims with a gentle force so that the occlusal imprints of the opposing teeth are recorded (Fig. 21.43).

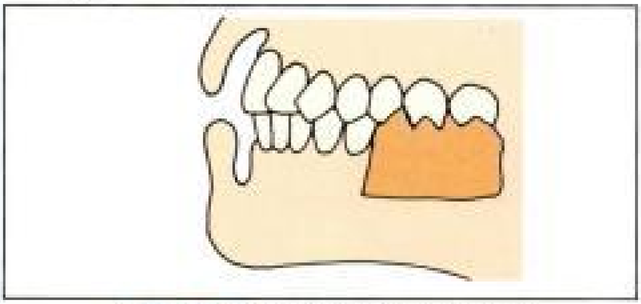

Fig. 21.43: Recording the jaw relation

- The base plate is removed from the mouth and re-seated on the master cast.
- The cast of the opposite arch is positioned to coincide with the recorded imprints (Fig. 21.44).

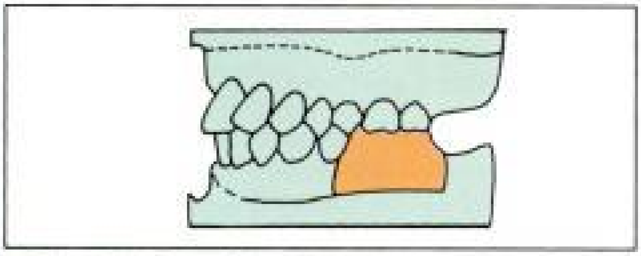

Fig. 21.44: Transferring the jaw relation record to the master cast

- This position is stabilized using sticky wax. *(Refer Chapter 9 for a detailed description about Jaw Relation)*

MOUNTING THE CASTS

The stabilized master cast assembly is mounted. The maxillary cast is mounted using face-bow transfer and the mandibular cast is mounted using the interocclusal record (centric relation) in relation to the maxillary cast.

(Refer Chapter 10 for complete details regarding Articulation)

DENTURE BASE SELECTION

Based on the material selected to fabricate the permanent denture base, the design and fabrication of the prosthesis will vary significantly. In this section we will discuss about the various materials available to fabricate a denture base, and the indication, advantages and disadvantages of each material.

Ideal Requirements for a Denture Base

An ideal denture base should fulfil the following properties:

- Provide support for artificial teeth.
- Contribute to the stability and retention of the prosthesis.
- Comfortable to the patient.
- Accurately extended into functionally developed borders.
- Intimate adaptation with the underlying mucosa.
- The base should neutralize twisting and tilting types of stress developed during function.
- Transmit forces to both the abutments and residual ridges
- Good physical, mechanical and biological properties like strength, rigidity, tarnish and corrosion resistance, biocompatibility, castability, etc.

Types of Denture Bases

Denture bases can be broadly classified as acrylic, metal and metal acrylic resin bases. Let us discuss about the indications, advantages and disadvantages of each.

Acrylic

Indications
- Distal extension cases where relining may be required frequently.
- Patient is allergic to metal.

Advantages
- Easy to repair
- Relining and rebasing are easy
- Less expensive.

Disadvantages
- Inadequate mechanical properties.
- Can only be used as a temporary replacement.

Metal

The most commonly used partial denture alloys are:
- Base metal alloy
- Ni-Cr
- Co - Cr
- Titanium (Pure Ti and Ti Alloy)

These alloys should have good castability, rigidity, tarnish and corrosion resistance and flexibility (clasp tips alone).

Indications
- All clinical situations where aesthetics permit. (Where aesthetic is not important).
- In patients with reduced inter maxillary space. (Where a thick base cannot be used).
- Deep bite cases. (For high strength).
- Patients with acrylic allergy.

Advantages
- Permits the sensation of heat and cold.
- Sense of taste and heat is well transmitted to the tissues giving a natural feel.
- More biocompatible.
- Good mechanical properties .

Disadvantages
- Proper extension cannot be achieved in buccal shelf area.
- Elaborate procedure
- Cannot be used in patients who are allergic to metal.

Metal-Acrylic Resin Base

Indication
- Where both aesthetics and strength are important.
- Indicated for most situations except in cases where relining may be necessary.

Advantages
- Lighter than all metal denture bases. Hence, better patient comfort.
- The base has the strength of the metal and the aesthetics of acrylic.

Disadvantages
- Cannot be relined.

TEETH SELECTION

The size, shape and mold of the artificial teeth are selected for the patient. The selection of teeth for a removable partial denture is similar to that of a complete denture. Hence, in this section we will discuss in brief about the available teeth, their indications, advantages and disadvantages.

Selection of Type of Teeth

Teeth selection can be broadly classified as:
- Anterior teeth selection
- Posterior teeth selection

After the jaw relation is completed, the casts are articulated, and the teeth are arranged in the occlusal rim fabricated on the framework.

Anterior Teeth Selection

Anterior teeth selection can be classified based on the selection of the type (material), shade and mould of the teeth.

Selection of the Type of Anterior Teeth

Acrylic denture teeth

Indications
- Most anterior spaces
- When the labial contour must be built with a flange (Excellent results).

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Porcelain Denture Teeth

Indications

- When the opposing teeth have porcelain or resin restoration.

Advantages

- Excellent aesthetics.
- Excellent wear resistance.
- Very high efficacy.

Disadvantages

- Brittle
- Weak in thin sections
- More difficult to process because it tends to break easily.
- May abrade the opposing natural teeth.

Acrylic Teeth with Gold Occlusals (Fig. 21.45)

Indications

- Where plastic is indicated but cannot be used due to poor wear resistance.

Advantages

- Excellent wear resistance
- Good chewing efficiency
- Fracture Resistance

Disadvantages

- Fabrication process is time consuming and expensive.
- Increase in the weight of the prosthesis.

Fig. 21.45: Acrylic teeth with gold occlusals

Cast Metal

Indications

- Small and restricted posterior edentulous space where aesthetics is not very important.

Advantages

- Easy to maintain.
- Good wear resistance.
- Good fracture resistance.

Disadvantages

- Very hard surface may produce discomfort during mastication.
- Heavy hence it may add to the weight of the prosthesis.

Pressed-on Acrylic

Indications

- Any posterior edentulous space.

Advantages

- Fits easily into small edentulous spaces.
- Adequate strength.

Disadvantages

- Aesthetics is inferior to porcelain and acrylic denture teeth.

Amalgam Occlusal Surfaces on Acrylic Teeth (Fig. 21.46)

Indications

- Same indication as acrylic teeth.

Advantages

- Improved wear resistance compared to acrylic teeth.
- Cheaper than gold occlusals.
- Simple technique; easy to fabricate.

Disadvantages

- Inferior wear resistance compared to gold.
- Cannot be used opposing metallic restorations.

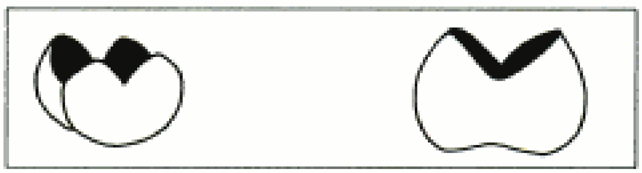


Fig. 21.46: Acrylic teeth with amalgam occlusals

ARRANGING THE ARTIFICIAL TEETH

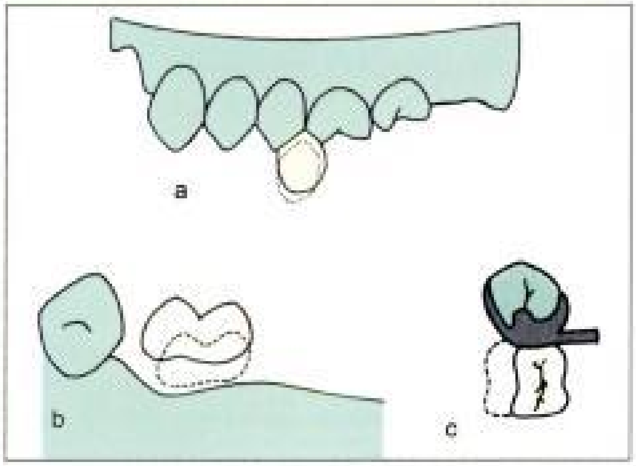
The framework with the occlusal rim is seated on the articulated master cast. The artificial teeth are arranged over the occlusal rim such that the occlusal relationship in the articulator is maintained. Articulating paper is used to check premature contacts on the occlusal surface.

Rules for Arranging Posterior Teeth

The universal setting principles described in Chapter 10 should be applied while setting the artificial teeth in a removable partial denture. The occlusal surfaces of the artificial teeth should be altered according to the opposing teeth to obtain occlusion. Apart from the setting principles there are certain considerations and rules for setting artificial teeth in a partial denture.

Factors that May Affect Positioning of Artificial Teeth in a Partial Denture

Positioning tooth adjacent to the clasp The artificial tooth should be adjusted and positioned according to three different structures namely, the clasp, residual ridge and the opposing teeth (Fig. 21.47).



Figs 21.47a to c: (a) Artificial tooth is arranged to occlusion (b) Next it is arranged in relation to the contour of the ridge (c) Finally it is arranged according to the adjacent direct retainer

The tooth is first adjusted to occlusion with the opposing teeth, next it is adjusted according to the ridge contour and finally it is adjusted to the framework before attaching it to the framework.

Positioning of maxillary bicuspids for maximum aesthetic effect A pleasing composition can be achieved if the buccal flange in the premolar region is removed and the teeth are kept butting directly against the mucosa. This gives a superior aesthetic appearance in comparison to a flange (Fig. 21.48).

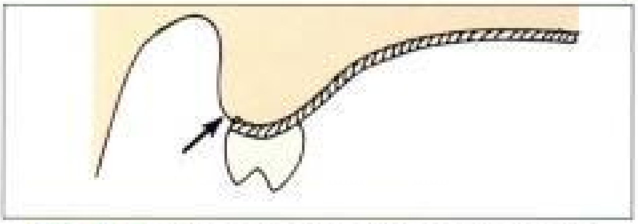


Fig. 21.48: Omitting the buccal flange for aesthetics

Intercuspating posterior teeth As a general rule an ideal occlusion should be strived for, but this however, may not be possible in all cases.

- Placing lower teeth buccal to the crest of the ridge would lead to the formation of undue stress within the prosthesis (Fig. 21.49).

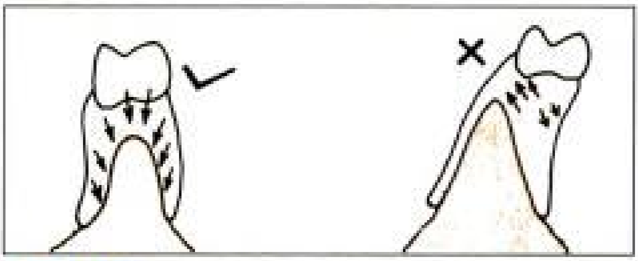


Fig. 21.49: Artificial teeth should be arranged along the long axis of the residual ridge

- The occlusal surface should have adequate grooves, ridges and spill/sluice ways to function efficiently.
- Flat broad occlusal surface of natural teeth should not be opposed to flat artificial teeth because this may lead to masticatory inefficiency (Fig. 21.50).
- The occlusal surface of the opposing teeth should be re-contoured to suit the opposing natural dentition. These re-contoured surfaces should be finished and polished before denture insertion.
- Maximum intercuspation may be achieved in the articulator but fine adjustments have to be done intraorally.
- Abrasion of the stone cast in the articulator can lead to discrepancies in the occlusion.

Trial Denture Try-in

Try-in procedure includes the verification of the fit of the trial denture. The try-in procedure is

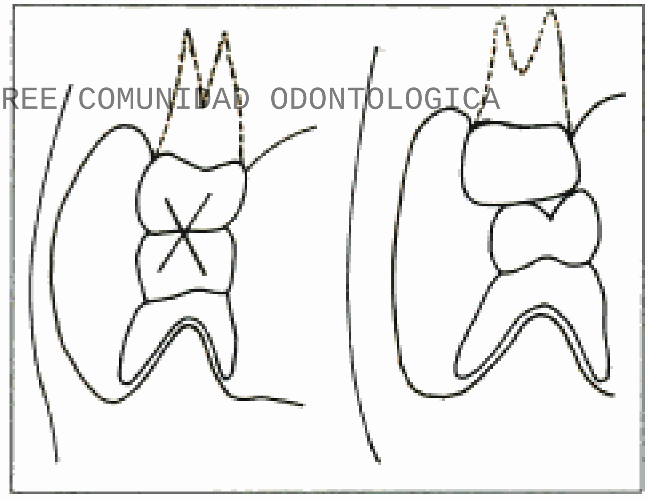


Fig. 21.50: Attrited natural teeth should be opposed with artificial teeth of good occlusal morphology to improve chewing efficacy

similar to the one explained for complete dentures in Chapter11. Hence, we have discussed only the salient features in the try-in of removable partial dentures.

Removable partial denture try-in can be broadly divided into anterior and posterior try-in.

Try-in of Anterior Teeth

The artificial anterior teeth should be arranged according to the setting principles and tried-on the patients mouth before processing. The shade, position, mould size and patient acceptability etc should be checked during try-in.

Some times a particular set of artificial teeth may look very suitable for the patient but after arranging they may look very displeasing during try-in. In such cases, the teeth are changed and try-in procedures are repeated.

Try-in of Posterior Teeth

Posterior try-in includes occlusal verification. Aesthetic try-in of posterior teeth is not as important as for anterior teeth. The denture should be inserted and the intercuspation of posterior teeth is visually examined. Lingual occlusion cannot be visualized. Visually identifiable discrepancies in occlusion should be corrected.

Thin strips of articulating paper is used to check the occlusion. The articulating paper is placed on the occlusal surface of the artificial teeth. The patient is requested to gently duplicate chewing/masticatory movements. The articulating paper is removed and the occlusal surfaces are examined for premature contacts. The occlusal surface of the artificial teeth are re-contoured until all the premature contacts are eliminated. After completing the occlusal adjustments, the trial denture is forwarded to the laboratory for processing. Final occlusal correction is made during insertion.

PROCESSING

After try-in, the waxed denture is flasked, dewaxed, packed and processed similar to a complete denture. Remember, the framework is a permanent structure. Only the denture base area covering the saddle is processed.

INSERTION

Objectives of Insertion Appointment

- To insert the prosthesis and make it as comfortable as possible.
- To teach the patient how to use the prosthesis.
- Instruct the patient how to maintain the prosthesis and oral cavity.

AppointmentTime

- Should be made early in the day so that the patient has enough time to call in the day or return to the office.
- The day should never be the end of the week, as the patient should be examined after 24-hour use.
- Patient should be instructed not to have social appointments immediately after insertion.

Before Insertion

- The tissue surface or *intaglio* surface of the prosthesis should be checked critically for blebs, bubbles, blisters or artifacts either in metal or acrylic.

- Borders should be checked to detect sharp edges.

During Insertion the Following Procedures are Completed

- Checking the framework
- Check for retention by seating the prosthesis.
- Providing good occlusion for the denture
- Check for flange extension.
- Adequate relief for frenae.

Checking the Framework

The fit and function of the framework should be checked. All the procedures described in framework try-in are repeated.

Insertion of the Prosthesis

- The prosthesis should never be forced into position directly during the first attempt.
- The prosthesis should be propriocepted (felt) for any resistance to insertion due to the presence of undercuts.
- The prosthesis should be relieved in the undercut areas. The pressure points, which require relief, are detected with the help of pressure indicating paste (PIP).

Pressure indicating pastes Commercially available PIPs usually contain equal parts of vegetable additives with zinc oxide or a mixture of calcium carbonate and chloroform ($CaCO_3$ + $CHCl_3$). A thin mix of ZOE cement can also be used for the same.

The two paste system is made into a homogeneous mix and a thin layer is applied over the occlusal and denture bearing area. As the patient may not apply uniform pressure over the prosthesis, the dentist should apply horizontal and vertical forces using his/her fingers.

Pressure areas commonly seen in the maxillary arch include the palate and the lateral sides of the tuberosity. This is because the acrylic resin typically contracts across the palate. Pressure areas in the labial flange region occur when the height of the labial flange is not properly recorded (Fig. 21.51).

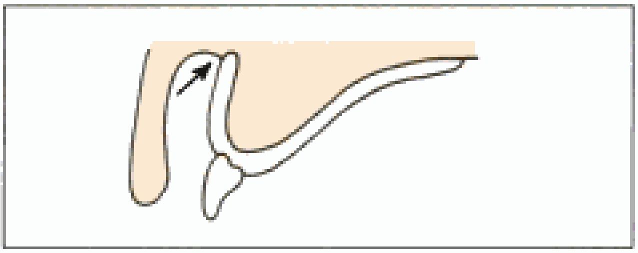


Fig. 21.51: Overextended labial flanges produce pressure points

Pressure areas commonly seen in the mandibular arch include the mylohyoid ridge area, area buccal to the bicuspids, border extension of the denture in the retromylohyoid space and distolingual border of the denture in the vicinity of the ascending ramus (Fig. 21.52).

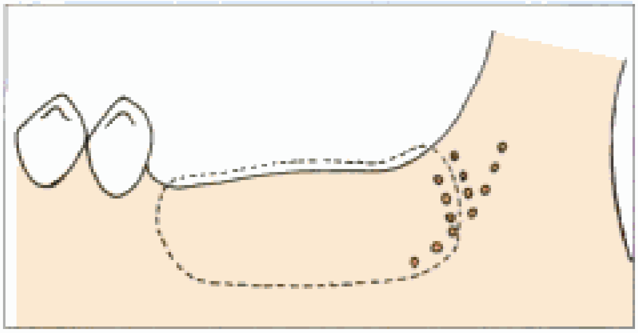


Fig. 21.52: Distolingual portion of mandibular ramus is a common zone of pressure concentration

Providing Good Occlusion

This is one of the most important procedures carried out during insertion. Faulty occlusion can produce severe tissue reaction like excessive ridge resorption, damage to the temporomandibular joint, etc. One should have a clear idea about the source of occlusal interference before treating such conditions.

Sources for occlusal interference include:

- Denture extension
- Contact between the natural and artificial teeth (occlusion)

Denture extension The heel or the posterior extension of the mandibular partial denture should be examined for interference with maxillary posterior teeth or the tuberosity. In such cases, the acrylic resin of the maxillary denture base should be reduced first without thinning or weakening the structure (Fig. 21.53). If the interference still exists, the mandibular flange should be adjusted and shortened till there is no interference during excursive movements.

Equilibration of occlusion Adjustment of occlusion can be done in two ways:

- Laboratory remount after processing: After processing, the partial denture is remounted in the articulator and adjusted. This method is best suited to adjust tissue-borne partial dentures.
- Intraoral adjustment: This is done by using articulating paper and simulating mandibular movements intraorally.

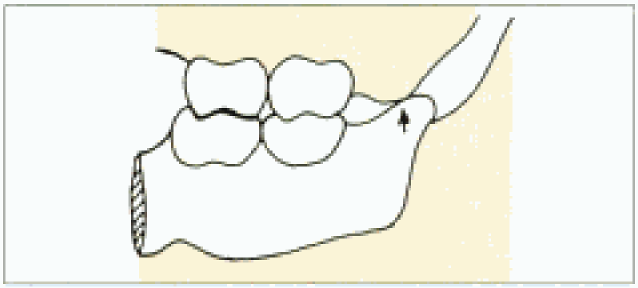


Fig. 21.53a: Distal heel of a mandibular denture base interfering with the maxillary tuberosity

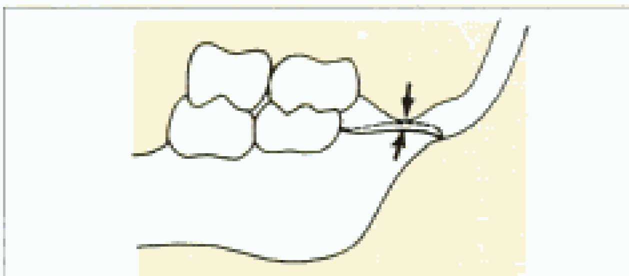


Fig. 21.53b: The distal heel can be reduced in thickness to avoid interference

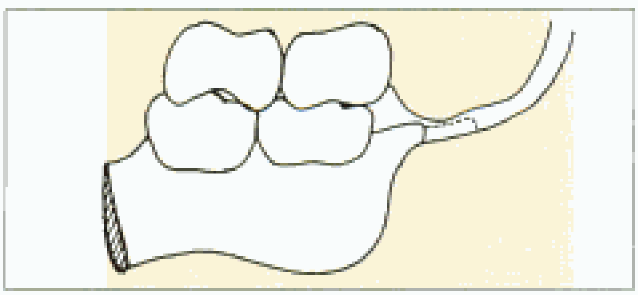


Fig. 21.53c: The distal heel can be shortened to avoid interference

Criteria to be followed before adjusting occlusion

- It is best to consider one arch as an intact arch so that the other one can be adjusted according to the intact arch.
- If one partial denture is tooth supported and the other tissue supported, the tooth-supported arch is first adjusted and is considered as the intact arch for adjustment of the tissue supported denture.
- If both partial dentures are entirely tooth borne, the one occluding with the most natural teeth is adjusted first, and considered as the intact arch.
- If both dentures are tissue supported, the final adjustment of occlusion on opposing tissue-supported base is usually done on the mandibular denture, since this is the moving member. Hence, even if the mandibular denture opposes more natural teeth and is considered as the intact arch, the final occlusal adjustments are made only on it.

Procedure

Laboratory remount procedure following processing

- The maxillary cast and mandibular casts are recovered from the investing medium. The casts should be deflasked gently without damaging the natural teeth.
- The restoration and the recovered casts are mounted in the articulator in their original relationship. (The original relationship of the casts in the articulator can be reproduced with the help of remounting plates or indices created on the cast).
- The mandibular cast is oriented against the maxillary cast with the help of an interocclusal check record.
- The interferences (between the opposing natural/artificial teeth) are detected by simulating condylar movements in the semi adjustable articulator. Articulating paper can be used to locate these contacts.
- Occlusal discrepancies are corrected on the denture by selective grinding until the movements become smooth and uninterrupted.

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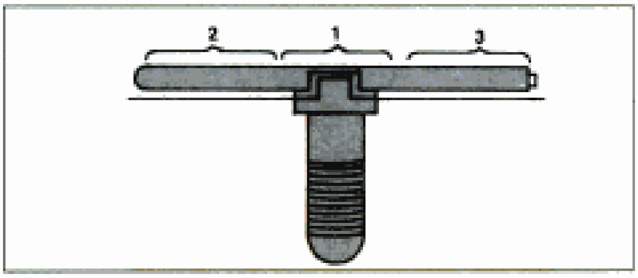
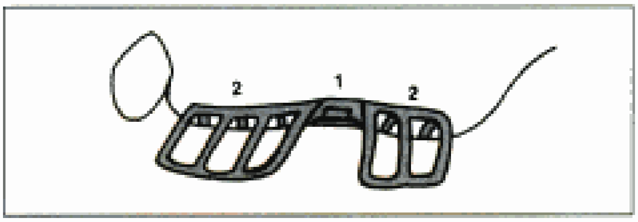
The edentulous ridge should be atleast 5mm in width and 8 mm in height to receive an implant. Radiological evaluation is one of the prime criteria to determine the placement of an implant.

The implant is placed into the ridge by a surgical procedure. It is left undisturbed for 4 months. The implant is uncovered and the prosthesis is constructed over the implant.

Usually, a bar super-structure is placed over the implant with a coping screw. The bar superstructure has two parts namely, a retention bar over the implant and a cantilever bar extending across the ridges from each implant (Fig. 22.4). If two implants are placed, then the bar superstructure will have three parts namely, a retention bar over the implant, a bridge bar extending from one implant to another and a cantilever implant extending from the distal implant to the free end of the denture (Fig. 22.5).





Figs 22.4a and b: An implant supported prosthesis will have an implant attachment with a retentive part (1) that fits onto the implant and a (cantilever) (2) part that supports the prosthesis

The tissue surface of the denture is fabricated with *Hader clips* (Refer internal attachment). Sometimes, retention is obtained by small ball like extensions projecting from the implant that fits into the rubber rings in the denture.

For treatment success, a team comprising of a surgeon, prosthodontist and a periodontist should coordinate. Evaluation of patient's general health, oral hygiene status, mental attitude towards treatment and case selection is critical because they efficiently determine the outcome of the treatment.

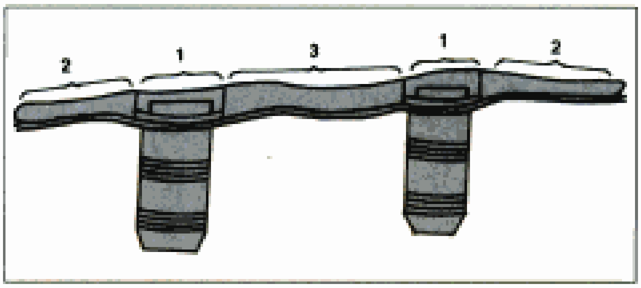


Fig. 22.5: A prosthesis supported with more than one implant will have an attachment with a retentive part (1) cantilever parts on the terminal ends (2) and an intermediate bridge part that connects the two retentive parts (3)

REMOVABLE PARTIAL OVERDENTURE

Overdenture abutments decrease the denture's need for tissue support. Since the teeth to be extracted are retained as overdenture abutments, the length of the edentulous span is also decreased (Fig. 22.6). Effectively, the residual ridge can be preserved and patient's comfort can be increased.

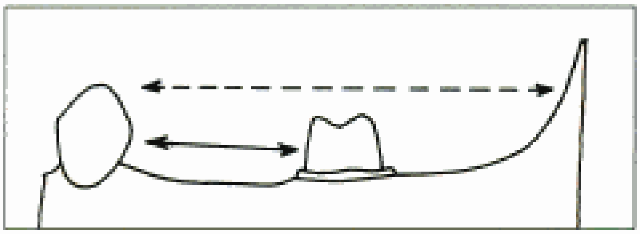


Fig. 22.6: Grossly decayed teeth should be retained as overdenture abutments to reduce the length of the edentulous span

Advantages

The advantages of retaining a weak tooth or root stump as an overdenture abutment are:

- Increased support for the denture.
- Increased resistance to occlusal forces.
- Overdenture abutments reduce the need for tissue support.
- They reduce the length of the edentulous span and thereby decrease the forces acting on the denture.

- The movements of the denture are minimized thereby reducing stresses on the abutment teeth and the residual ridge.

- It is not necessary to fabricate overdentures with long flanges for support because the overdenture abutment provides the necessary support. Generally, the labial flange is not fabricated for anterior overdentures where there is nil or minimal ridge resorption (Fig. 22.7).

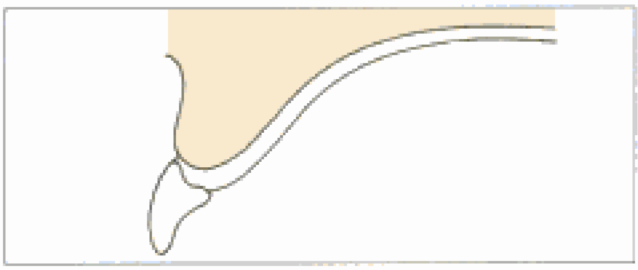


Fig. 22.7: Labial flanges for overdentures can be omitted for aesthetics

Indications

- Retaining the posterior most abutment will help to prevent the tissueward movement of the denture.
- When an additional support for a distal extension denture base is required to reduce the leverage forces acting on the abutment teeth mesial to the edentulous space (Fig. 22.8).

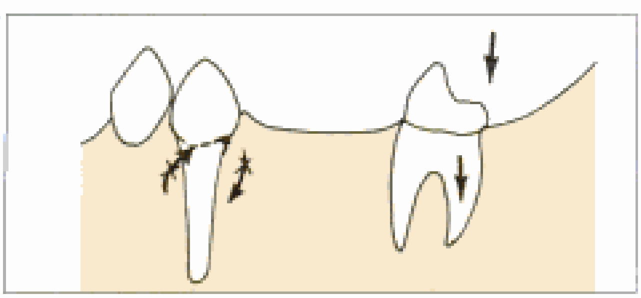


Fig. 22.8: Overdenture abutments retained in distal extension cases prevent the action of torquing forces on the terminal healthy abutment

- Anterior teeth should be retained to avoid the tissueward movement of the prosthesis, which in turn decreases residual ridge resorption.
- To provide additional support to weak abutments.
- Used for supporting a removable partial denture in cases with few remaining teeth.
- Used for supporting an interim prosthesis.

Criteria for Selecting Overdenture AbutmentTeeth

Careful case selection and clinical evaluation should be done before planning a removable partial overdenture. The criteria for selecting overdenture abutment teeth are:

Positional Considerations

Position of the remaining teeth and the length of the edentulous span should be considered. Presence of soft tissue undercuts is not very critical because it is not necessary to extend the denture base into the vestibular sulcus for support.

Periodontal Considerations

The abutment tooth should be free from periodontal pockets, have atleast 2mm of attached gingiva and good oral hygiene. The periodontium (periodontal ligament, cementum and alveolar bone and gingiva) should be healthy (Fig. 22.9).

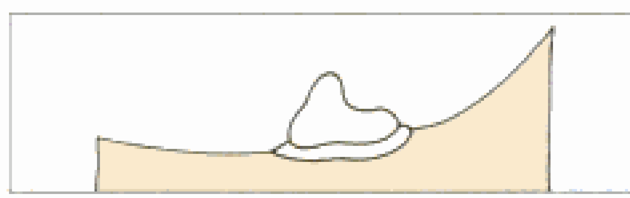


Fig. 22.9: Overdenture abutments should have a sufficiently thick attached gingiva

Endodontic Considerations

Most of the overdenture abutments should be endodontically treated so that the clinical crown can be reduced to 2 or 3 millimetres in height. Teeth with calcified pulp canals do not need endodontic treatment.

Caries Considerations

Root caries should be eliminated (For cases with extensive caries, endodontic treatment is done. If the tooth is susceptible to fracture, the abutment is covered with a coping (*"Thin metal covering"*-GPT).

Oral Hygiene Considerations

For treatment success, the patient should maintain adequate oral hygiene so that the overdenture abutment remains plaque-free. This eliminates the risk of developing root caries or periodontal disease.

Design of the Prosthesis

The component parts of the partial denture are chosen and selected as described in Chapter18. Special design considerations for an overdenture include:

Selection of Tooth Replacement

The tooth that is to be placed over the overdenture abutment should be selected according to the coping design of the abutment. Usually acrylic resin teeth are used for such cases because they can be easily modified to suit (avoid interference) the abutment coping. They have higher fracture resistance than porcelain. Acrylic tube teeth can also be modified and used.

Denture Base Design

The part of the denture base that is to seat on the overdenture abutment should be designed such that the denture is easy to remove and replace. The denture base should not damage the abutment and the retention of the denture base over the coping should not be decreased.

The denture-overdenture abutment junction can be one of the following types:

- Stud attachments like Rotherman, Dalla Bona, Gerber, GPC, Octolink and other attachments are used for retention. These overdenture abutments are used to provide vertical support (Fig. 22.10).
- The denture may have a metal-to-tooth or metal-to-metal coping contact. These designs can be incorporated in a metal or acrylic denture base. The fit of the prosthesis may not be complete in these cases (Fig. 22.11).
- Resin-to-tooth contact by the denture base is the best form. The acrylic resin is fabricated over the abutment tooth leading to a closer fit (Fig. 22.12).

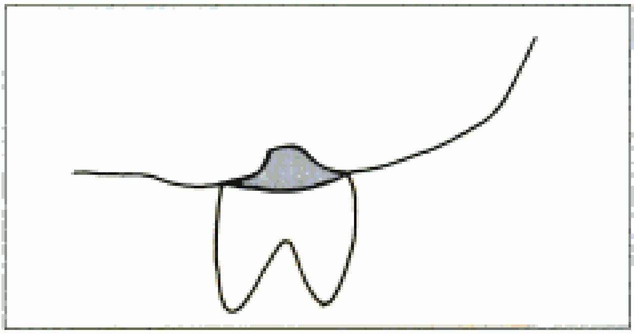
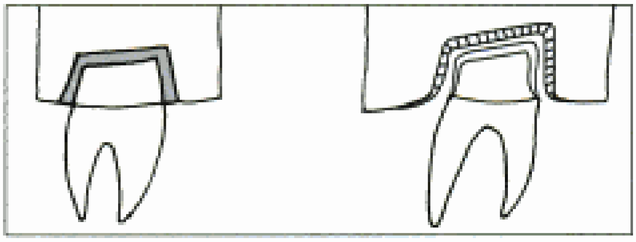


Fig. 22.10: Special attachments can be used to provide additional retention for overdentures (Refer internal attachments in Chapter 11)



Figs 22.11a and b: (a) Metal to tooth contact (b) Metal to metal coping contact

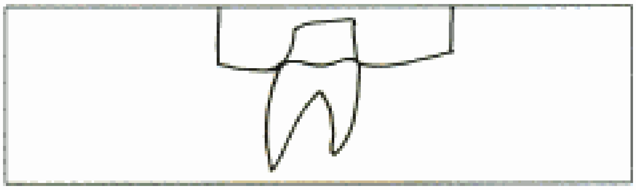


Fig. 22.12: Resin to tooth contact

Preparation of the Abutment Teeth

- The abutment teeth are prepared as for a full veneer crown but the height of the abutment is considerably reduced such that the occlusal surface of the prepared tooth is only 2-3mm above the crest of the ridge (Fig. 22.13).

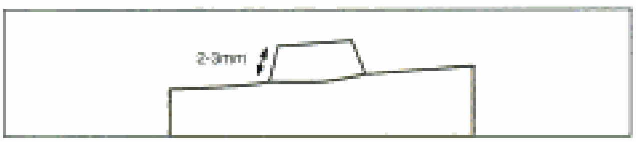


Fig. 22.13: Overdenture abutments can be reduced similar to a full veneer crown preparation (long copings) or to just 2-3 mm occlusogingival height (short copings)

- The taper of the preparation on the labial surface should be 25°-35° and that of the proximal and lingual margins should be 10°-15° (Fig . 22.14a).

- The occlusal surface should be rounded to remove unsupported tooth structure (Fig. 22.14b).

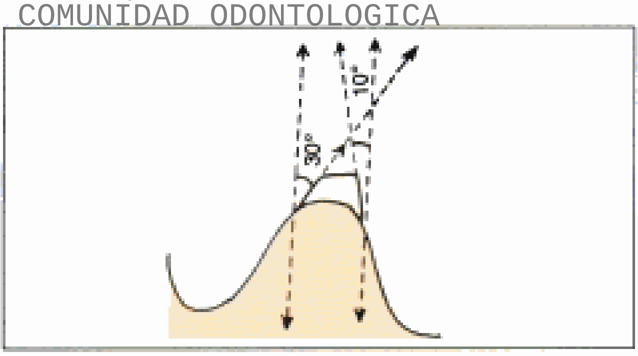


Fig. 22.14a: The buccal surface of overdenture abutments should have a taper of 35° whereas the lingual surface should have a taper of 10-15°

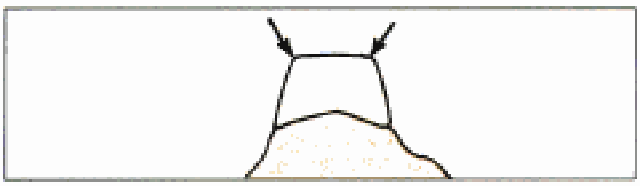


Fig. 22.14b: Unsupported enamel should be removed and the line angles should be rounded

Insertion

- The prosthesis is seated on the overdenture abutment at the time of insertion.
- A bur is used to relieve the contact between the denture base and the overdenture abutment (Fig. 22.15).

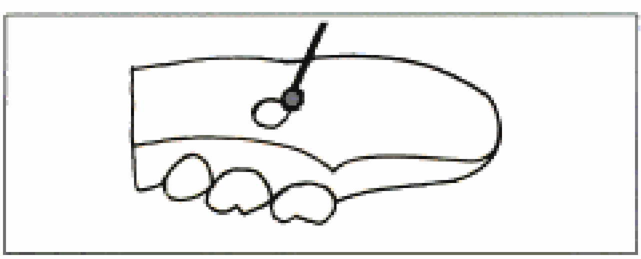


Fig. 22.15: Relief created on the denture prior to insertion

- The prosthesis is inserted and occlusion is verified.
- A butt joint finish line is prepared on the tissue surface of the denture base (Fig. 22.16).
- An escape hole is prepared on the area of the denture base above the abutment (Fig. 22.17).

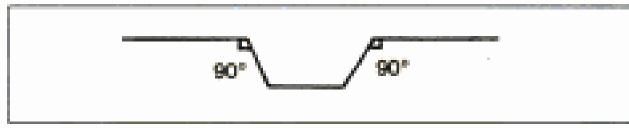


Fig. 22.16: Butt joints or 90° angle formed at the denture margins adjacent to the overdenture abutment

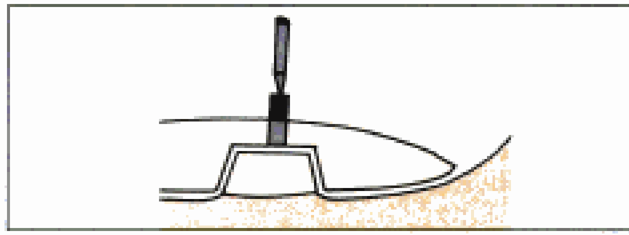


Fig. 22.17: Escape hole made on the denture to allow escapment of excess acrylic

- Self-cured acrylic resin is placed over the abutment tooth and the denture base is seated.
- Pressure is applied by finger pressure or biting on a cotton roll, until the resin sets.
- Excess acrylic is trimmed and the denture is finished and polished.

Post-insertion Care

Oral hygiene should be maintained. Fluoride application can be done over the prepared teeth to prevent caries. Frequent recall visits are conducted to verify the outcome.

The prognosis depends on the design, accuracy of fit of the denture and occlusal harmony and last but not the least the maintenance by the patient.

GUIDE PLANE REMOVABLE PARTIAL DENTURE

These are removable partial dentures, which have multiple proximal plates, which slide on the guide planes and clasps with rests, all added to provide additional stability to periodontally weakened teeth (Fig. 22.18a).

Indications

It is used for stabilizing weakened teeth in vertical, mesiodistal and buccolingual directions (fixed splints can only provide buccolingual stabilization). This denture provides cross arch stabilization because of its rigid major connector,

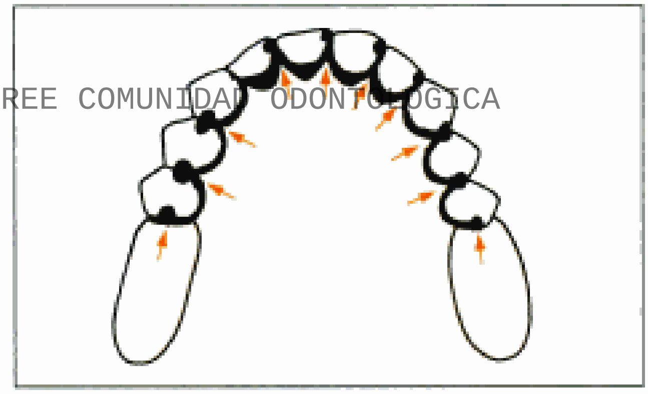


Fig. 22.18a: A distal extension edentulous condition to be restored using a guide plane RPD. Notice the multiple rests and guide planes (highlight areas)

which extends to the opposite side of the edentulous space.

Design

The factors to be considered for evaluating the periodontal status of the weak teeth are:

- Protection of the teeth from continuous or intermittent movement.
- Protection of the gingiva and the interproximal tissues from food impaction.
- Prevention of unnecessary occlusal forces.

Usually a broad stress distribution concept is used. A rigid major and minor connector with multiple rests and clasps are used. Most clasps are not retentive, i.e. when multiple buccal clasps are used only two clasps on each side have retentive function and the remaining clasps are designed *only* to provide stability.

The stabilizing clasps are designed such that the retentive tip of the clasp contacts the tooth at or above the height of contour so that the retentive tip will not produce any tooth movement during insertion or removal of the denture (Fig. 22.18b).

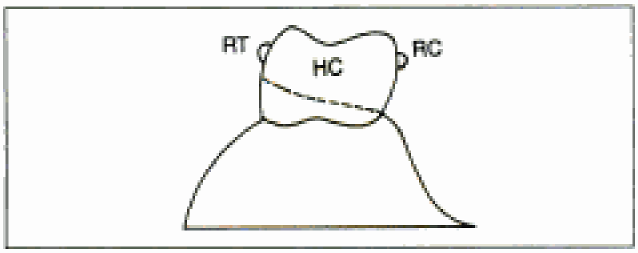


Fig. 22.18b: All stabilizing clasps will have both their arms above the height of contour. Key: HC = Height of contour, RC = Reciprocal arm, RT = Retentive terminal

The framework is completely passive in the oral cavity. Multiple parallel guide planes are placed. When there is generalized bone loss the tooth/teeth should be supported on both the buccal and lingual sides.

Disadvantages

Because multiple clasps, proximal plates of minor connectors are used, the denture is not so aesthetic. It cannot be used in cases with esthetic requirement (Kennedy's class IV).

Alternative Treatment

Total extraction and placement of a complete denture.

Role of Lingual Plate in a Guide Plane RPD

Usually the muscular action of the lips during speech and mastication, stabilize the weak anterior teeth on the labial/buccal side. In cases with anterior tongue thrust or severe bone loss, the lingual plate is used for stabilization.

Mesial and distal incisal rest seats are prepared on the remaining anterior teeth. These are engaged by metallic extensions (minor connectors) from the lingual plate (Fig. 22.19). The lingual plate should fill the interproximal spaces between the weakened teeth to avoid food impaction. The plate should have an accurate, thin, knife-edged fit on the lingual aspect of the teeth. Thus the lingual plate has three functions namely:

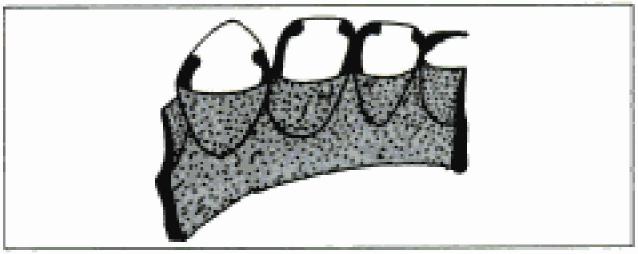


Fig. 22.19: Lingual plate supporting multiple auxiliary rests in a guide plane RPD

- It acts as a major connector for the prosthesis.
- Provides cross arch stabilization.
- Provides lingual support for the remaining teeth.

Before insertion, the fit of the framework should be verified for pressure spots. A properly constructed guide plane removable partial denture has excellent prognosis.

I-BAR REMOVABLE PARTIAL DENTURES

I-bar RPD is a special type of removable partial denture designed by *Kratochvil* to reduce tooth contact of the retainer. They differ from regular RPD's in the following manner (Fig. 22.20):

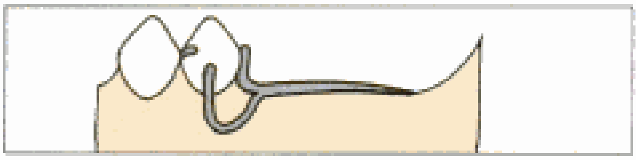


Fig. 22.20: I-bar RPD

- A mesial rest instead of the usual distal rest in the primary retainer (for a distal extension denture base). In other words, the rest is on the proximal side away from the edentulous space (Fig. 22.21).

Fig. 22.21: Mesial rest

- I-bar retainer is used instead of a occlusally approaching retainer for direct retention (Fig. 22.22).

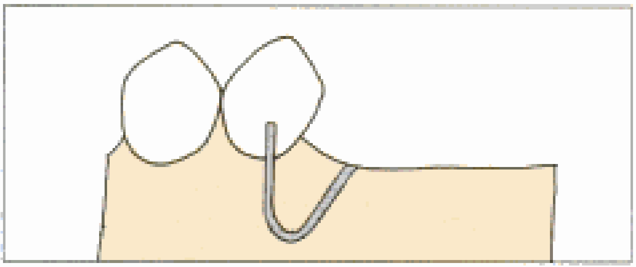


Fig. 22.22: I-bar retainer

- Long guide planes are prepared on the abutment and they extend onto the tooth tissue junction (Fig. 22.23).

Design Concepts

Design concepts are explained for an I-bar denture constructed over a distal extension denture base. Now let us look at the design of the various parts of the denture.

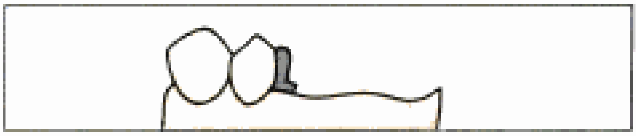


Fig. 22.23: Long proximal plate

Mesial Rest

The mesiocclusal rest is connected to the major connector by a minor connector placed on the mesiolingual embrasure. This minor connector does not contact the adjacent tooth. A mesial rest seat is preferred in this design for the following reasons:

- The occlusal force is directed vertically thus eliminating harmful effects due to horizontal forces (Fig. 22.24a and b).

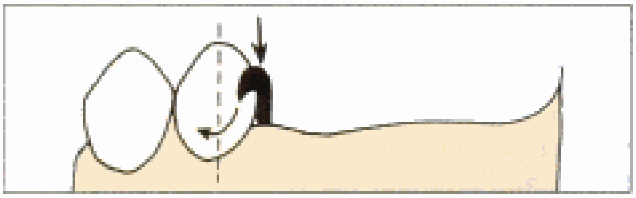


Fig. 22.24a: A distal rest on a terminal abutment of a distal extension edentulous space will produce distal tipping force on the abutment

Fig. 22.24b: A mesial rest on a terminal abutment of a distal extension edentulous space will not produce mesial tipping of the abutment because it is reciprocated by the adjacent teeth

- This rest tends to produce mesial tipping of the abutment tooth, which is prevented due to the presence of adjacent tooth contact (Fig. 22.25).
- It shifts the fulcrum line more anteriorly from the edentulous ridge. Hence, the damage to the oral tissues is decreased (Fig. 22.26).

Proximal Plates

The minor connector, which supports the mesial rest, will have a proximal plate. An additional proximal plate is fabricated to fit the distal surface

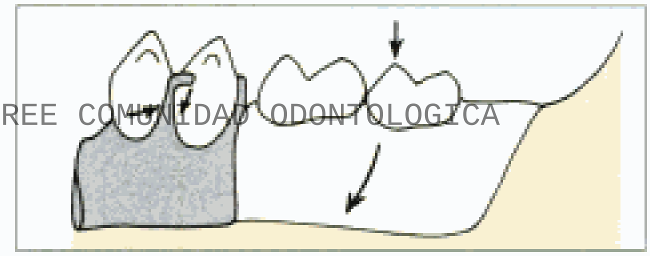


Fig. 22.25: Reciprocation of mesial tipping of the terminal abutment by the adjacent teeth

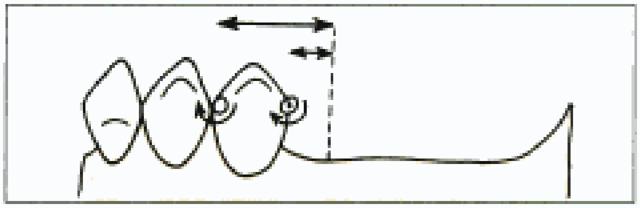


Fig. 22.26: A mesial rest of a terminal abutment of a distal extension edentulous space helps to transfer the fulcrum line (axis of rotation) more anteriorly (away from the denture base)

of the abutment. This proximal plate is special and it differs from ordinary proximal plates in many ways.

Usually the proximal plate is fabricated to measure about 2-5 mm occlusogingivally. In an I-bar RPD, the proximal plate is very long as it extends from the marginal ridge of the abutment tooth to about 2 mm across the tooth tissue junction. This proximal plate continues over the attached gingiva for 2 mm (Steward *et al*) (Fig. 22.27). The buccolingual width of the proximal plate is determined by the proximal contour of the tooth adjacent to the edentulous space. It is thinnest at the buccal aspect and thickest at the lingual end. This design allows proper placement of denture teeth.

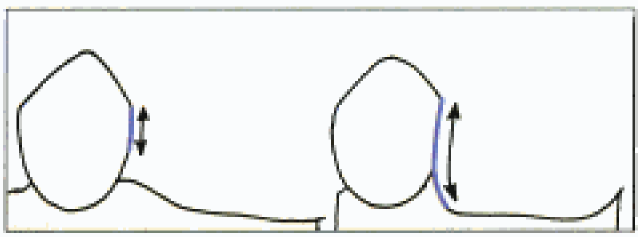


Fig. 22.27a and b: (a) Extension of proximal plate in a conventional RPD (b) Extension of a proximal plate in a I-bar RPD

Advantages of using a long guide plane/proximal plate

- Increased horizontal stability as guide planes at opposing sides of an arch provide cross arch stabilization.
- Better retention as the guiding planes (which are parallel to the path of insertion) provide a single path of dislodgment.
- It provides good reciprocation. (explained under I-bar retainer).
- Protects the soft tissues in the tooth-tissue junction from injury.
- Distributes the occlusal load uniformly across the arch.

Direct Retention (I-bar)

Retention is obtained by the means of an I-bar retainer (it is a modified bar or Roach clasp) (Fig. 22.28). The arm of the I-bar is long and tapering with a half round cross-section. Retentive I-bars are placed on the buccal surface of the abutment, mesial to the mesiodistal height of contour (Fig. 22.29). The I-bar retainer should extend about 2 mm above the tooth tissue junction.

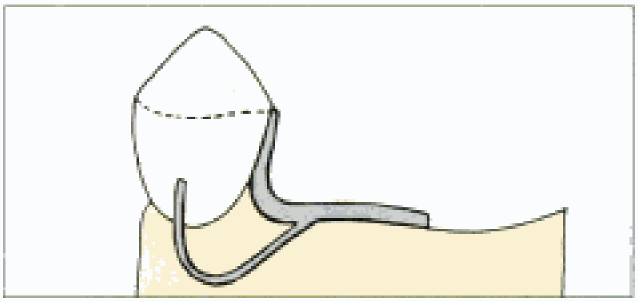


Fig. 22.28: I-bar retainer

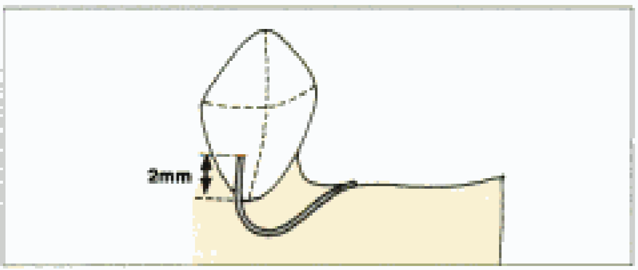


Fig. 22.29: The I-bar retainer should extend 2 mm above the gingival margin to engage an undercut mesial to the mesiodistal height of contour

The position of the I-bar in relation to height of contour is important to this design. When occlusal loading takes place on the denture base, the flexible tip of the I-bar engages the undercut mesial to the mesiodistal height of contour. As the I-bar is flexible it engages the undercut passively without producing any deleterious forces on the abutment tooth. All the forces produced by the I-bar push the abutment distally. The proximal plate placed on the distal surface of the abutment reciprocates the distal tipping force produced by the I-bar retainer (Fig. 22.30).

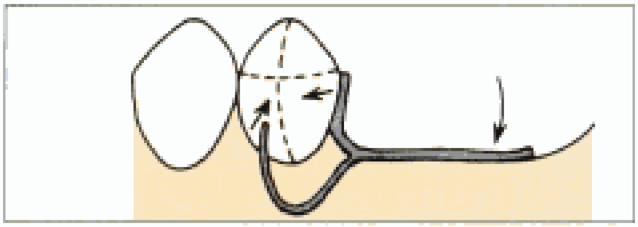


Fig. 22.30: The action of the I-bar retainer is reciprocated by the proximal plate. Retention/Reciprocation occurs mesiodistally in contrast to Aker's clasps where it occurs buccolingually

Advantages

- As maximum tooth surface is left uncovered, food accumulation is decreased.
- Minimal tooth coverage. Hence, it is more aesthetic and preferred for anterior abutments.
- I-bar has a passive relationship to the abutment tooth.
- Can be used to even engage a 0.01 inch undercut.

Disadvantages

- Reduced retention due to a flexible tip.
- It provides less horizontal stability than its counterparts (rest and proximal plate).

Major Connector

For a maxillary partial denture, an anteroposterior palatal strap is preferred and for a mandibular partial denture, a lingual bar is preferred.

Maxillary major connectors are placed 5 to 6 mm away from gingival margin and the mandibular major connectors are placed 3 to 4 mm away from the gingival margin or on the unattached mucosa.

Modifications are made according to the anatomical requirements. Maxillary major connectors are not relieved, as close adaptation prevents mucosal hypertrophy and food impaction.

Minor Connectors

You must have noticed that in an I-bar retainer the body of the direct retainer is eliminated and the components of the clasp like rest, retentive tip and proximal plate etc are separated from one another. All these components are connected separately to the major connector with the help of minor connectors (Fig. 22.31). Hence, the minor connector becomes more vital in providing direct and indirect retention and encirclement for the clasp. Minor connectors are designed such that they cross the tooth tissue junction at right angles to avoid food impaction.

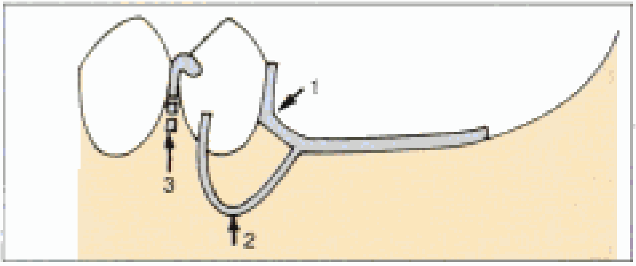


Fig. 22.31a: Buccal view of the minor connector (MC) connecting the rests and retainer:
Key: 1—Proximal plate MC, 2—I-bar MC, 3—Mesial rest MC (lingual side)

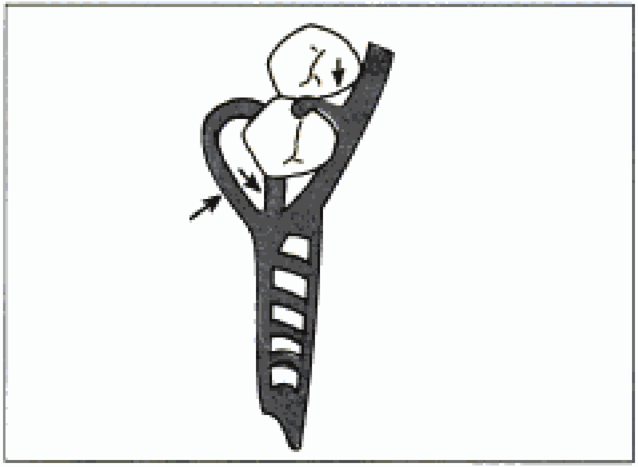


Fig. 22.31b: Minor connector connecting the rests and retainer: Occlusal view

Denture Base Connectors

Denture base connectors should be thin and strong to accommodate artificial teeth. 1mm relief is given for acrylic to flow under the meshwork. The retentive meshwork extends only over the crest and the lingual side of the ridge in order to avoid interference with tooth placement on the facial side (Fig. 22.32).

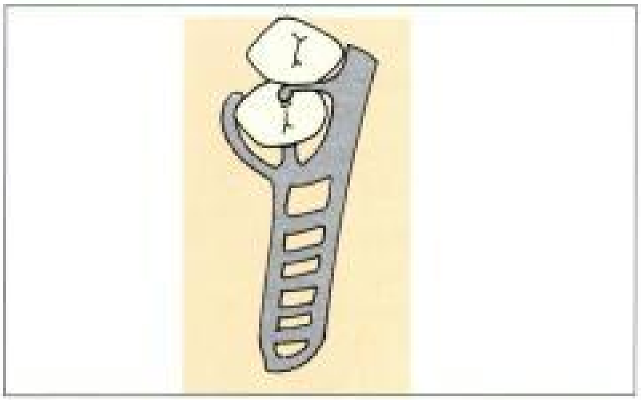


Fig. 22.32: Denture base of I-bar RPD's extending only over one half of the ridge

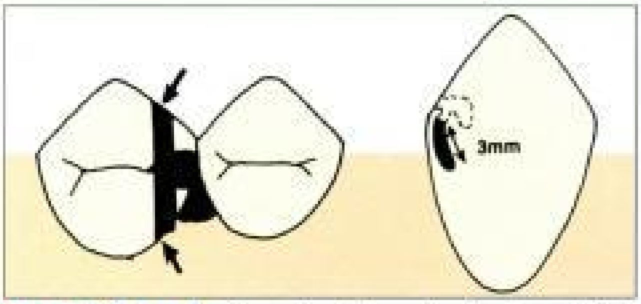
The tooth tissue junction is covered by metal for strength. The acrylic over the metal ends as a butt joint 2 mm away from the abutment tooth (Fig. 22.33). A dual impression procedure can be followed to record the impression for such cases.

Indirect Retention

This is obtained from the rests placed on secondary abutments, which are located away from the axis of denture rotation and the edentulous ridge. They help to stabilize the major connector.

Design Variations

- In case of a tilted abutment with excessive undercuts, enameloplasty or a cast restoration can be done.
- In cases with excessive mesiodistal tipping, where enameloplasty cannot be done a cast restoration is given to get parallel opposing guide planes.
- Buccally tipped abutments (the I-bar cannot adapt to the tooth on the buccal side) without a lingual undercut, enameloplasty is not possible. Hence, the rest seat is modified and made extensive to extend on to the buccal and lingual surfaces of the teeth. This helps to increase the retention. The facial and lingual extensions of the rest seat should be 3 mm long occlusogingivally (Fig. 22.34).



Figs 22.34a and b: Buccal and lingual extensions of the rest added for retention (b) The axial extension of the rest should be 3 mm long occlusogingivally

- RPA clasps (discussed later) are used for tipped abutments where an I-bar can produce tissue impingement.
- If a buccal undercut is absent and a lingual undercut is present, the buccal undercut is prepared by enameloplasty (dimpling).

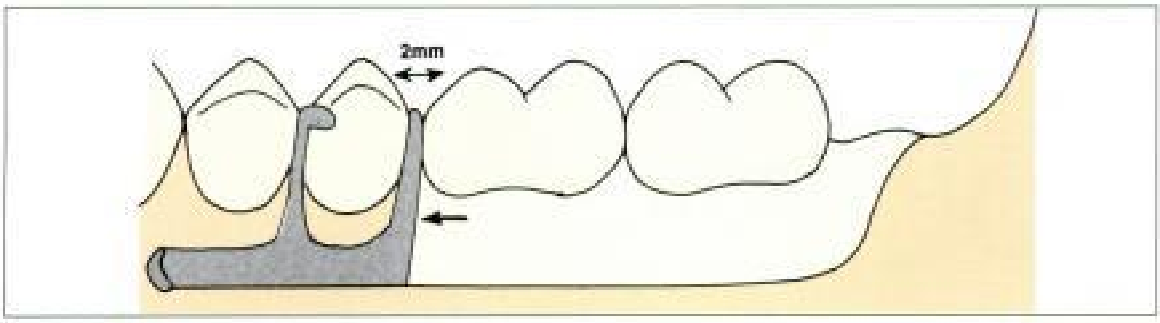


Fig. 22.33: Metal acrylic butt juction

- In cases with high frenal or muscle attachments surgical corrections like frenectomy should be done.

- In cases with inadequate attached gingiva, tissue undercuts etc, a graft procedure is done.

RPI (Rest, Proximal Plate and I-bar)

RPI is a modified I-bar retainer system. Krol devised it in 1973. All the components of the I-bar assembly were modified significantly to fulfill Krol's design. The principle of Krol's design was *"stress control with minimal tooth and gingival coverage"*.

The speciality of these dentures is that the direct retainer is modified such that the retentive and reciprocal units of the clasp act in the mesiodistal direction (in a conventional design the retentive and reciprocal units act buccolingually). The advantage of adopting this design is the minimal tooth contact/coverage produced by it. Hence, these dentures are more easy to maintain. Now we shall discuss about the modification of each component of the I-bar retainer required to form a RPI system.

Mesial Rest Modification

The mesial rest extends only into the triangular fossa even in molar preparations (Fig. 22.35). The canine rests are circular, concave depressions prepared on the mesial marginal ridge. It does not cover the entire marginal ridge (Fig. 22.36).

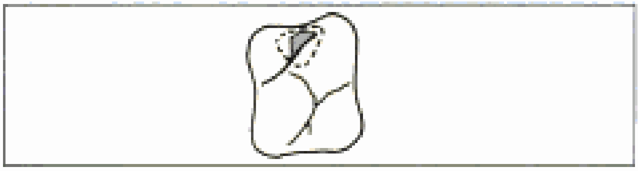


Fig. 22.35: Conservative rest seat preparation limited to the triangular fossa

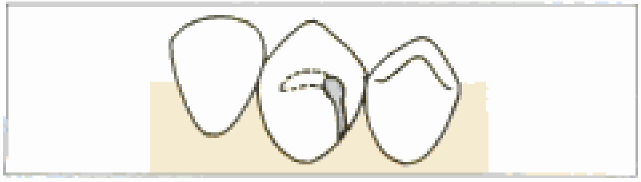


Fig. 22.36: Conservative circular lingual rest used instead of the usual cingular canine rests

Proximal Plate Modification

One of the major disadvantages of the I-bar denture was the excessive tooth contact produced by the extra long proximal plate. Krol introduces three modifications to the proximal plate. Any one of these modifications may be followed while designing an RPI retainer. The three different design modifications of the proximal plate are:

Design modification I Here, the proximal plate is designed to extend from the marginal ridge to the junction between the middle and cervical third of the tooth. (Remember, in an I-bar retainer the proximal plate extends about 2 mm across the tooth tissue junction) (Fig. 22.37).

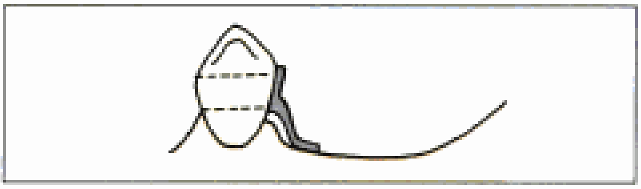


Fig. 22.37: Design modification I of RPI proximal plates

Design modification II Here, the proximal plate is designed to extend along the entire length of the proximal surface of the abutment with a minimum tissue relief. A relief is provided near the gingival margin at tooth tissue junction. This allows the proximal plate to disengage into proximal undercut during occlusal loading (Fig. 22.38).

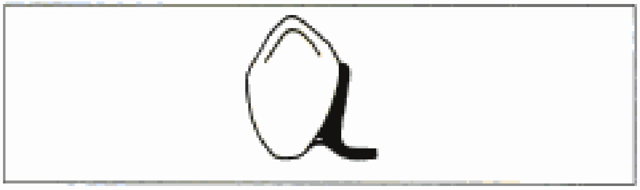


Fig. 22.38: Design modification II of RPI proximal plates

Design modification III Here, the proximal plate is designed to contact just about 1 mm of the gingival third of the guiding plane of the abutment tooth. The purpose of reducing the length of the proximal plate is to improve the gingival health (Fig. 22.39).

Fig. 22.39: Design modification III of RPI proximal plates

I-bar Modification

- The tip of the I-bar is modified to have a pod-shape in order to allow more tooth contact. It is placed more mesially so that it shifts towards the mesial embrasure space under occlusal load and increases reciprocation (Fig. 22.40).

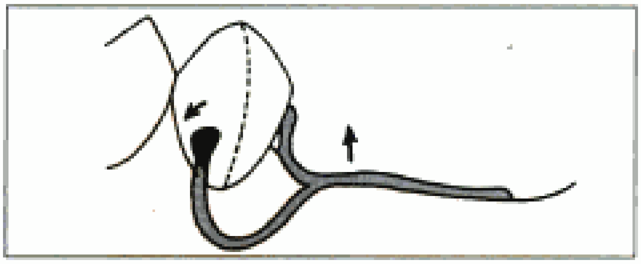


Fig. 22.40: Pod-shaped I-bar retainer of a RPI system

- The I-bar is designed to compensate for the decreased encirclement, (tooth contact), provided by the proximal plate and mesial rest.

RPA System (Rest, Proximal Plate and Aker's Clasp)

This is a modification of the RPI retainer, again devised by Krol in 1980. The I-bar in the RPI system could not be used for patients with soft tissue undercuts and high frenal attachments. In such cases the I-bar of the RPI retainer is replaced with an Aker's (circumferential) clasp to form the RPA retainer (Fig. 22.41).

SWING-LOCK REMOVABLE PARTIAL DENTURES

It was first described by Dr. Joe J. Simmons (1963). This denture has a labial bar in addition to the lingual major connector. The labial bar extends labially all along the arch like a major connector. The labial bar is attached to the remaining parts of the denture by a hinge on one side and a lock on the other (Fig. 22.42).

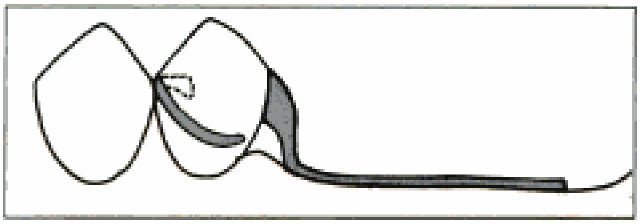


Fig. 22.41a: Facial view

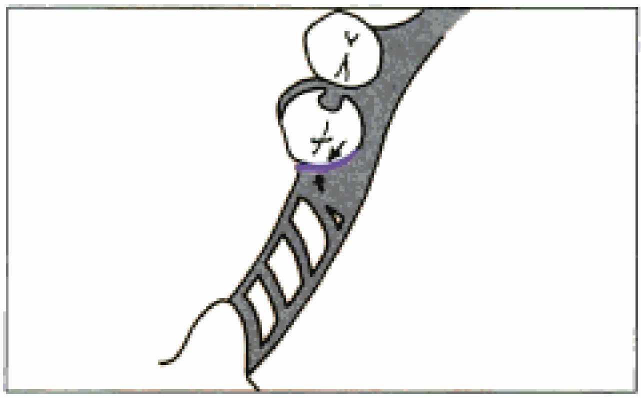


Fig. 22.41b: Occlusal view

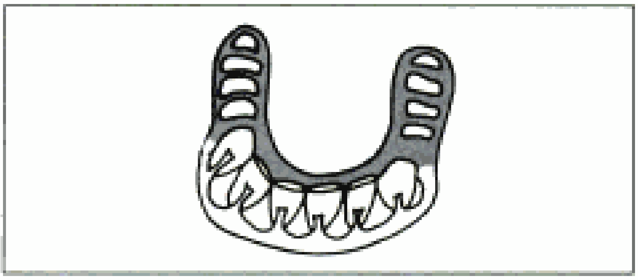


Fig. 22.42: Swing lock partial denture

The labial bar can be unlocked during insertion and locked after insertion. Since the labial bar moves around a hinge joint these dentures are called *swing lock dentures*. The main function of the labial bar is to support the periodontally weak teeth.

Indications

- Missing key abutments:
  It is almost impossible to fabricate a conventional removable partial denture in the absence of key abutments (primary abutments). Since, the swing lock denture uses the remaining teeth to derive support, retention and stability, it can be used here.

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and occlusal rim is inserted into the patient's mouth and all the three jaw relations are recorded. After jaw relation, the casts with the jaw relation records are mounted in an articulator.

Arranging Artificial Teeth to Occlusion

- Occlusion should be such that no lateral forces act on the prosthesis during occlusion.
- Simultaneous contact between natural and artificial teeth should be present.
- These factors are checked during trial denture try-in.
- After arranging the artificial teeth, the modelling wax that is to form the denture base is contoured and polished (Fig. 22.45).
- Consecutively the trial denture is flasked and acrylized as usual.

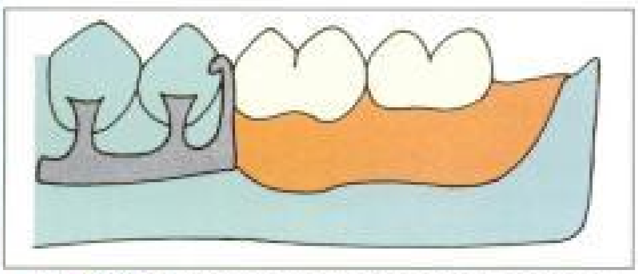

Fig. 22.45: Waxed-up swing lock prosthesis ready for processing

Insertion

- A lingual path of insertion is used.
- Pressure indicator paste is used to detect pressure areas.
- Occlusion is evaluated in centric and eccentric relations.
- In case of distal extension RPD, the vertical projections should be bent away from the teeth using two prong pliers, so that the anterior teeth are not tipped lingually by the labial bar under occlusal load.

Post-insertion Care

- Oral hygiene measures must be emphasized.
- Distal extension RPD has to be frequently relined.
- Loosened lock mechanisms should be tightened.
- Teeth can be added to the framework at later stages after the removal of any tooth.

TEMPORARY PARTIAL DENTURES

It is defined as *"A dental prosthesis to be used for a short interval of time for aesthetics, mastication, occlusal support or convenience or to condition the patient to the acceptance of an artificial substitute for missing natural teeth until more definitive prosthetic therapy can be provided "* - GPT.

There are three types of Temporary partial dentures. They are:

- Transitional partial denture.
- Interim partial denture.
- Treatment partial denture.

Transitional Partial Dentures

It is defined as *"A removable partial denture serving as a temporary prosthesis to which artificial teeth will be added as natural teeth are lost and which will be replaced after post-extraction tissue changes have occurred"* - GPT.

Indications

It is given when some or all the remaining teeth have periodontally poor prognosis but immediate extraction of all teeth are not indicated for physiological and psychological reasons.

Basically transitional dentures are used as a supportive therapy when the patient is expected to transit from a partially edentulous condition to a completely edentulous condition due to poor periodontal prognosis of the existing teeth.

Fabrication Procedure

The transitional denture may be prepared using a metal framework or an acrylic denture base. Metal-based transitional dentures are preferred because they are more biocompatible. Acrylic denture bases can produce severe tissue reaction under improper use. The step-wise procedure for the fabrication of a transitional partial denture is described as follows:

Impression making Mouth preparation and impression making procedures are similar to those done for conventional designs. The impression material of choice is alginate. After impression making the primary cast is poured using a two-pour technique. The primary cast in this case alone is poured using *hydrocal* (dental stone).

Fabricating retentive clasp The close adaptation of the denture base with the soft tissues provides sufficient retention. A 0.020 wire 'c' clasp is fabricated only when needed. The clasp wire is fabricated using orthodontic pliers. The clasp should have smooth curves and adapt closely to the abutment teeth. The free end of the clasp should engage the undercut on the buccal surface of the tooth (Fig. 22.46). Other end should be looped for retention within the denture base (Fig. 22.47).

Fabricating the temporary denture base After adapting the clasp, a temporary denture base is adapted. Shellac is the material of choice and auto-polymerizing resin is the second material of choice. The temporary denture base is fabricated as described in chapter 6. The base plate should extend upto the depth of the sulcus.

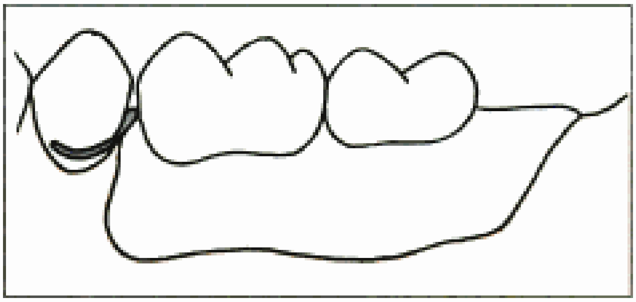

Fig. 22.46: C-clasp engaging the undercut on the buccal aspect of the abutment

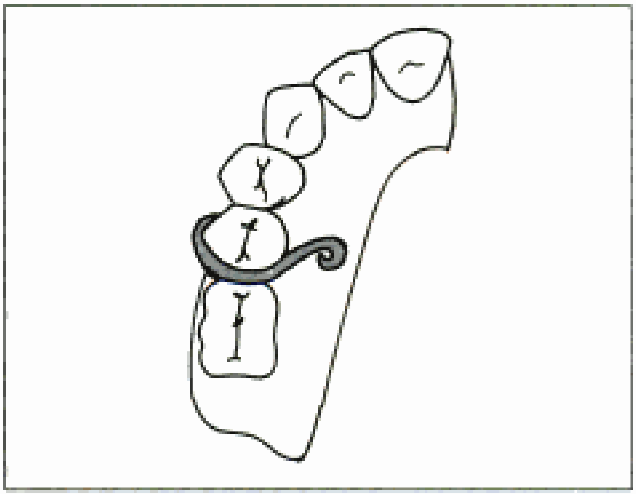

Fig. 22.47: Retentive loop of a c-clasp

The denture base material to be used in the final prosthesis determines the fabrication of the temporary denture base. If an acrylic denture is planned, the temporary denture base is fabricated directly on the master cast as described in chapter 6, but, if a cast metal denture (used for long-term cases) is planned, a refractory cast is made and a framework is fabricated and cast. The framework is tried in and the temporary denture base is fabricated using this framework. (Remember that acrylic based transitional dentures are generally avoided).

Designing the extent of the denture base: The labial flange of the denture is omitted if there is little or no resorption of the edentulous ridge. If labial flange is not planned, the crest and labial portion of the ridge is scrapped on the cast so that there is an intimate contact between the teeth and the ridge (Fig. 22.48). If a labial flange is used, scrapping of the ridge is not necessary.

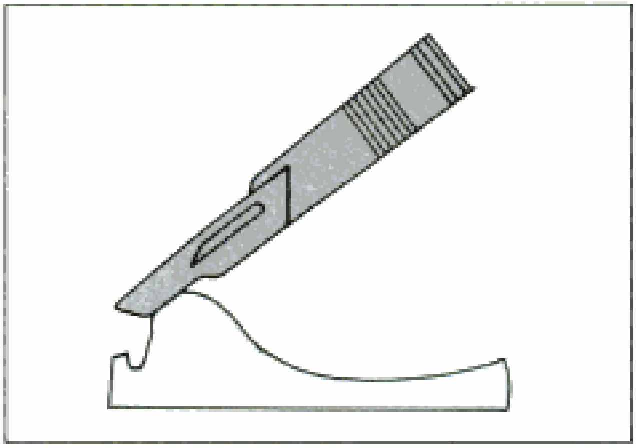

Fig. 22.48a: Scrapping the labial portion of the ridge on the cast to obtain close adaptation of the denture base

The palatal portion of a maxillary denture base should resemble a horseshoe (Fig. 22.49). The lingual flange of a mandibular denture should extend till the floor of the mouth but it should not produce any interference to the movable

Fig. 22.48b: Closely adapted flangeless denture

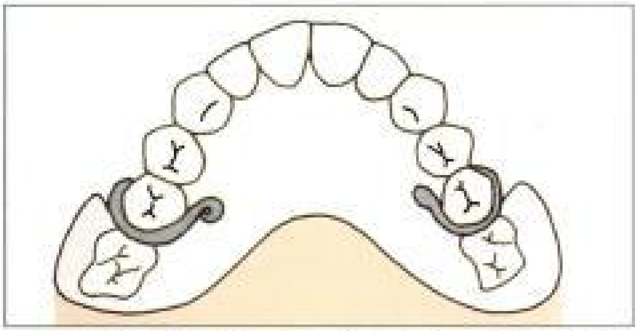

Fig. 22.49: Palatal extension of a maxillary denture base

tissues. Both palatal and lingual extensions of the denture base should extend up to the first molar for retention. If teeth posterior to the first molar are missing, then the palatal/lingual extension should extend up to the tooth replacements (Fig. 22.50).

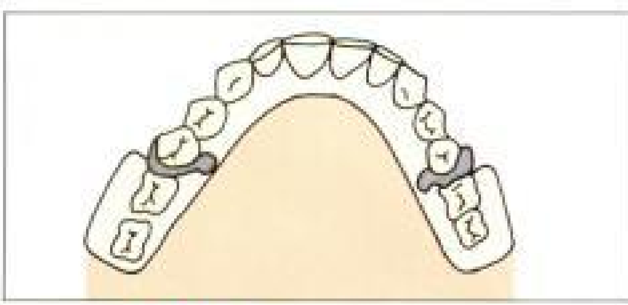

Fig. 22.50: Lingual extension of a mandibular denture base

Jaw relation and articulation After adapting the base plate, occlusal rims are fabricated using modelling wax as described in complete dentures. The next step in fabrication of a transitional denture is recording jaw relation. Jaw relation is recorded as described in Chapter 9. Mounting the casts in an articulator helps to preserve the jaw relation records and simulate the jaw movements. Hence, the jaw relation records are transferred to the articulator.

Arranging the artificial teeth The artificial teeth are arranged on the occlusal rims using the setting principles described in Chapter 10. The ridge lap portion of the artificial teeth should be trimmed for better adaptation. After setting the artificial teeth, a stone matrix is prepared.

V-shaped notches are produced vertically on the base of the master cast to act as an index to position the matrix template (Fig. 22.51). Separating medium is applied on the cast a usual.

A matrix or template is prepared using a thick mix of stone (slurry stone mix). The thick mix is manipulated manually and adapted over the buccal surfaces of the artificial teeth. Once the stone sets, the matrix is removed and smoothened. The thickness of the matrix should be 8 to 10 mm (Fig. 22.52).

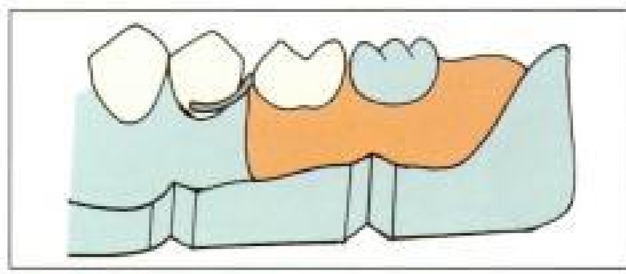

Fig. 22.51: Groove indexing the labial walls of the base

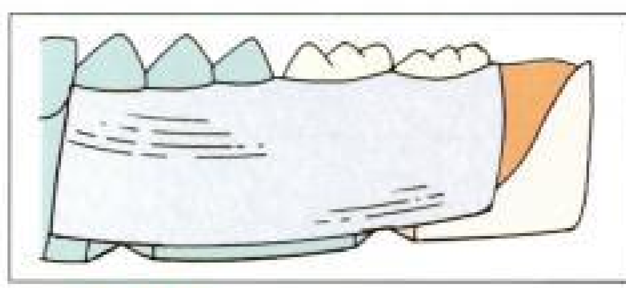

Fig. 22.52: Fabricating a matrix or template

Aesthetic try-in for anterior teeth It is done to verify the aesthetic quality of the anterior tooth replacement. The patient should be asked not to apply excessive force during try-in.

The position, shade, shape and mould of the artificial teeth are verified against the patient. Any abnormalities in the position, shade, shape and mould of these teeth are corrected during this phase of treatment.

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Mode of action

- Evenly distributes the occlusal load over the denture.
- Produces an intimate tissue contact and has a massaging effect on the soft tissues.
- Increases the blood flow and reduces inflammation.

Preparing/Fabricating the Treatment Partial Denture If an existing RPD can be used for this purpose, the tissue surface of the denture beneath the area of tissue irritation should be relieved to give space to carry the treatment material. If the existing partial denture is unsuitable for this purpose, a new treatment partial denture is fabricated.

The fabrication of a treatment partial denture is similar to that of a transitional denture except that a wax spacer is adapted over the tissue surface of the cast before acrylising the denture base using auto-polymerising resin (Fig. 22.59). After the denture base is cured, the spacer is removed and the space created is used to carry the treatment material.

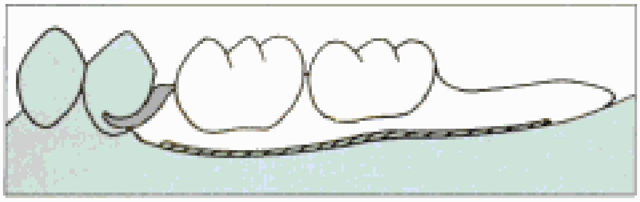

Fig. 22.59: Spacer adapted in the treatment partial denture base to allow placement of tissue conditioning material

Using the tissue conditioner The treatment partial denture is coated with a pressure indicating paste and a try-in procedure is carried out. Areas of interference are relieved and the occlusion is corrected. The procedure for applying a tissue conditioner can be described as follows:

- The external polished surface of the denture is coated with a separating medium.
- The tissue conditioner is mixed in a disposable cup to a heavy cream consistency and allowed to flow on the denture. It is distributed evenly on the tissue surface of the denture using a cement spatula (Fig. 22.60).

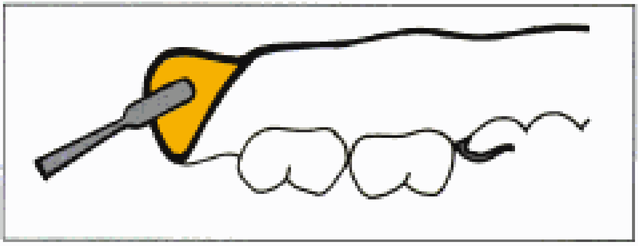

Fig. 22.60: Applying the tissue conditioner

- The working time of the mixed conditioner is about a minute.
- The denture is seated in the mouth with light pressure. The pressure is maintained as the material flows. Border tissues are manipulated as the material sets in order to mould the material at the borders.
- For establishing a proper lingual extension, various movements of the tongue are performed.
- Occlusion is established by asking the patient to gently close (bite) on the teeth.
- Once the denture is aligned, the patient is asked to remain still for 4 to 5 minutes till the gel stage is reached.
- The denture is then removed and examined. Voids on the tissue surface are filled with new material using a paintbrush.
- If the denture base is visible through the material, the denture is trimmed and new material is added and inserted. This procedure is done until a smooth tissue surface is obtained.
- The denture is washed in cool running water.
- The borders are trimmed with a scalpel blade and smoothened with a sharp knife or scissors.
- Please refer the uses of a tissue conditioner in a complete denture.

Changing the Vertical Dimension using Treatment Partial Denture

A change in vertical dimension should not be made directly on the RPD. The vertical dimension should be altered incrementally with the help of temporary appliances, which come under treatment partial dentures.

These appliances are similar to cap splints that cover the teeth. They distribute the occlusal stress evenly to prevent any tooth submergence. They should occlude in centric relation and centric occlusion to prevent supra-eruption.

Clinical procedure

- The casts are mounted in a semi-adjustable articulator along with face-bow transfer.
- The patient is guided to keep his jaws in the desired vertical dimension. Multiple layers of baseplate wax are adapted over the maxillary teeth until the space between the two jaws is filled up and the mandibular teeth occlude with the interocclusal wax (Fig. 22.61).

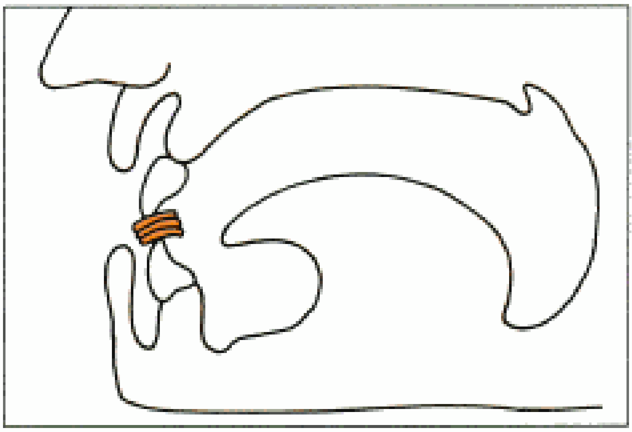

Fig. 22.61a: Closing on the interocclusal wax: Anterior teeth

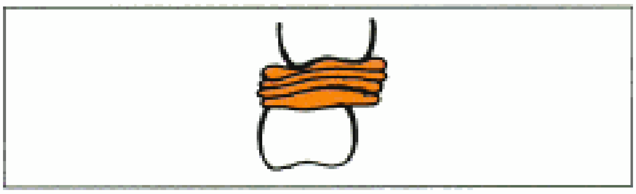

Fig. 22.61b: Closing on the interocclusal wax: Posterior teeth

- The adapted/recorded wax should be removed carefully without distortion. It is then fitted over the maxillary cast according to the record.
- The mandibular cast should be remounted against the interocclusal record.
- The interocclusal record is invested, flasked and processed.
- After acrylization, the interocclusal record resembles a cap splint (Fig. 22.62). The cap splint is verified against the articulated casts.

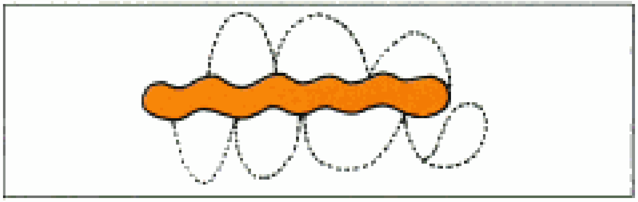

Fig. 22.62: Wax after the record

Insertion is simple wherein the occlusal plate or cap splint is seated against the occlusal surfaces of all the teeth. After insertion, the patient should be followed up regularly for several months and the vertical dimension at rest is measured. When the jaw relation (VDR) attains and stabilizes in the preferred value, the permanent restoration can be fabricated.

Surgical Splints

Surgical splints are used to protect post-operative surgical sites in the oral cavity to improve the healing. They are most commonly used on the maxillary arch and the lingual side of the mandibular ridge where tori and exostoses are most likely to occur.

Clinical procedure

- Impression is made with irreversible hydrocolloid.
- The contour of the surgical site after surgery is determined by the operator or surgeon.
- A mock surgery can be prepared on the cast to determine the contour of the site after surgery.

Laboratory procedures

- The master cast is scraped off to the desired configuration (Fig. 22.63).

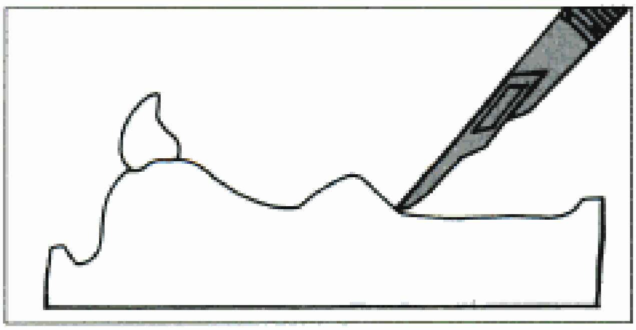

Fig. 22.63a: A mock surgery preparation on the cast

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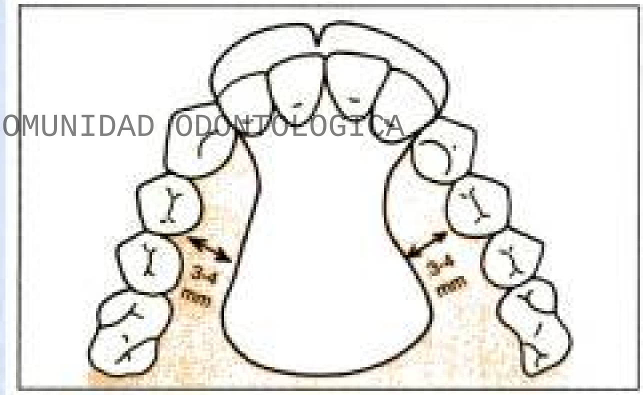

Fig. 22.68: Palatal extension of a spoon denture (occlusal view)

support and indirect retention respectively (Fig. 22.69).
- Closeness of occlusion: Factors like inter-cuspation with opposing teeth, overjet, etc. also affect the retention of the denture.
- Degree of overbite

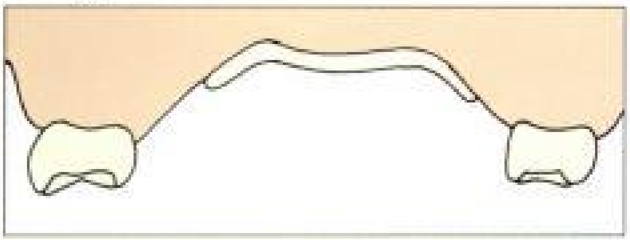

Fig. 22.69: Palatal extension of a spoon denture (cross-sectional view)

Advantages

- Easy to fabricate, requires less time.
- The gingiva is not affected because it is relieved.
- Since extensive tooth contact is not present, incidence of caries is considerably decreased.

Disadvantages

- Poor retention
- Tends to get displaced during insertion.

EVERY DENTURES

These dentures are called so because they were first described by Every. Craddock termed them as *"Precision plastic base dentures"*. They are used in Kennedy's class III cases with modifications. They are more commonly used in the maxilla.

The denture is designed based on broad palatal coverage, which helps to withstand the vertical load. The palatal tissues and the teeth in the anterior segment help to withstand the lateral load (Fig. 22.70).

Fig. 22.70: Every denture

Design Principles

The Every denture is designed based on the following principles:
- The denture should contact the natural teeth to transfer the axio-mesio-distal stress acting on the denture (Fig. 22.71).

Fig. 22.71: Limited tooth contact in an Every denture

- The proximal surfaces of the denture teeth should be convex and have a high survey line. This design helps to shift the contact point with the natural abutments occlusally (Fig. 22.72).
- Since the contact points are placed occlusally, the gingival embrasures are widened. This

Fig. 22.72: High contact points maintained to obtain wide embrasure spaces

produces a natural look in addition to minimizing the incidence of caries and periodontal pockets.

- The posterior teeth that support the denture should be clasped to prevent backward movement of teeth. The denture base is extended posteriorly to clasp the distal-most tooth (Fig. 22.73).
- The denture base should never extend over the gingiva.
- The denture gains its retention through adhesive forces and atmospheric pressure.

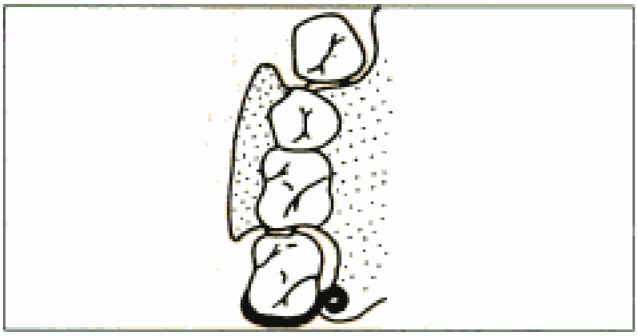

Fig. 22.73: A clasp encircling the distal molar to prevent distal tipping of the last molar tooth

Disadvantages

- The denture lacks strength and is considered to be too flexible.

Advantages

- It is more economical.

TWO-PART DENTURES

Described by Lee, these dentures were designed to overcome the technical problems in using the proximal undercuts in unilateral dentures.

These dentures are constructed in 2 parts, which have different paths of insertion. Together, the two parts are designed to engage the mesial and distal undercut of a single abutment tooth.

Consider a Kennedy's class III condition without any modification. This unilateral bounded saddle will obtain support from both mesial and distal abutments (Fig. 22.74). A two-part denture fabricated for this condition will have the following characteristics:

- The first part of the denture is designed to be inserted front backwards (front to back). This part will engage the mesial undercut of a distal abutment (Fig. 22.75).

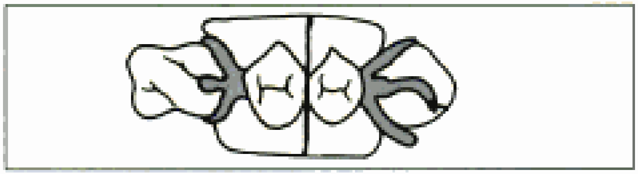

Fig. 22.74: Two part denture

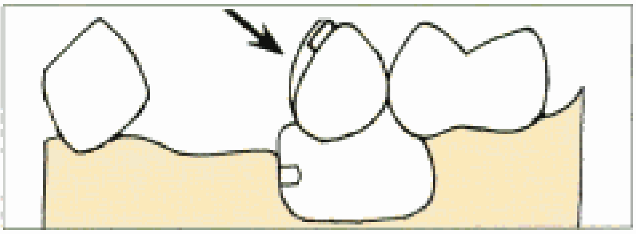

Fig. 22.75: Distal part of the two part denture (notice the direction of insertion)

- The second part is designed to be inserted from behind forwards (back to front). It is inserted after inserting the first part. It fits over the first part to engage the distal undercut of the mesial abutment (Fig. 22.76).
- A cobalt-chromium bolt is incorporated into the denture to lock the two parts in position (Fig. 22.77).
- The denture is usually fabricated with a metal denture base.

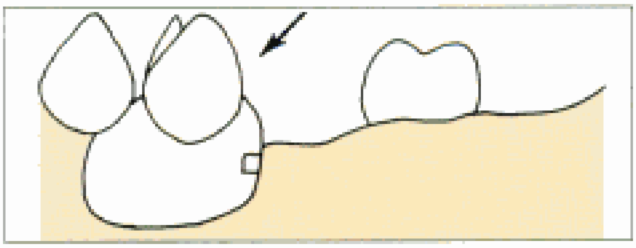

Fig. 22.76: Mesial part of the two part dentures (notice the direction of insertion)

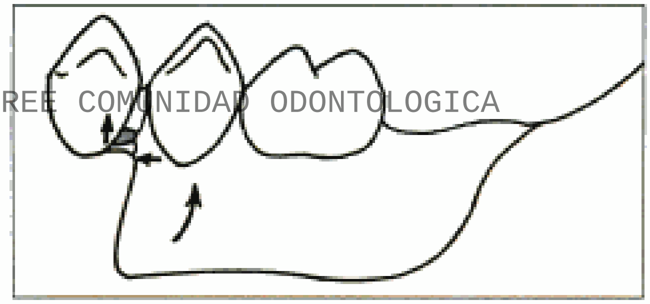

Fig. 22.82: Undercut engaged by the nipple

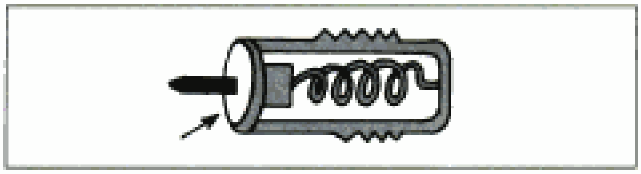

Fig. 22.83: Collar of the casing that controls the movement of the nipple out of the casing

Advantages

- This attachment is quite small; hence, it can be used even in a single tooth removable partial denture.

Disadvantages

- Metal nipple might abrade the tooth.
- Nylon nipple may wear out soon
- Requires frequent replacement

DISJUNCT DENTURES

These are nothing but Kennedy's class I dentures with special stress breakers between the tooth-supported part and the tissue-supported part of the denture. The stress breaker is special in that it is a bar and slot and not a conventional hinge. The bar of the stress breaker is called a *disjunct bar*.

These dentures are indicated when the remaining teeth are periodontally weak. This denture has two parts connected by a stress breaker. The two parts are termed based on the structures from which they obtain support.

Tooth Borne Part

It consists of a lingual plate major connector (lingual plate because the remaining teeth are periodontally weak) and the retentive clasps embracing the primary abutments. At the posterior end, the plate has a disjunct bar projecting lingual to the edentulous saddle area (Fig. 22.84).

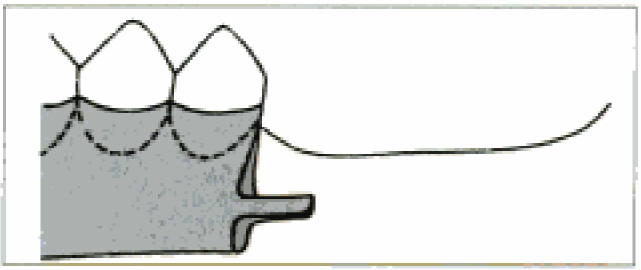

Fig. 22.84: Disjunct bar at the posterior end of the tooth-supported portion of the denture

Mucosa or Tissue Borne Part

This part includes the artificial tooth replacements and the denture base on the saddle area. They have a slot incorporated into the denture base, which is designed to accept the disjunct bar (Fig. 22.85). The bar slot connection is not rigid and allows free movement of the two parts of the denture. Since the bar slot joint is not rigid the load on the mucosa-borne part of the denture is not transferred to the tooth-borne part of the denture. Thus, the periodontally weak teeth are protected by this design.

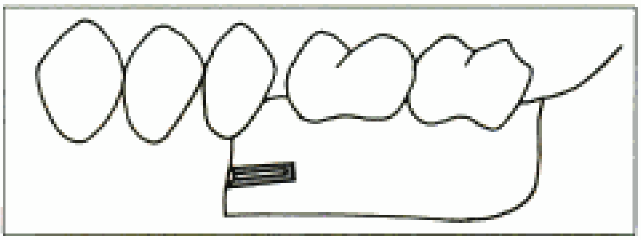

Fig. 22.85: Disjunct slot in the tissue-supported portion of the denture that accepts the disjunct bar

Advantages

- Periodontally weak teeth are preserved.

Disadvantages

- Technically difficult to construct.
- Movement of the two parts separately during use (due to its design) can lead to patient discomfort.

Chapter 23
Correction of Removable Partial Dentures

- Relining
- Rebasing of Removable Partial Dentures
- Reconstruction of Removable Partial Dentures
- Repair of Removable Partial Dentures

23 Correction of Removable Partial Dentures

RELINING

Relining is the addition of new denture base material to the existing resin to make up for the loss of tissue base contact caused by the resorption of the alveolar ridge. Relining is defined as *"To resurface the tissue side of a denture base with new base material to make the denture fit more accurately"* - GPT.

Indications

- Loss of occlusion between the denture and the natural teeth.
- Fit of the denture is altered. Loss of retention. The need for relining is assessed by visual examination of the loss of support from the supporting tissue:
  - *Using alginate:* A thin mix of alginate is made (one scoop of powder with 2 measures of hot water). This provides a mix, which is thin enough to prevent displacement of soft tissues, yet sets quickly. The thin mix of alginate is loaded under the denture base and the partial denture is seated in the mouth. The position is maintained until the alginate sets. The amount of alginate is clinically evaluated. If two or more millimeters of alginate is present, then the patient is a candidate for relining (Fig. 23.1).
  - *Using finger pressure:* Finger pressure is applied to the retromolar pad area of the distal extension denture base. If there is loss of supporting tissues, then the anterior indirect retainer will lift from its rest preparation. The amount of space under the indirect retainer is clinically evaluated. If the indirect retainer lifts two or more millimetres, then the patient is a candidate for relining (Fig. 23.2).

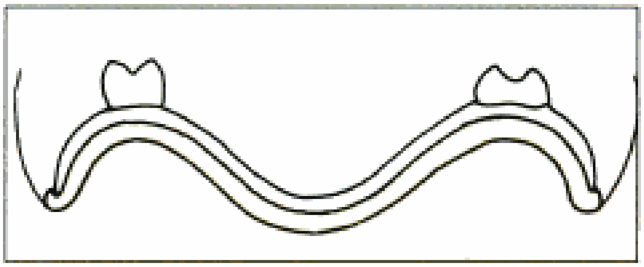

Fig. 23.1: Using alginate to measure tissue support

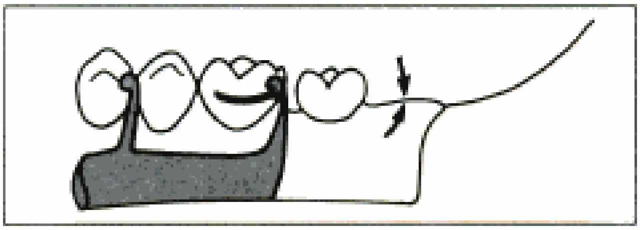

Fig. 23.2a: Dentures with good support, resist tissueward movement

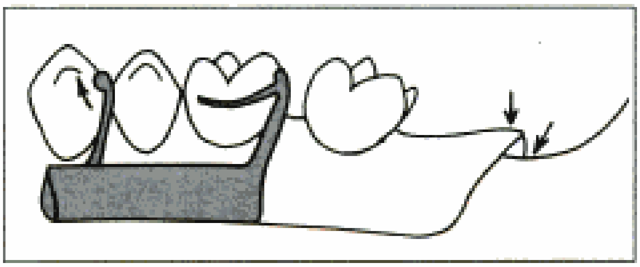

Fig. 23.2b: Dentures with poor tissue support rotate under finger pressure

Techniques for Relining

- Laboratory technique or extraoral technique.
- Intraoral reline technique.

Laboratory Technique

- A uniform amount of resin is removed from the tissue side of the denture base. This is done for two reasons:

  — Space must be created so that the impression material does not displace the soft tissues.
  — The tissue surface of the denture base should be removed so that the new resin can bond to the underlying dense, uncontaminated resin in the existing denture.
- The reduced denture base is used as a special tray to make an impression of the edentulous ridge. The impression material of choice varies for individual cases:

• Mobile tissue on the crest of ridge	- Free flowing zinc oxide eugenol
• Dense, firm edentulous ridges	- Polysulphide, silicone, mouth temperature wax

- Tissue conditioners can be used for either cases but they distort the tissues.
- The most important factor to be preserved during relining procedure is the maintenance of tooth-framework relationship. This is accomplished by holding the framework against the abutment teeth until the reline material sets.
- Small defects in the impression are corrected using mouth temperature wax.
- The extensions beyond the denture border should be removed and the rough edges created during removal are covered with a thin coat of mouth temperature wax.
- The completed reline impression is reinserted in the mouth. During this procedure, the framework is moved around its fulcrum to verify whether the reline has restored the desired support to the denture base (Fig. 23.3).
- The impression is forwarded to the laboratory for processing.
- The removable partial denture with the reline impression is directly flasked in the lab.
- After the plaster in the flask is set, the flask is opened up.
- The denture base area should be completely cleared of impression material using denture-

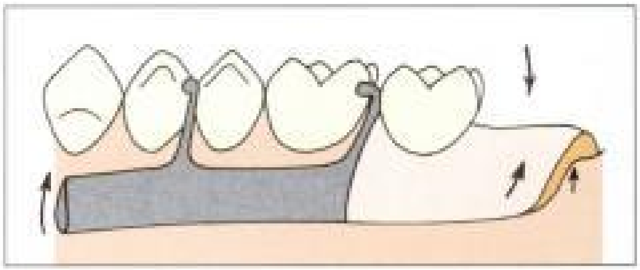

Fig. 23.3: Evaluating tissue support after relining

finishing burs. De-waxing can be done to remove Zinc oxide eugenol base impression material or mouth temperature wax. Polysulphide rubber or silicones can be separated without heating.
- A separating medium is applied in the mould space. The resin is kneaded and placed in the flask. Tight closure of flask is necessary.
- After the resin is completely polymerized, deflasking is done carefully with a sand blaster to prevent distortion of clasp arms and damage to the removable partial denture (Fig. 23.4).

Fig. 23.4: Sand blasting with alumina

- Another laboratory technique involves the mounting of the relined impression on a duplicating device. The entire partial denture should be in the top half of the duplicating device. Auto-polymerizing denture resin is used with this device. Refer relining jigs in Chapter 14.
- The relined removable partial denture is finished and polished.

Intraoral Reline Technique

All the four intraoral techniques described in the relining of a complete denture can be used for removable partial dentures. (Refer relining of complete dentures). One of the most commonly used techniques is described here.

- A uniform amount of denture base resin is removed from tissue side of the base and undercuts.
- Mouth-curing resin or auto-polymerizing resin is mixed. Special care should be taken such that the polymer is incorporated into the monomer by sifting to prevent air entrapment.
- The external surface of the denture base is covered by adhesive tape (Fig. 23.5).

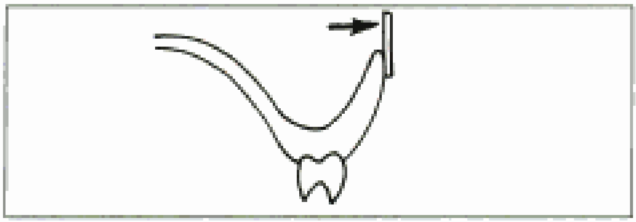

Fig. 23.5: Adhesive tape attached to the borders of the denture to prevent the external flow of the reline material

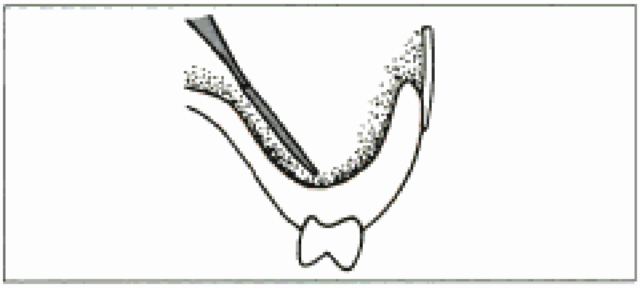

Fig. 23.6: Loading the reline material

- The inner surface is wetted with monomer and the prepared resin is applied with the spatula with care to avoid air entrapment (Fig. 23.6).
- The removable partial denture is inserted in the mouth and held in proper relationship.
- The denture is removed and any excess should be trimmed off with a sharp curved scissors in the dough stage itself.
- The denture is reseated after trimming while the resin is still plastic and held in position till it sets. Then it is removed and placed in pressure pot to complete residual or final curing.
- Complete polymerization occurs in 12 to 15 minutes after mixing.
- Later finishing and polishing is done.

Advantages

- The Procedure is quick

Disadvantages

- Chair side or mouth relining is inferior to lab reline. Therefore it is indicated only in temporary or transitional situations.
- The material is porous and is not colour stable.

REBASING OF REMOVABLE PARTIAL DENTURES

Rebasing is defined as *"A process of refitting a denture by the replacement of the denture-base material"* – GPT.

Rebasing is a laboratory technique similar to relining wherein the bulk of denture base material is removed along with the impression material and replaced by new resin.

Indications

- When the denture borders do not extend to cover all the supporting tissue.
- When the denture is fractured in the denture base.
- When the denture is stained or discoloured.

Technique

- The tissue surface of the denture base is relieved and trimmed to provide space for re-adaptation of borders with modelling plastic.
- Border moulding is done.
- After border moulding, a final impression is made using the framework.
- A cast is poured against the rebase impression.
- The modelling plastic and the final impression material is scrapped away from the denture base.
- The denture base extending over the area to be rebased should be trimmed leaving just about 2-3 mm adjacent to the base of the teeth.
- When the anterior teeth are involved, the junction of the new resin and the existing denture base should be kept in an area that is not visible. A faint line will always exist at this junction and it may be visible when the patient smiles (Fig. 23.7).
- This observable line is reduced when the borders of the resin are at 90° to the external

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- This clasp arm is not indicated for single tooth addition.
- The teeth are added as described earlier.

Metal Repair

- The most common of the metal repairs is retentive clasp arm.
- A repair cast is made. The design of the replacement clasp is drawn on the abutment tooth. The cast and denture are submitted to the laboratory (Fig. 23.20).

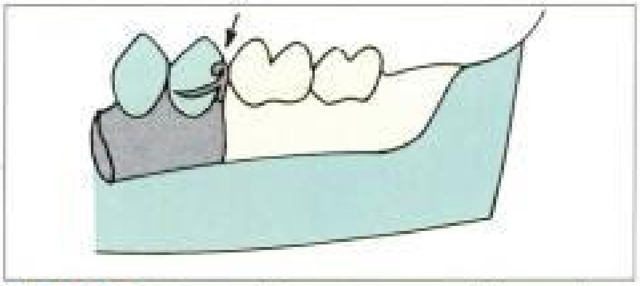

Fig. 23.20: Broken terminals or clasp assemblies are drawn on the cast. Fresh clasps are made and soldered to the existing connectors

- The replacement clasp can be embedded in the resin of the denture base or electro-soldering to the framework itself (Fig. 23.21).
- Both infra-bulge clasps and circumferential clasps are used.
- They may be cast or made of wrought metal.

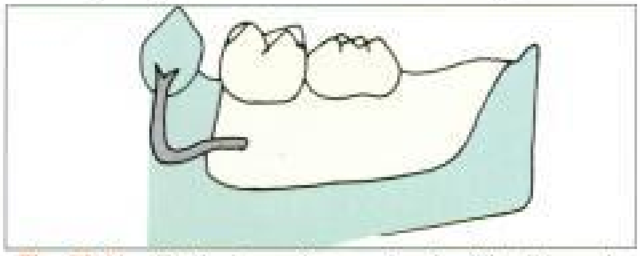

Fig. 23.21a: Replacing a clasp and embedding it in resin usually done for approach arms of roach clasps

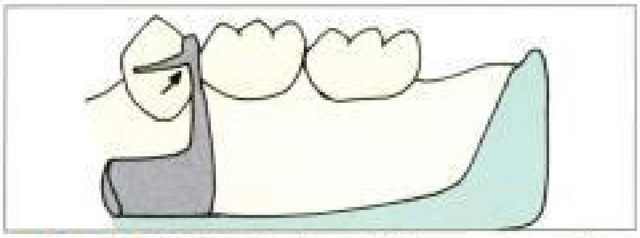

Fig. 23.21b: Cast circumferential clasps are usually soldered to the minor connectors

Repair of Major and Minor Connectors

- Sectioning of the framework is done if the major connector is distorted and does not adapt properly. The framework is sectioned with a carborundum disc (Fig. 23.22).
- A full mouth impression is made and a cast is poured. The sectioned framework is seated on the cast.

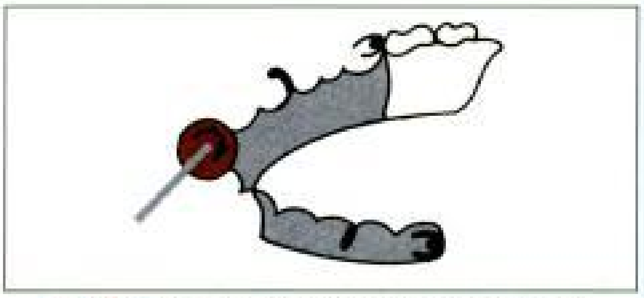

Fig. 23.22: Slicing an ill-fitting framework using a carborundum disc

- A high-heat platinum 0.001-inch foil is adapted to the cast in the areas where the major connector was sectioned. Fluoride flux is used. (Fig. 23.23).
- A precious metal solder or industrial brazing alloy can be used with the electro-soldering machine to complete the repair.

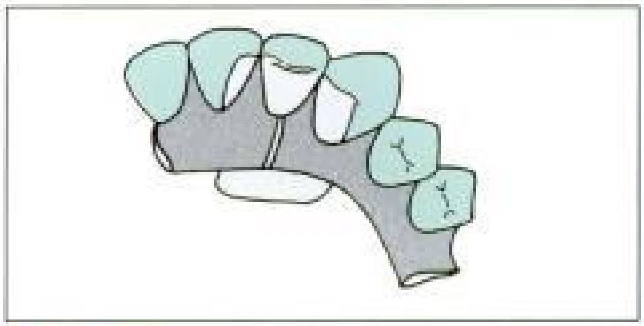

Fig. 23.23: The sliced parts of the framework are repositioned on the cast. Platinum foil is placed under the sliced portions as a separating medium

Denture Base Addition

- An accurate repair cast is required. The repair cast is the one poured in an impression made using the existing framework of the RPD.
- A new denture base minor connector is adapted over the repair area. This minor connector

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Section Three

Fixed Partial Dentures (FPD)

- Introduction to Fixed Partial Dentures
- Parts of a Fixed Partial Denture
- Design of a Fixed Partial Denture
- Occlusion in Fixed Partial Dentures
- Types of Abutments
- Tooth Preparation
- Types of Fixed Partial Dentures
- Impression Making in Fixed Partial Dentures
- Temporization or Provisional Restoration
- Lab Procedures Involved in the Fabrication of FPD
- Cementation of Fixed Partial Dentures

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24

Introduction to Fixed Partial Dentures

INTRODUCTION

A fixed partial denture is defined as *"A partial denture that is cemented to natural teeth or roots which furnish the primary support to the prosthesis"*-GPT.

A fixed prosthesis is defined as, *"A restoration or replacement which is attached by a cementing medium to natural teeth, roots, implants."*–GPT. These dentures are often termed as *Bridges*.

In the previous section, we discussed about removable partial dentures, which can be removed and inserted by the patient. In this section, we will be studying about fixed partial dentures. These dentures are fabricated in a complex manner. The prosthesis is cemented to the supporting teeth and cannot be removed by the patient.

COMMONTERMS USED IN FIXED PROSTHODONTICS

Crown

It is a cemented extracoronal restoration that covers or veneers the outer surface of the clinical crown. The primary function of a crown is to protect the underlying tooth structure and restore the function, form and aesthetics. Crowns may be of three types, namely, clinical crowns, anatomical crowns and artificial crowns. "Clinical crown" depicts the intraorally visible tooth structure. "Anatomical crown" depicts the area of the tooth covered by enamel.

If the prosthetic crown covers all five surfaces of the clinical crown it is referred to as a *Full veneer crown* (FVC) (Fig. 24.1). If the prosthetic crown

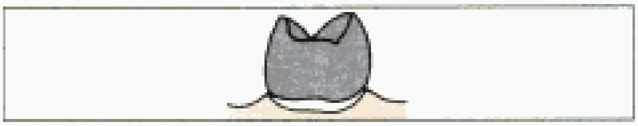

Fig. 24.1: Full veneer crown

does not cover the entire clinical crown, it is referred to as a *Partial Veneer Crown (PVC)* (Fig. 24.2).

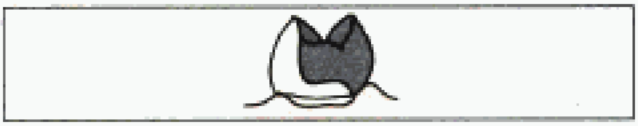

Fig. 24.2: Partial veneer crown

Retainer A crown that is used as a part of the fixed partial denture for retention and support from the abutment tooth is called as a *Retainer*.

Laminate Veneers or Facial Veneers

These are prosthesis, which are made of ceramic. They are used as a thin layer over the facial surface of the tooth, primarily for aesthetic reasons (Fig. 24.3).

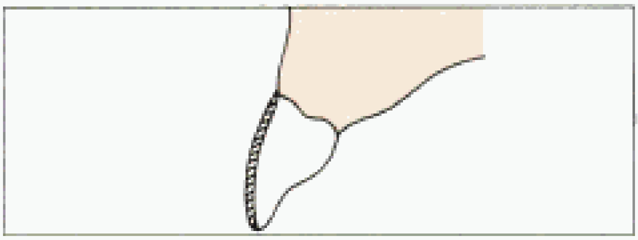

Fig. 24.3: Labial veneer

Inlay

It is an intracoronal restoration, which is used for medium sized single tooth proximo-occlusal and gingival lesions. They are usually made of gold alloy or ceramic material (Fig. 24.4).

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- Distal extension denture bases as in class I and II cases.

DIAGNOSIS AND TREATMENT PLANNING

Diagnosis

Diagnosis and treatment planning play an important role in the success of any prosthetic treatment. The success of a fixed partial denture depends on the health of the abutment teeth. Factors like dental caries, periodontal diseases can affect the health of the abutment leading to total failure of the treatment. For making a proper diagnosis, history taking, clinical examination, radiological examination and preparation of diagnostic casts are vital. The various steps in diagnosis and treatment planning are not discussed in detail here. Instead, we shall see about some relevant factors in relation to the health of an abutment tooth. Refer Chapter 2 for basics in diagnosis and treatment planning.

History

Various psychological and medical conditions will affect the success of the prosthesis. The mental attitude of the patient should be assessed using House's classification.

The following conditions should be considered during diagnosis:

- *Diabetes:* In diabetic patients the risk of occurrence of a periodontal lesion is very high. In such patients, a fixed prosthesis will increase the risk of abutment failure. Patients with diabetes should be made aware of these problems and medical treatment should be instituted to control the condition.
- *Xerostomia:* Decreased salivary flow can predispose to caries due to accumulation of debris and decreased buffering capacity. In cases with Xerostomia (Vitamin A deficiency, salivary gland disease) use of anticholinergics, anorectics and antihypertensives should be controlled or avoided and alternate medication should be chosen.
- *Cardiovascular diseases:* Patients using pace makers have to be treated with caution. All electrosurgical procedures are contraindicated for these patients. Adrenaline is avoided in the local anaesthetic and the gingival retraction cord should be free of adrenaline.
- *Miscellaneous conditions:* Patients should be enquired on any history of drug allergy, nickel sensitivity. He should be examined for presence of any infectious diseases to prevent cross infections.

Clinical Examination

Clinical examination can be grouped as:

- Systemic examination
- Local examination
  - — Extraoral examination
  - — Intraoral examination

Systemic examination Along with history, a thorough check-up should be made to rule out the presence of any systemic disease. (Refer Chapter 2).

Local examination Extraoral examination (TMJ evaluation):

Objective and subjective symptoms of pain and discomfort in the TMJ should be examined. Further examination and treatment should be carried out if there is a sign of disease of the TMJ. Along with TMJ evaluation, the muscles of mastication (anatomy, physiology and pathology) should be evaluated.

Intraoral Examination

It includes hard tissue and soft tissue examination. First, the patient's oral hygiene should be examined, following which, the presence of attached gingiva and the presence of any occlusal disharmony should be examined. Other factors that require observation include, risk of dental caries and periodontitis, amount of residual ridge and presence of wear facets. The type of occlusion should be examined.

Diagnostic Casts

Diagnostic casts of both the arches should be prepared before the commencement of treatment. These casts should be mounted on a semi-adjustable articulator using a face-bow transfer and interocclusal records.

Mounted diagnostic casts serve the following purposes:

- To assess the dimensions of the edentulous space.
- The height, rotations, inclination of the abutment teeth can be observed.
- The number, size and position of wear facets can be seen.
- It gives an idea about the occlusion and the morphology of the opposing teeth. It also guides us in determining the amount of occlusal load anticipated from the opposing teeth.

Radiographic Examination

A full mouth radiographic examination should be carried out. The radiographs should be used to detect:

- The number, size and location of caries.
- Evidence of caries beneath existing restorations.
- The level of alveolar bone.
- Crown-root ratio of the abutment teeth.
- Morphology of the roots of the abutment teeth.
- Quality of endodontic restorations.
- Width of the periodontal ligament space. It is increased in patients with trauma from occlusion.
- Presence of any root stumps in the edentulous area.
- Thickness of the soft tissues in the edentulous area.

Treatment Planning

Treatment planning should be based on the choice of design of the partial denture that best suits the patient.

Treatment planning for fixed prosthesis includes:

- Intraoral examination and selection of an appropriate prosthesis.
- Evaluation of the abutment and selection of an appropriate prosthesis (discussed in Chapter 26).
- Biomechanical considerations and fixed partial denture design (discussed in Chapter 26).
- The patient's needs.
- Type of material/technique that best suits the patient.
- Residual ridge of the patient and treatment of ridge defects.
- Occlusion with the opposing teeth.

Intraoral Examination and Selection of an Appropriate Prosthesis

Various factors in the oral cavity influence the choice of a partial denture. They include aesthetics, periodontal and biomechanical factors. Each type of partial denture is controlled by its own group of factors that are unique to it. The various indications for different partial dentures are discussed below. The design and function of these dentures are discussed in detail later.

Conventional tooth supported fixed partial dentures: (Fig. 24.8) It is indicated for the following cases.

- Patients with periodontally sound teeth.
- Short and straight edentulous span.
- Absence of any uncorrectable soft tissue defect.
- Presence of proper salivation (fluoride application is advised for xerostomic patients).

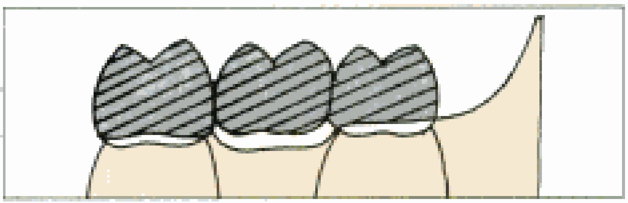


Fig. 24.8: Conventional tooth supported FPD

Resin bonded fixed partial denture: (Fig. 24.9) It is indicated in:

- Presence of defect-free abutments.
- Presence of single missing anterior tooth or premolar.
- Sometimes a single missing molar with minimal opposing occlusal load.
- Presence of sound abutments on either side of the edentulous space.
- Young patients with low-risk of caries and large pulp chambers.

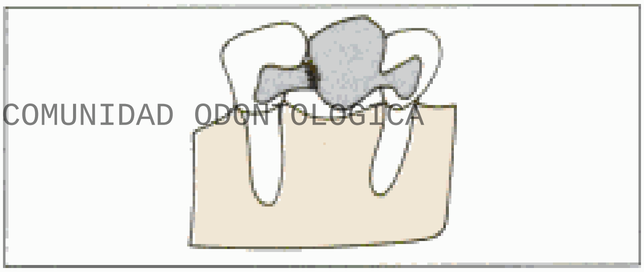


Fig. 24.9: Resin bonded FPD

- Abutments with less than 15° axial inclination.
- Absence of deep vertical overlap.

Implant supported fixed partial denture (Fig. 24.10) It is indicated in

- Absence of sufficient number of abutments for a long edentulous span.
- Absence of distal abutment but presence of good density of bone.
- Broad flat ridge configurations.
- Single tooth replacements.
- High caries risk patients.
- Young adults.

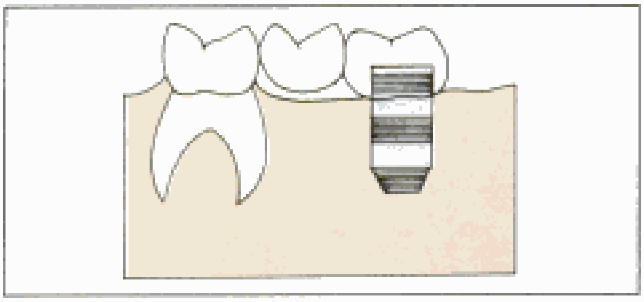


Fig. 24.10: Implant supported FPD

Patient's Needs

The title should **not** be interpreted as the desire of the patient. The purpose for the fabrication of a prosthesis is different for each patient. For example, in some, a crown may be needed to restore decayed teeth, whereas in others a crown may be needed to prevent further occurrence of caries. Crowns may be placed to protect a weakened or malformed tooth. In many cases, a prosthesis may be needed to restore aesthetics.

Hence, we should understand that the prosthesis should be designed such that it best fulfils its primary function.

Type of Material/technique to be Used

The type of material used for the restoration or prosthesis should be determined based on the following factors:

- Age (Younger patients need stronger materials like metal crowns)
- Amount of occlusal load (FVC are preferred for areas under high stress)
- Amount of remaining tooth structure (PVC is preferred for teeth with small lesions or destruction)
- Existing state of oral hygiene (Fluoride releasing materials should be applied for patients with high caries index)
- Viscosity of saliva
- Type of opposing teeth (Stronger materials are needed for restorations opposing natural teeth).

In the following section, we shall have a brief discussion about the properties of different materials, which affect the design of an FPD. These materials determine the tooth preparation and other design concepts of the prosthesis.

Plastic materials These types of materials require considerably less amount of tooth preparation. But their success is limited due to their poor strength. They are used as temporary crowns over the prepared teeth.

Cast metal The material is strong and provides a very good fit and finish. They have an excellent success rate and hence, are most commonly used. Cast metals are generally classified as intracoronal and extracoronal replacements.

Intracoronal replacements: Gold is one of the most commonly used metal for intracoronal restorations. It gives an excellent fit and finish. The major disadvantage is that they require extensive tooth preparation even for small lesions. Base metal alloys are widely used.

Extracoronal replacements: They are used for teeth with extensive carious lesions. The material requires extensive tooth preparation. The margins are placed near the gingiva, predisposing it to periodontal problems.

Metal ceramics These materials require extensive tooth reduction. The junction between the metal and the ceramic is very unaesthetic. For aesthetic reasons the margins of the restoration is placed subgingivally which frequently leads to periodontal problems.

Resin veneer This material was widely used before the arrival of porcelain. Nowadays methacrylate in the material is replaced by Bis-GMA. This is done to enhance strength and wear resistance. It is used only for long-term temporization.

Fiber reinforced resin This is a type of fiber-reinforced indirect composite. It provides a good fit and finish and is very aesthetic. Long-term results are under study.

Complete ceramic It has the best aesthetics but worst marginal finish. It is a brittle material due to low elastic strain. Now high strength fillers like alumina and zirconia are used.

The Residual Ridge of the Patient

The type and amount of destruction of the residual ridge should be evaluated. It determines the selection of a pontic. Some cases require surgical correction. Hence, examination of the residual ridge is done in treatment planning. *Seibert* grouped residual ridges into three categories based on the amount of destruction.

Class I (Fig. 24.11) It is a ridge with loss of faciolingual width, with normal apicocoronal height. It constitutes to 32.4% of the edentulous ridges.

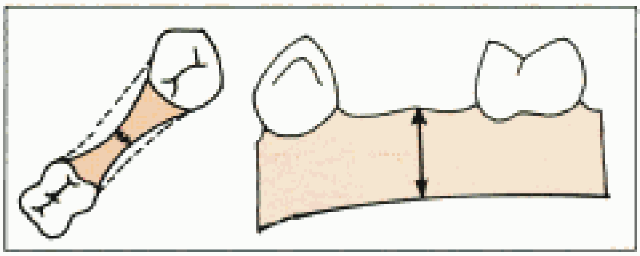


Fig. 24.11: Class I residual ridge

Class II (Fig. 24.12) It is the ridge with loss of ridge height with normal ridge width.

Class III (Fig. 24.13) It is the ridge with loss of both height and width.

Class N (Fig. 24.14) It indicates normal ridges. This class does not belong to the original classification. It was added later.

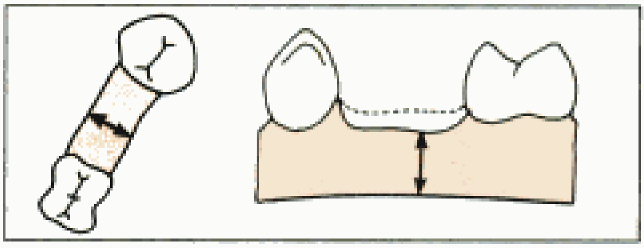


Fig. 24.12: Class II residual ridge

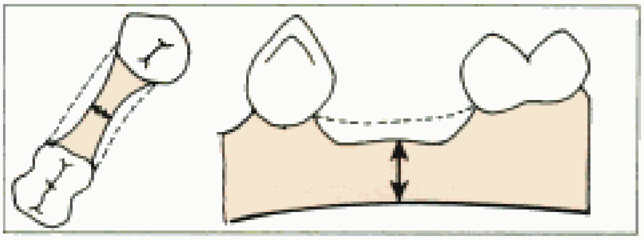


Fig. 24.13: Class III residual ridge

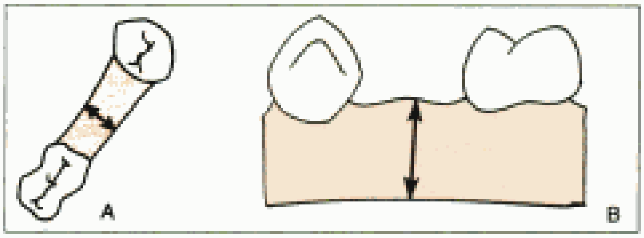


Fig. 24.14a and b: Class N residual ridge

There are various surgical techniques available to reform these defects. We shall discuss some popular techniques.

Treatment of ridge defects

Ridge augmentation: Langer, Kaldhal et al and Calanga proposed this technique. Generally, Class I ridge defects can be surgically corrected by ridge augmentation. Results are excellent.

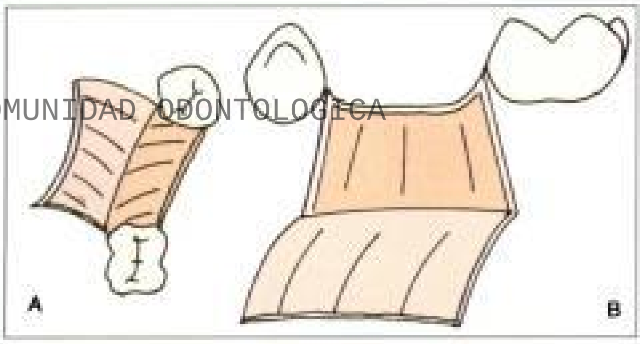
Steps:

- A trapezoidal split thickness flap is reflected with its margins 1 mm below the free gingival margin (Fig. 24.15).
- Donor tissue usually taken from the molar region of the palate is placed over the connective tissue and the flap is sutured enclosing the donor material (Fig. 24.16).

Seibert's onlay graft or thick free gingival graft: Class II ridges can be surgically repaired by this method.

Steps:

- The recipient site is scraped to remove the epithelium (Fig. 24.17).



Figs 24.15a and b: Trapezoidal split thickness graft

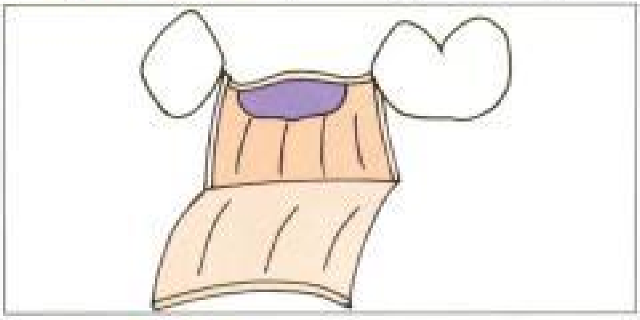


Fig. 24.16: Placing the donor tissue

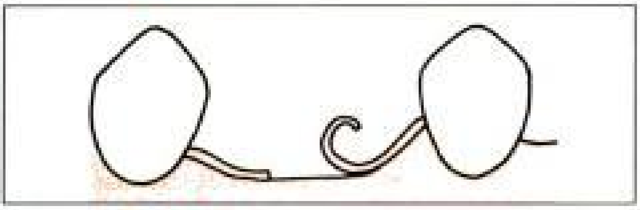


Fig. 24.17: Scrapping the epithelium

- Later, the site is striated (cut, not sliced) with a Bard Parker blade to induce bleeding (Fig. 24.18).

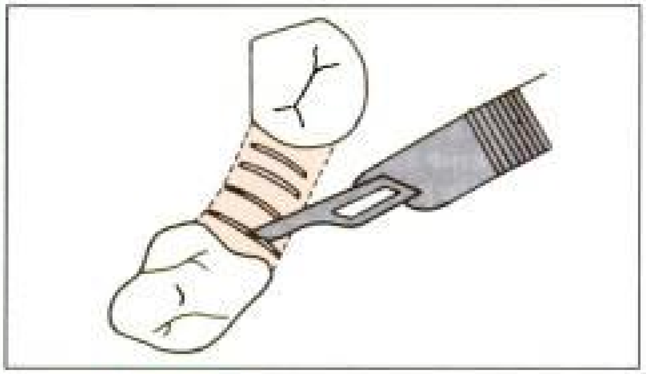


Fig. 24.18: Making transverse incisions

- A full thickness graft especially from the palate near the tuberosity or premolar region is used as donor tissue. Fatty grafts will shrink proportional to their fat content (Fig. 24.19).

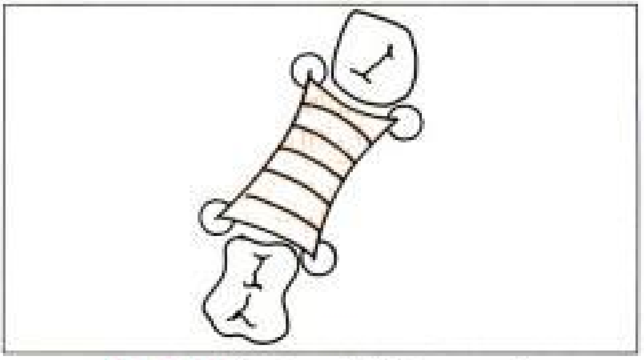


Fig. 24.19: Placing a full thickness graft

- Some cases may require multiple surgeries. In such cases, a minimal period of 8 weeks should be given for tissue healing.

Andrews's bridge system: (Fig. 24.20) It consists of two fixed retainers attached to their abutments and connected by a rectangular bar that follows the curve of the ridge under it. A removable teeth set with a gingival flange is fabricated to seat on the bar. The flange tends to accumulate calculus deposits. Refer chapter 30 for further details.

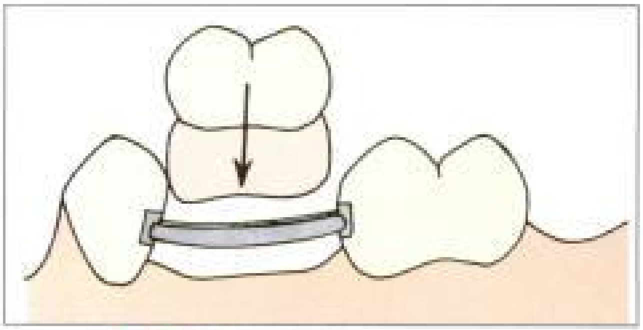


Fig. 24.20: Andrew's bridge system for covering ridge defects

Other techniques: (Fig. 24.21) Some ridge defects can be corrected by slightly modifying the design of the denture. Tissue colored porcelain can be used at the base of the pontic to fill the gingival embrasures to resemble interdental papillae. This method is good for mandibular teeth.

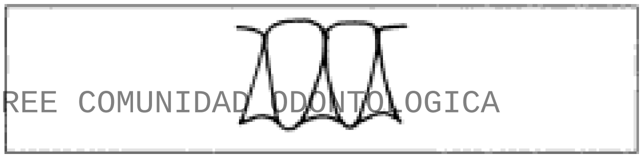


Fig. 24.21: Gingival porcelain used to close embrasures

Occlusion with the Opposing Teeth

Occlusion of the opposing teeth is an important factor that determines the design of a FPD. FPD's opposing edentulous spaces or prosthetic teeth are not subjected to heavy occlusal load and hence strong materials are not required. High strength alloys should be used for cases with traumatic occlusion. Teeth should be arranged such that the occlusal load on the pontic is minimal.

CLASSIFICATION OF FPD

Fixed partial dentures are usually grouped into various categories based on factors like abutments, components, length of the span, etc.

An ideal classification should fulfill the following criteria:

- Allow visualization of the type of partially edentulous arch being considered.
- Permit differentiation between tooth-supported and tooth tissue supported partial dentures.
- Serve as a guide to the type of design to be used.
- Be universally accepted.
- Should include codes for the designs that are in common use.

All fixed partial dentures fall into three major classes. These classes are further divided into three divisions and the divisions are further divided into four subdivisions. It should be understood that upto 12 designs are possible in each single class.

Class

A class identifies the location of the edentulous space.

Class I: Posterior edentulous spaces. One or more of the posterior teeth (premolars and molars) are missing (Fig. 24.22).

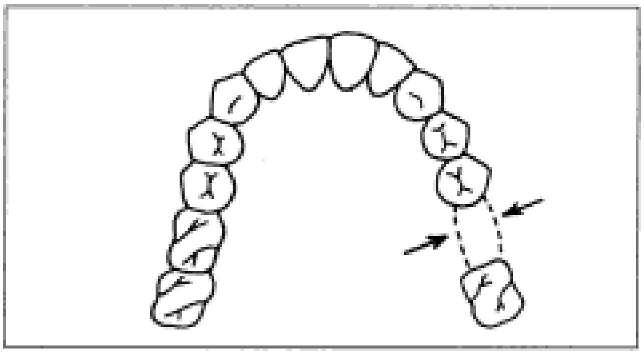


Fig. 24.22: Posterior edentulous space

Class II: Anterior edentulous spaces. One or more of the anterior teeth (incisors and canines) are missing (Fig. 24.23).

Class III: Antero-posterior edentulous spaces. Edentulous spaces involving both the anterior and posterior regions, i.e. some anterior and posterior teeth are missing (Fig. 24.24).

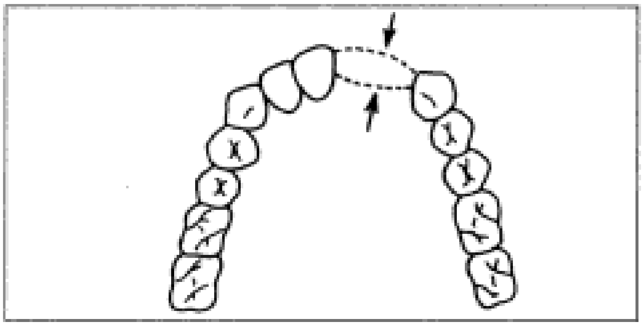


Fig. 24.23: Anterior edentulous space

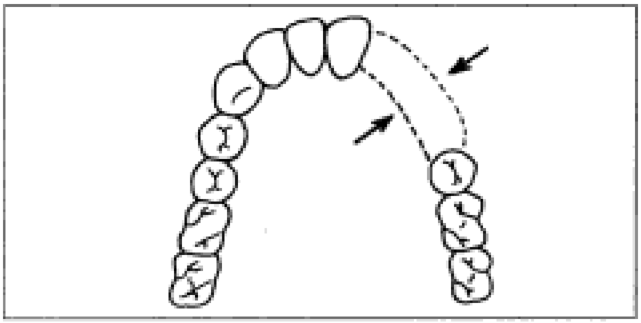


Fig. 24.24: Antero-posterior edentulous space

Division

A division gives information about the teeth present adjacent to the edentulous space that are capable of taking support.

Division I: Cantilever FPDs. Abutments present only on one side of the edentulous space are capable of taking support (Fig. 24.25).

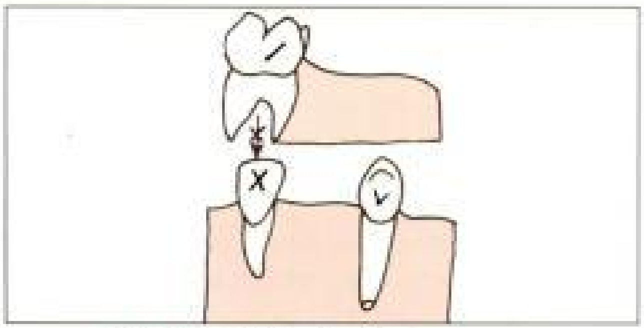


Fig. 24.25: Division I edentulous space

Division II: Conventional FPDs. Abutments that are capable of taking up occlusal load are present on both sides of the edentulous space (Fig. 24.26).

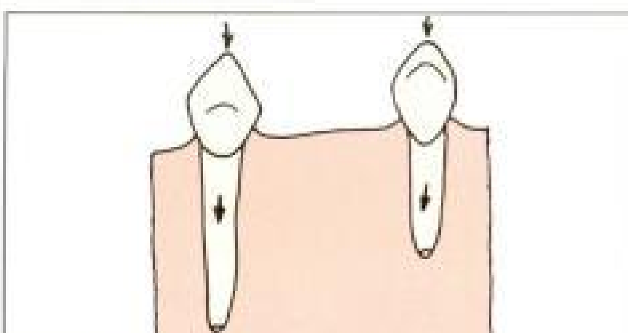


Fig. 24.26: Division II edentulous space

Division III: Pier Abutments. A single tooth is surrounded by an edentulous space on either side (Fig. 24.27). Two division II FPDs separated by a single tooth, which is capable of providing support is a Division III FPD. Such cases are treated with a single prosthesis.

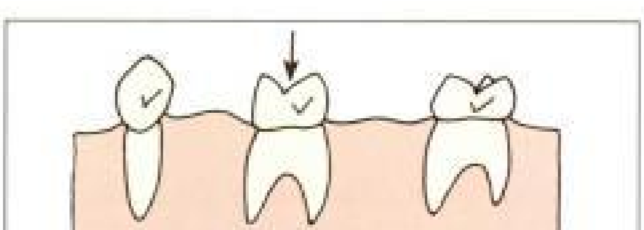


Fig. 24.27: Division III edentulous space

Sub-division

A sub-division denotes the status of the tooth that is to be used as an abutment.

Sub-division I: Ideal abutments. Healthy teeth, which provide good support (Fig. 24.28).

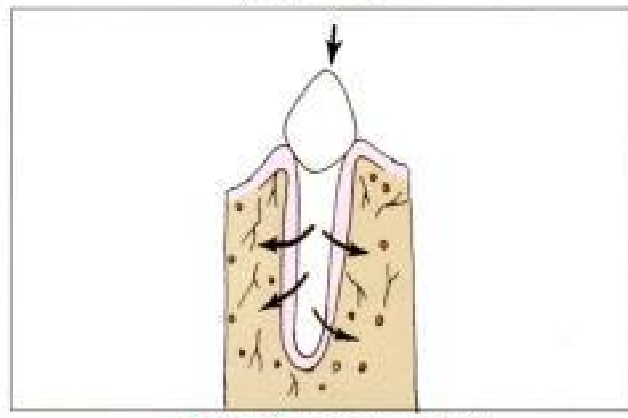


Fig. 24.28: Healthy abutment

Sub-division II: Tilted Abutments. Either the design of the prosthesis should be modified or the tilt of the abutment should be corrected (Fig. 24.29).

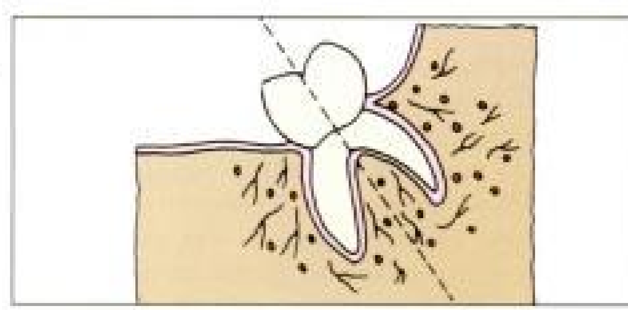


Fig. 24.29: Tilted abutment

Sub-division III: Periodontally weak abutment. This abutment cannot take up occlusal load as effectively as healthy abutment (Fig. 24.30).

Sub-division IV: Extensively damaged abutment. The abutment has good bone support but require exten-

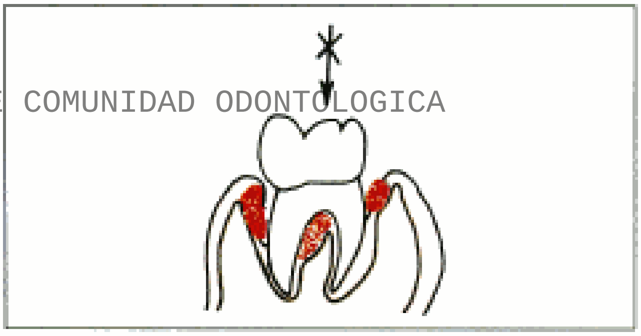


Fig. 24.30: Periodontally weak abutment

sive restoration e.g. inlay, onlay, dowel core. The status of the abutment crown determines the type of attachment required for the FPD (Fig. 24.31).

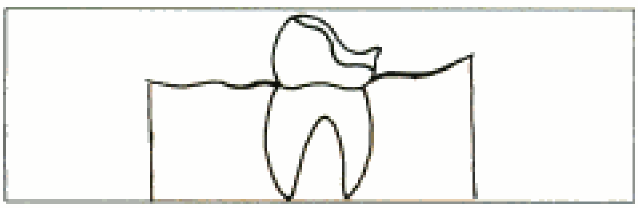


Fig. 24.31: Extensively damaged abutment

Sub-division V: Implant abutment. The abutment is an implant and the design of the prosthesis should be modified accordingly (Fig. 24.32).

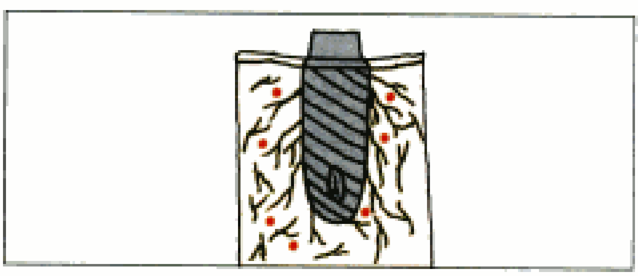


Fig. 24.32: Implant abutment

Each sub-division can be further grouped into A an B.

A: Figure 24.33 denotes that the support for one side of the edentulous space is taken from a single abutment.

B: Denotes that the support for one side of the edentulous space is taken from more than one abutment tooth (Fig. 24.34).

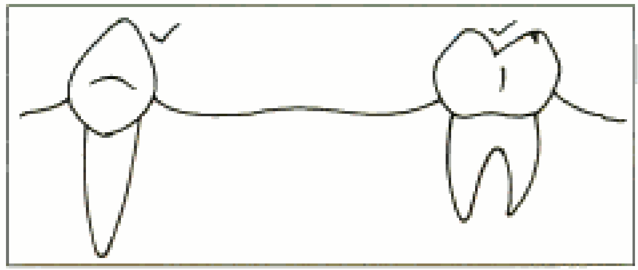


Fig. 24.33: Single abutment support

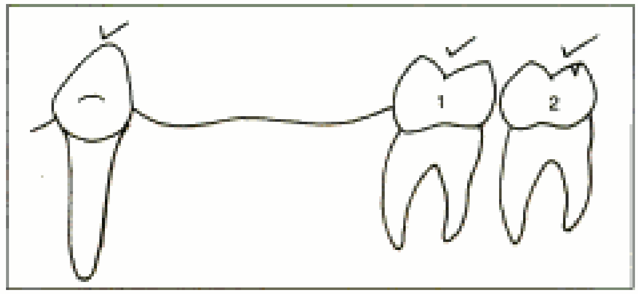


Fig. 24.34: Double abutment support at one end

According to this classification, each class can denote as many as 30 different designs. This classification helps us to visualize:

- Location of the edentulous space.
- Occlusal load expected on the prosthesis.
- The basic design of the prosthesis.
- It also gives us information about the details for the design.
- The status of the abutment teeth.

Since we have followed this classification of FPDs throughout the book, let us see some examples.

1. *"Class I, Division I, Sub-division I-B"* (Fig. 24.35) Consider a case with a missing first and second premolars with healthy posterior teeth and periodontally compromised anterior teeth.

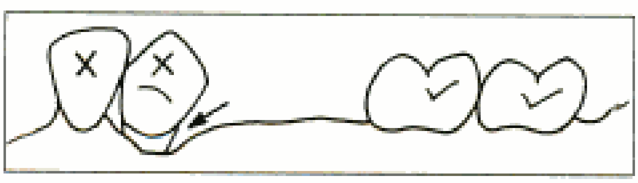


Fig. 24.35: Class 1 division 1 sub-division 1-B edentulous space

It is a Class I case because it involves the replacement of posterior teeth.
Since the anteriors are periodontally compromised, support can only be derived from the

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Chapter 25
Parts of A Fixed Partial Denture

- **Introduction**
- **Retainers**
- **Pontics**
- **Connectors**

25

Parts of a Fixed Partial Denture

INTRODUCTION

All fixed partial dentures are made up of retainers that obtain support from the abutment, pontics that replace the missing teeth and connectors that connect the pontics to the retainers.

In this section we shall discuss in detail about the types of retainers, pontics and connectors commonly used in the construction for a fixed prosthesis. The design considerations for each of these components have been discussed in Chapter 26 and the fabrication of these components have been explained in Chapter 32.

RETAINERS

Retainer in a fixed partial denture is defined as, *"the part of a fixed partial denture which unites the abutment(s) to the remainder of the restoration"* – GPT.

Retainer is a crown or any restoration that is cemented to the abutment. *Major retainers* are retainers, which cover the entire occluding surface of the tooth. E.g. full veneer crowns, partial veneer crowns. *Minor retainers* are small metallic extensions that are cemented onto the tooth. Eg: inlay, onlay.

Types of Retainers

Retainers in fixed partial dentures can be broadly classified as:

Based on tooth coverage:

- Full veneer crowns
- Partial veneer crowns
- Conservative (minimal preparation) retainers

Based on the Material Being Used

- All metal retainers
- Metal ceramic retainers
- All ceramic retainers
- All acrylic retainers

All retainers except conservative retainers require the abutment tooth to be prepared (reduced) to accept them. The amount of required tooth preparation varies according to the type of retainer. The technique, advantages, disadvantages, indications and contraindication for each retainer are described in Chapter 29. In this section, we shall have a brief discussion about the structure and certain salient features of each retainer.

Full Veneer Crowns

These retainers cover all the five surfaces of the abutment. They are fabricated like a cap and are usually indicated for extensively damaged teeth. They are the most retentive and ideal retainers because their design can resist masticatory forces in all directions (Fig. 25.1).

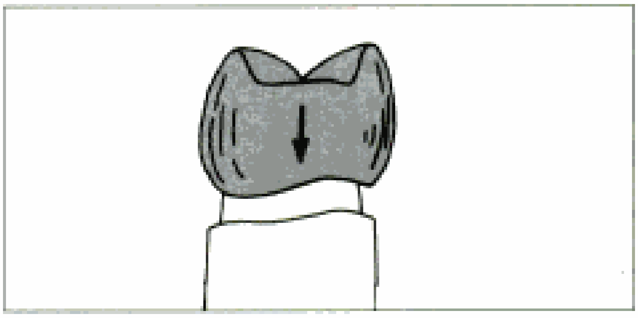

Fig. 25.1: Full veneer crown

Partial Veneer Crowns (Fig. 25.2)

They are preferred over full veneer crowns because they require less tooth reduction. But, they are less retentive compared to full veneer crowns. Pins can be fabricated to fit pin holes created on the tooth for additional retention.

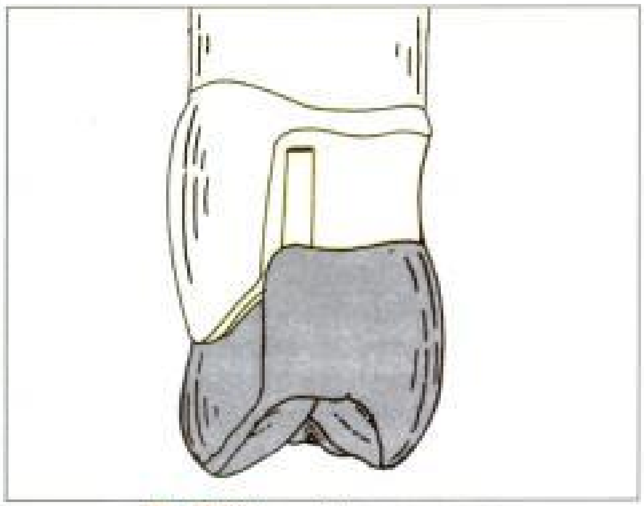

Fig. 25.2: A partial veneer crown

Conservative Retainers

They require minimal tooth reduction/preparation, e.g. acid etching. These dentures cannot accept heavy occlusal load and are primarily indicated for anterior teeth. They have small metallic extensions, which are designed to be luted directly onto the lingual surface of the abutment teeth using a resin cement (Fig. 25.3a).

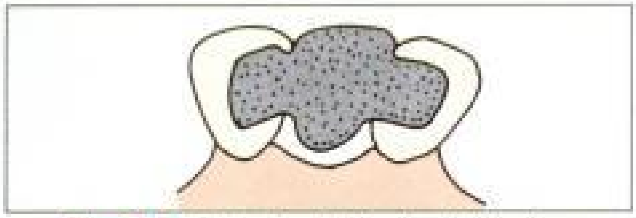

Fig. 25.3a: Resin-bonded fixed partial denture

Telescopic Retainers

This type of retainer is used when the path of insertion of the fixed partial denture does not coincide with the long axis of the abutment tooth. The design involves the fabrication of two copings, one over the other.

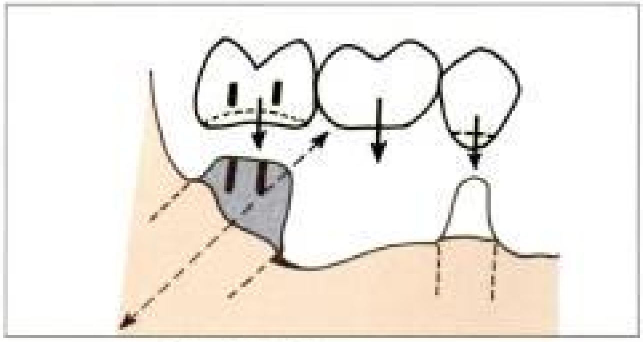

Fig. 25.3b: Telescope crown

The internal or primary coping functions to modify the morphology of the tooth. Hence, the primary coping helps to change the path of insertion. The secondary coping is designed to fit over the primary coping along the new path of insertion. Accurate parallelism of the copings is necessary (Fig. 25.3b). This can be obtained by the use of milling machines.

All Metal Retainers

They can either be partial or full veneer crowns. These retainers require minimal tooth reduction. They are strong even in thin sections (Fig. 25.4).

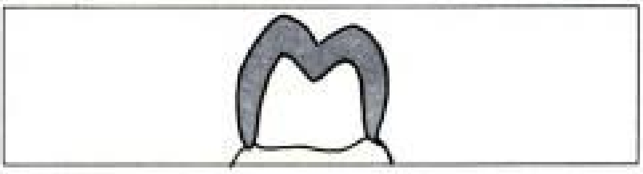

Fig. 25.4: All metal retainer

Metal Ceramic Retainers

They can be fabricated over an entire full veneer crown or they can be fabricated as a facing over the labial/buccal surface of the full veneer crown, or they can be fabricated over a partial veneer crown. They require more tooth reduction (Fig. 25.5).

All Ceramic Retainers

They may also be fabricated as a partial veneer or full veneer crown. They require maximum tooth reduction because porcelain requires sufficient bulk for adequate strength.

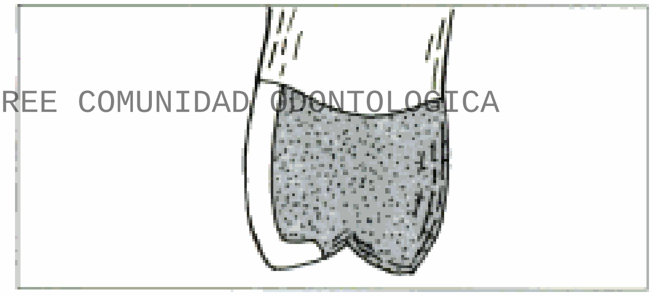

Fig. 25.5: Metal ceramic retainer

All Acrylic Retainers

They are used for long-term temporary fixed partial dentures. They are not indicated for permanent restorations.

Criteria for Selecting Type of Retainers

Retainers can be specifically designed to suit the condition of the abutment.

Alignment of abutment teeth and retention: This criterion can also be used to select the type of connectors (discussed later).

- If the abutment teeth are aligned parallel to one another, a full veneer crown can be given. In such cases, a fixed-fixed bridge (fixed partial dentures with rigid connectors) can be designed, because parallel alignment helps to provide a single path of insertion (Fig. 25.6).

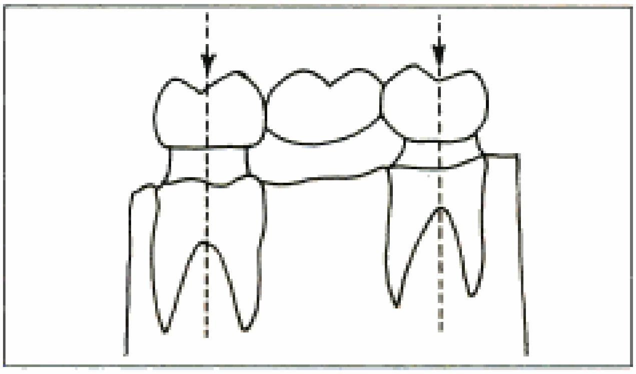

Fig. 25.6: A fixed partial denture using conventional retainers can be fabricated if the edentulous space is bound by parallel abutments

- If the abutment teeth are not aligned parallel to one another, a common path of insertion is not possible. A fixed-fixed bridge cannot be designed. Hence, a pin-retained crown, which need not be placed along the long axis of the tooth can be given (Fig. 25.7).

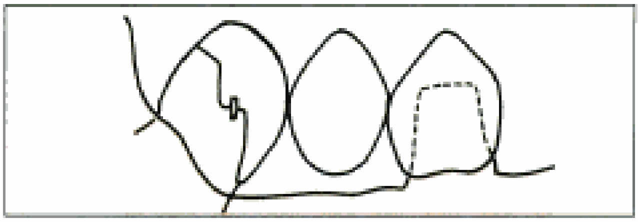

Fig. 25.7: Non-parallel abutments require pin retained retainers

Appearance

- Sometimes full veneer crowns show superior aesthetics to partial veneer crowns and sometimes neither type will be completely satisfactory.
- It is best to retain the facial /buccal surface of the natural tooth as they provide the best aesthetics.
- In cases with inadequate pontic spaces, full coverage restorations can be designed for better appearance.

The Condition of the Abutment Teeth

It is obvious that the abutment controls the design of a retainer. A detailed explanation about the types of abutments and their management has been described in Chapter 27.

- Partial veneer crowns are preferred for non-carious abutments or abutments with large restoration but intact facial/buccal surface (Fig. 25.8).
- Endodontically treated teeth may have to be restored with core/post before designing the retainer (Fig. 25.9).

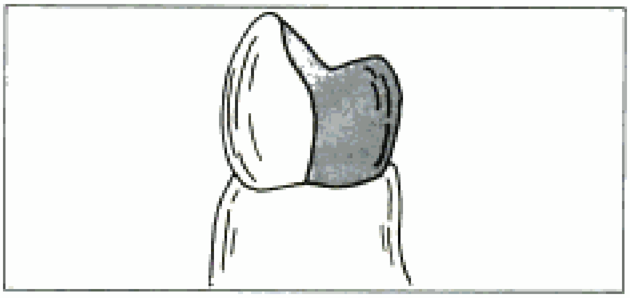

Fig. 25.8: Partial veneer crowns are preferred for healthy abutment teeth

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Based on Mucosal Contact

Saddle pontic: A pontic with a concave gingival surface that overlaps the ridge buccally and lingually is called a saddle. The gingival surface of the saddle pontic will not have continuous contact with the ridge instead only the buccal and lingual ends of the gingival surface will contact the tissue (Fig. 25.15). The major disadvantage of this design is the difficulty in maintenance. Special instructions to floss (clean) the gingival surface should be given to the patient.

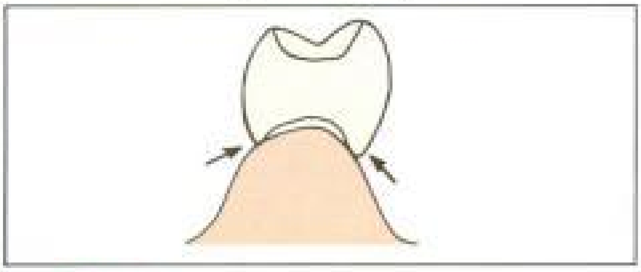


Fig. 25.15: Saddle pontic with buccal and lingual tissue contact

Though some researchers have demonstrated acceptable short-term results, it is not a widely accepted design. The short-term success may be due to close adaptation of the pontic to the ridge. The close adaptation could have prevented the collection of food debris in-between the pontic and the mucosa.

These pontics are generally avoided because they are very difficult to maintain and it is impossible to avoid accumulation of food debris.

Ridge lap pontics

This pontic resembles a natural tooth (Fig. 25.16). It is designed to adapt closely to the ridge. It is avoided because it is difficult to maintain and often leads to inflammation of the tissues in contact.

Modified ridge lap pontic

Ridge lap pontics evolved from saddle pontics. Though the ridge lap pontics had relatively less tissue contact, they were also difficult to maintain. Hence, ridge lap pontics were modified and evolved as the modified ridge lap pontics. Modified ridge lap pontics were designed to further reduce the tissue contact (Fig. 25.17). They

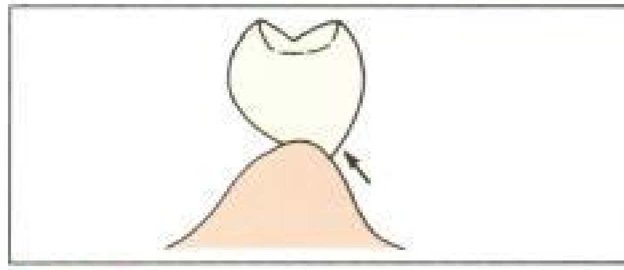


Fig. 25.16: Ridge lap pontics where the tissue contact is predominantly on the labial surface of the ridge

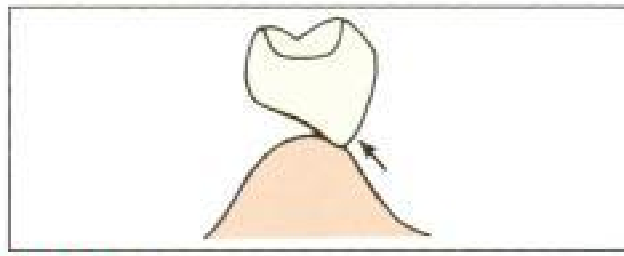


Fig. 25.17: Modified ridge lap pontics where tissue contact is strictly limited to the labial surface of the ridge

do not overlap the ridge on either sides like saddle pontics instead the tissue contact is limited to the buccal surface of the ridge crest.

This pontic is designed with a slight bucco-lingual concavity wherein food entrapment can occur. Food entrapment is avoided by designing a convex mesiodistal surface. The mesiodistal surface should be more convex to avoid food entrapment.

Tissue surface of the pontic shows a 'T' shaped contact. The vertical arm of the 'T' ends at the crest of the ridge. The horizontal arms form the contact along the buccal surface of the ridge. Contact with the facial/buccal surface of the ridge is essential to provide a natural appearance (Fig. 25.18a).

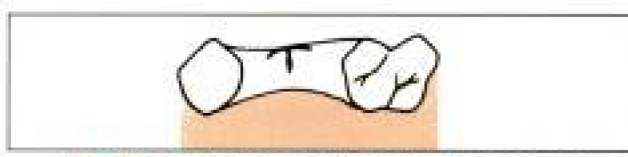


Fig. 25.18a: T-shaped tissue contact of modified ridge lap pontics

Customized ridge lap designs are fabricated in patients with nervous habits who show irritation on the lingual surface. Generally, this pontic is avoided because the buccolingual concavity is difficult to clean and maintain. When the modified ridge lap is further reduced, they are known as *lap facings* (Fig. 18b).

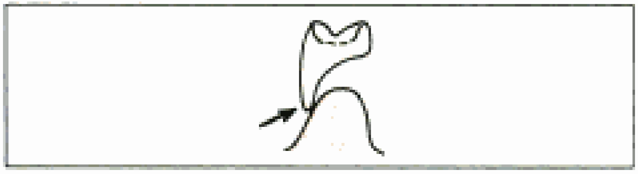


Fig. 25.18b: Lap facing

Ovate pontics

These pontics are used in cases where the residual ridge is defective or incompletely healed. They can also be used in broad and flat ridges. The pontic is designed such that its cervical end extends into the defect of the edentulous ridge (Fig. 25.19). The pontics should be reduced as healing progresses. This pontic is more aesthetic as it appears to arise from the ridge like a natural tooth. It is said to have evolved from *root extended or root tipped pontics*.

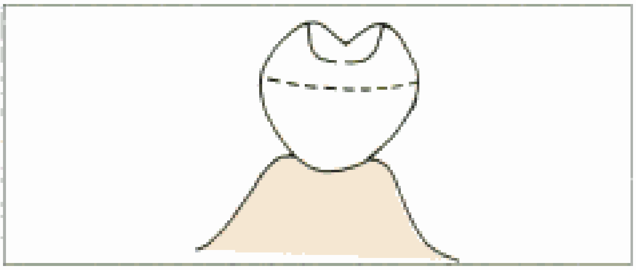


Fig. 25.19: Ovate pontic

Bullet-shaped or conical or heart-shaped pontic

This pontic has a convex tissue surface, which contacts the tissue at one single point without any pressure (Fig. 25.20a). This pontic is very easy to clean and maintain. The only disadvantage of this design is its poor aesthetics, which results due to wide embrasures. It is indicated for the replacement of mandibular posterior teeth where aesthetics is not a major concern.

Spheroidal and modified spheroidal pontics (Figs 25.20 b and c)

- These pontics contact the tissue only at the ridge crest.
- They do not have concave gingival surfaces
- They are indicated for cases with reduced inter-arch space, where the pontic should give

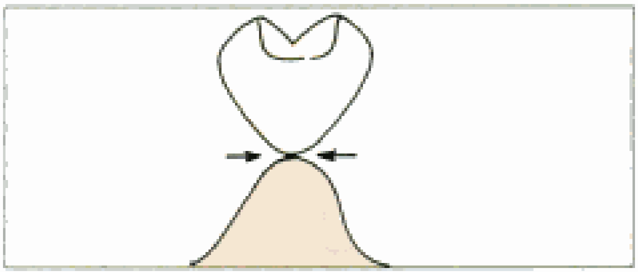
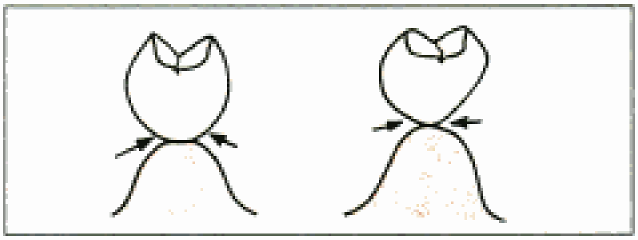


Fig. 25.20a: Conical pontic



Figs 25.20b and c: (b) Spheroidal pontic
(c) Modified spheroidal pontic

the appearance of an exaggerated occluso-gingival dimension.

Sanitary or hygienic pontics

These pontics have zero tissue contact. Though they are easy to maintain, they are highly unaesthetic. Hence, they are used only for posterior teeth. The pontic should be atleast 3 mm high occluso-gingivally and at the same time provide adequate tissue clearance for easy maintenance.

Three common designs can be employed while fabricating a sanitary pontic. They are:

Bar sanitary pontics These pontics have a flat gingival surface that has sufficient gingival clearance (Fig. 25.21a).

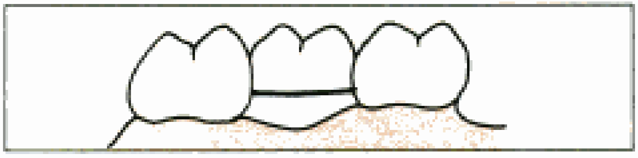


Fig. 25.21a: Bar sanitary pontic

Conventional sanitary or fish belly pontic The gingival surface of the pontic is convex both buccolingually and mesiodistally. The pontic resembles the belly of a fish and hence the name (Fig. 25.21b). This design has two disadvantages namely, the size of the connectors are decreased, hence, the strength of the prosthesis is reduced

Fig. 25.21b: Fish belly pontic or conventional sanitary pontic

and the mesial and distal contours of the pontic are difficult to maintain.

Modified sanitary or perel pontic or arc-fixed partial denture The gingival surface of the pontic is designed to be a hyperparaboloid. That is, the gingival surface of the pontic is concave mesiodistally and convex buccolingually (Fig. 25.22).

Fig. 25.22: Modified sanitary pontic or perel pontic

This pontic overcomes the limitations of the fish belly pontic. The arch shape increases the size of the connectors and is easier to maintain.

Articulated pontics These are modified pontics with inbuilt connectors. The pontic is fabricated in two portions that fit on to one another during insertion. Refer split pontic and cross pin-wing connectors in the next part of the chapter.

Based on Material

Metal-ceramic Pontics

Advantages:
- Aesthetic
- Biocompatible
- Straightforward procedure.

Disadvantages:
- Difficult to fabricate if the abutment is not metal ceramic.

Indications:
- Most situations

Contraindication:
- Long span bridges

Resin veneered pontic

Advantages:
- Straightforward procedure.
- Conventional gold alloy substructure.

Disadvantages:
- Lesser strength compared to all metal pontics
- Poor abrasion resistance
- Staining at resin metal interface
- Permeable to oral fluids
- Unaesthetic

Indications:
- Long-term provisional restoration

Contraindications:
- Definitive restorations.

All metal pontic

Advantages:
- Strength
- Single step procedure

Disadvantages:
- Permeable to oral fluids
- Poor aesthetics

Indications:
- Mandibular molars especially under high stress
- Bruxism.

Contraindications
- Where aesthetics is more important.

Based on method of fabrication

Custom-made pontics: These pontics are fabricated individually for the patient. A wax pattern is prepared and cast to prepare the pontic. These are the most commonly used types of pontics. They offer superior aesthetics and flexibility but the fabrication procedure is tedious compared to prefabricated pontics. Most of the previously mentioned designs are custom made pontics.

Pre-fabricated pontic facings: They are commercially available as porcelain pontics. They should be adjusted according the individual requirement. They are finally reglazed and fit to a metal *backing* (usually gold). A metal backing is a custom fabricated portion of the pontics designed to accept a prefabricated facing (Fig. 25.23). Some of the commonly used pontic facings have been discussed below.

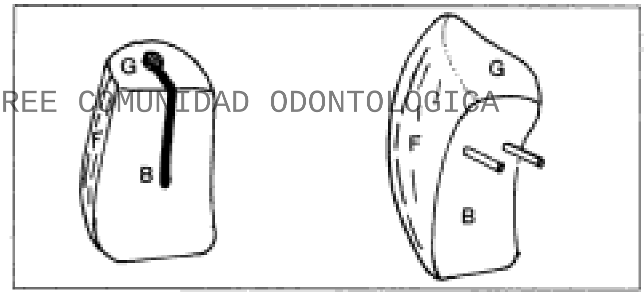


Fig. 25.23: Prefabricated facings
Key: G: Gingival surface of the facing, F: Facial surface of the facing, B: Backing surface of the facing

Trupontic

This pontic consists of a large gingival bulk, which can be adapted to the ridge. It has a horizontal tubular slot running in the centre of the lingual surface of the facing. It has two proximal slopes/bevels on either side of the central bulk (Fig. 25.24). This slot and the proximal bevels provide retention. It is indicated in cases with limited inter-arch distance. It cannot be used when there is reduced inter-occlusal distance due to the presence of a large gingival bulk.

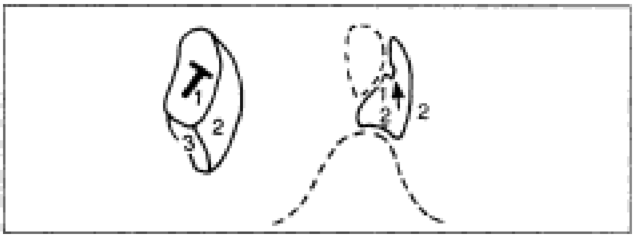


Fig. 25.24: (a) Trupontic (b) Lateral view in relation with the backing and the ridge.
Key: (1) Backing surface of the facing (2) Facial surfaces of the facing (3) Tissue surface of the facing

Interchangeable facing or flat back facing

It consists of a vertical slot in its flat lingual surface. The facing is retained by a backing with a lug (elevation), which is designed to engage the retention slot (Fig. 25.25). The tissue contact should be a part of the backing (not the backing facing junction) to ensure a smooth finish (Fig. 25.26). The major disadvantage of this system is its complex design, which leads to accumulation of plaque and gingival inflammation.

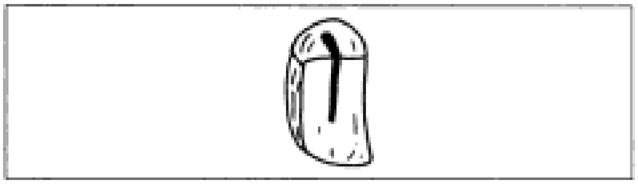


Fig. 25.25: Interchangeable facing

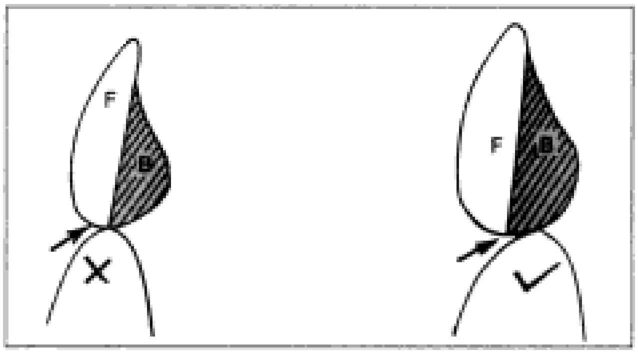


Fig. 25.26: Tissue contact should be made by the backing and not the facing backing junction

Sanitary facings

These are prefabricated pontic facings, which resemble sanitary pontics described before. These pontics have slots on the proximal surface to fit into the metal projections made in the fixed partial denture (Fig. 25.27). The facing has a flat occlusal surface which is customised as needed.

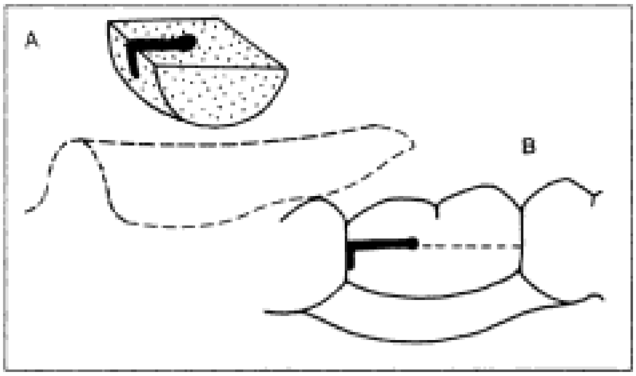


Fig. 25.27a and b: (a) Sanitary facing (2) Customised occlusal form over a sanitary facing

Pin facing

The lingual surface of this facing is flat and consists of two pins for retention (Fig. 25.28). It should be positioned over the backing such that the gold porcelain junction does not contact the tissues (Fig. 25.29). It is indicated in cases with reduced occluso-gingival height.

Modified pin facing

Here, the flat lingual surface of the pin facing is modified by adding additional porcelain onto the gingival portion of its lingual surface (Fig. 25.30).

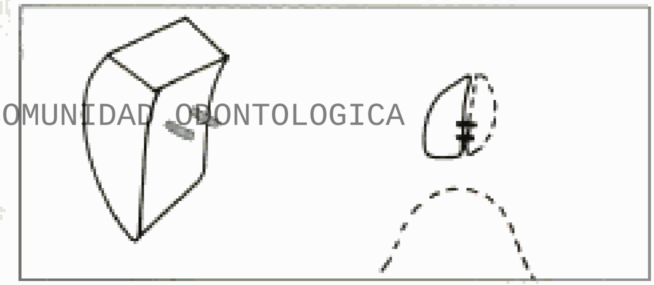


Fig. 25.28: Pin facing

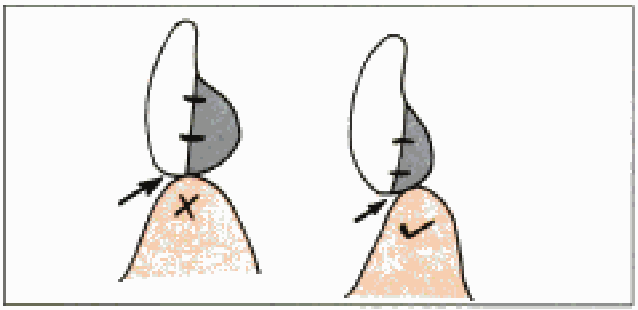


Fig. 25.29: Tissue contact should be made by the backing and NEVER the facing backing junction

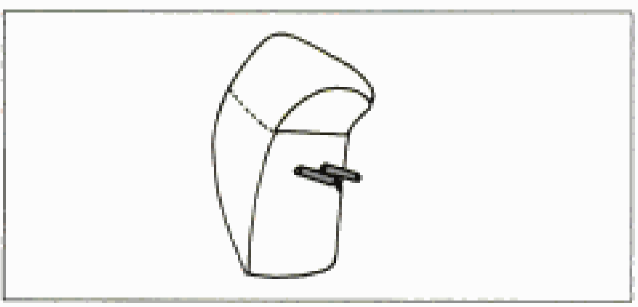


Fig. 25.30: Modified pin facing

They differ from Harmony facings (discussed later) in that the entire gingival portion of the facing is custom-made.

Reverse pin facing

Commercially available porcelain denture teeth with pins can be altered to obtain this facing. The pins in the porcelain tooth are ground off and the tooth is altered and customized according to the ridge (Fig. 25.31). Precision drill holes are made on the lingual surface of the facing and these act as source of retention (Fig. 25.32). Nylon bristles are aligned to the drill holes and incorporated into the wax pattern of the backing (here the backing is fabricated according to the facing) (Fig. 25.33). It is indicated for cases with deep overbite where short pins are required.

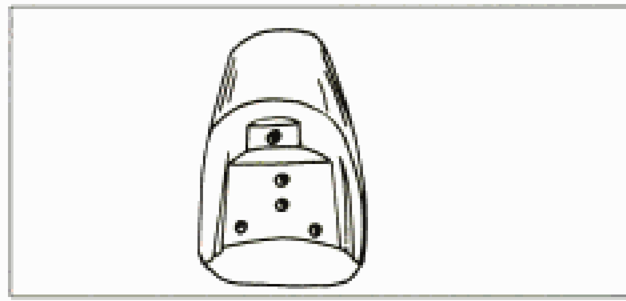


Fig. 25.31: Reverse pin facing

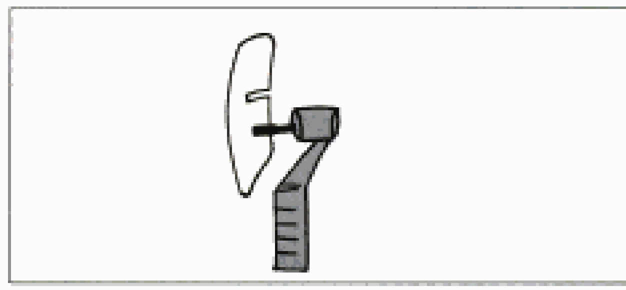


Fig. 25.32: Placing retention holes on porcelain denture teeth

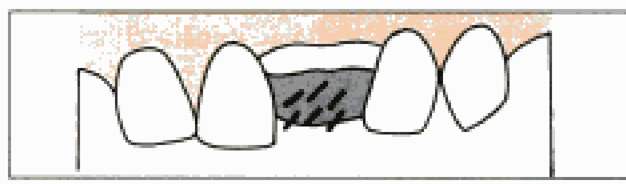


Fig. 25.33: Backing with retentive pins to accept a reverse pin facing (The pins in the backing are fabricated according to the facing and not the vice versa).

Harmony facing

The facing consists of a flat lingual surface with two retentive pins. The gingival surface is usually supplied uncontoured. Porcelain is added to the gingival surface and contoured according to the ridge, finally glazed and finished (Fig. 25.34). These facings are *not* indicated for cases with

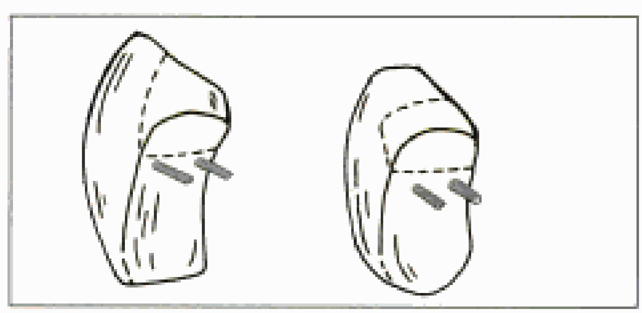


Fig. 25.34: Harmony facing: (a) anterior (b) maxillary posterior

decreased occlusogingival height as the placement of the pins are difficult and a proper facial contour cannot be achieved.

It should be remembered that the entire gingival bulk is custom fabricated in a modified pin facing whereas in a harmony facing a portion of the gingival bulk is custom fabricated (Fig. 25.35).

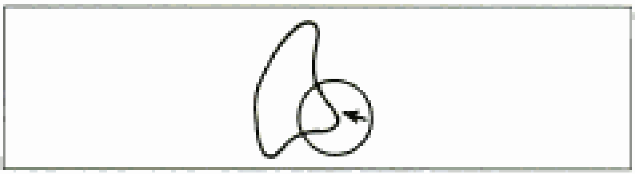


Fig. 25.35: Only a portion of the gingival bulk is contoured in a harmony facing

Porcelain fused to metal facing

This facing consists of a metal core over which porcelain is fused to closely resemble the contours of a natural tooth. Care should be taken to avoid contact of the metal porcelain junction with the tissues. It is more aesthetic; hence, it is indicated for anterior teeth (Fig. 25.36a).

Pontips

These facings are used when the tissue contact of the pontic should of glazed porcelain. The pontip has a convex gingival surface that favours a pin point tissue contact. It is attached to the backing occlusally with the help of retentive pins. The occlusal surface is customised over the backing (Fig. 25.36b). They resemble sanitary facings but they have positive pin point tissue contact.

Pontic Modification

If the edentulous ridge is heavily resorbed, then the large gingival embrasures between the pontic(s) and retainer(s) will appear highly unaesthetic. These large embrasures or so-called *'black triangles'* act as a source of plaque accumulation and flossing interference (Fig. 25.37).

Such cases can be treated by two methods. One is to modify the pontic and fill the entire embrasure space with pink porcelain (Fig. 25.38). This can be done in aesthetically low profile areas like lower anteriors and upper posteriors. The other method is the fabrication of an Andrew's bridge system discussed in detail in chapter 30 (Fig. 25.39).

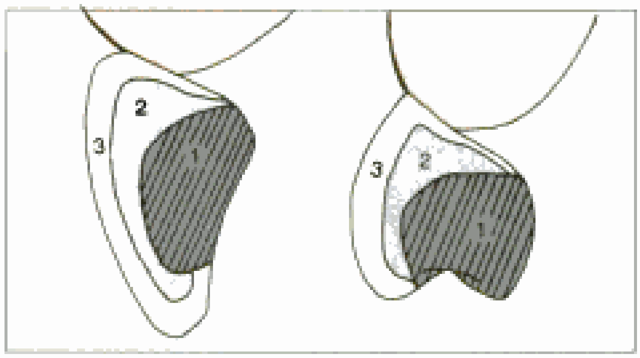


Fig. 25.36a: Porcelain fused to metal facing (1) Metal backing (2) Metal of the facing (3) Ceramic fuse to metal of the facing

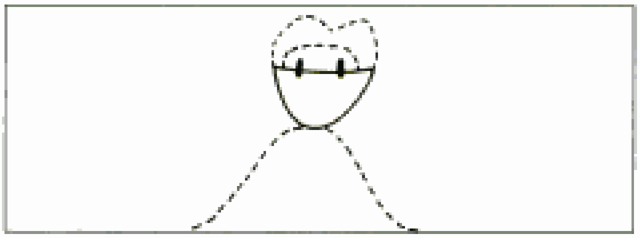


Fig. 25.36b: Pontips

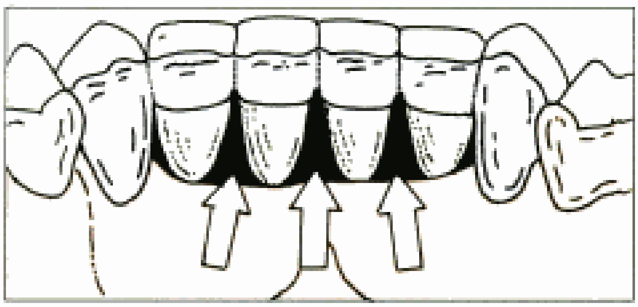


Fig. 25.37: Lingual view of open gingival embrasures ("black triangles") on a fixed partial denture

The design of the pontic is probably the most important factor in determining the success of the restoration. If the patient is unable to effectively clean and maintain the pontic, the restoration will be unsuccessful. Special considerations are needed to create a design that combines ease of maintenance with a natural appearance and adequate mechanical strength.

CONNECTORS

Connector in a fixed partial denture can be defined as, *"The portion of a fixed partial denture that unites the retainer(s) and pontic(s)"*- GPT. Connectors can be broadly classified as:

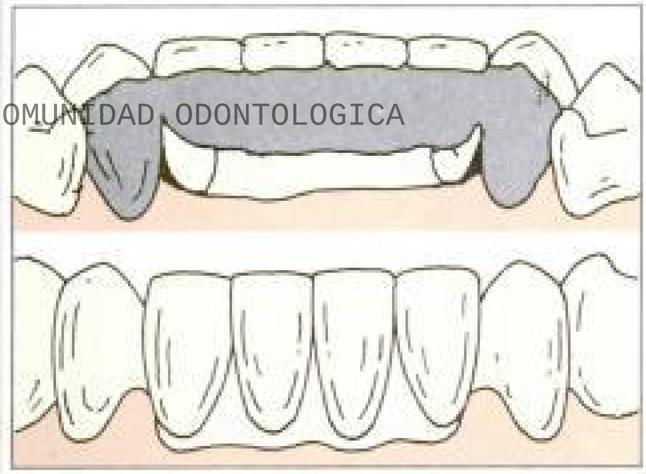


Fig. 25.38: Lingual (above) and facial (below) views of fixed partial denture with embrasure filled with pink porcelain. This is aesthetic as long as the patient does not show the porcelain-gingiva junction

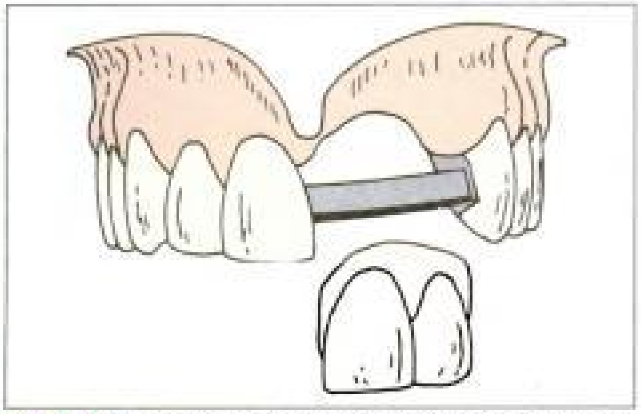


Fig. 25.39: In some cases, larger anterior defects may be better managed by an Andrews bridge system with a removable acrylic insert that clamps down over a bar linking the abutments

- Rigid connectors
- Non-rigid connectors
  - — Tenon-Mortise connectors
  - — Loop connectors
  - — Split pontic connectors
  - — Cross pin and wing connectors

Rigid Connectors

They are used to unite retainers and pontics in a fixed-fixed partial denture. These connectors are used when the entire load on the pontic is to be transferred directly to the abutments.

A rigid connection can be made by casting as part of a multiunit wax pattern or by soldering (Fig. 25.40). The design of rigid connector is incorporated in to the wax pattern. Connectors that are to be soldered are sectioned in the wax pattern with a thin ribbon saw so that when the components are cast they can be joined on a flat, parallel and at a controlled distance of 0.13 mm (Fig. 25.41).

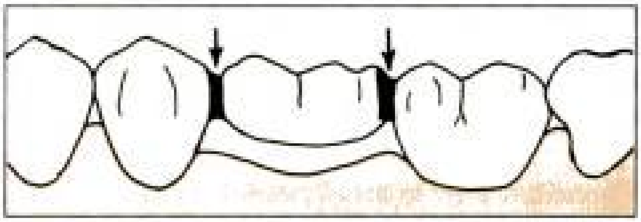


Fig. 25.40: Rigid connector of a fixed-fixed bridge

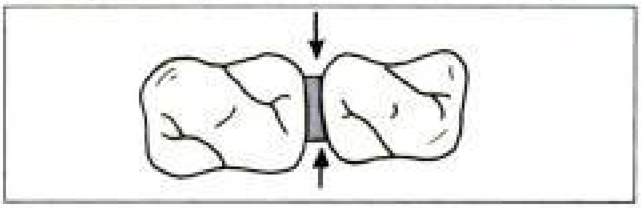


Fig. 25.41: A rigid connector with parallel surfaces and a controlled dimension

Non-Rigid Connectors

These connectors are indicated in cases where a single path of insertion cannot be achieved due non-parallel abutments. These connectors allow limited movement between the retainer and pontics. The common non-rigid connectors are discussed below.

Tenon Mortise connectors (TMC) with a male and female component or Dovetail connectors:

The non-rigid connector (incorporated during the wax pattern stage) consists of a Mortise (female) prepared within the contours of the retainer and a Tenon (male) attached to the pontic (Fig. 25.42). The alignment of this dovetail connection is critical; it must parallel the path of withdrawal of the other retainer. Paralleling is normally accomplished by means of a dental surveyor. The female component may be prepared free hand in the wax pattern or with a precision milling machine. Alternatively a special mandrel

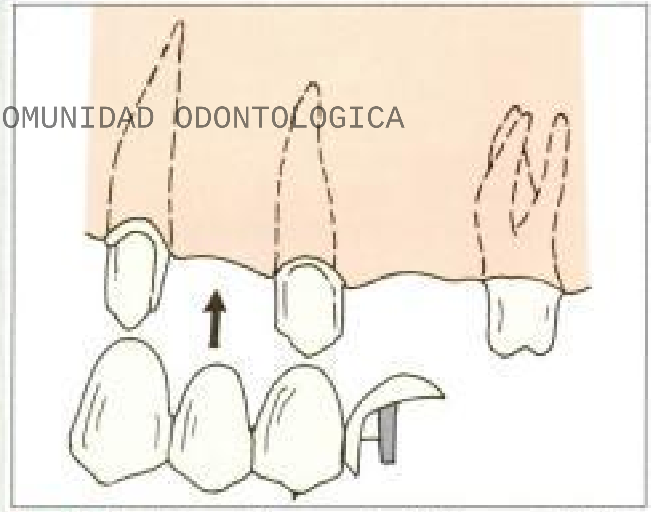


Fig. 25.44a: The mesial segment, which is cemented first, has a distal shoe in the gingival portion of the pontic

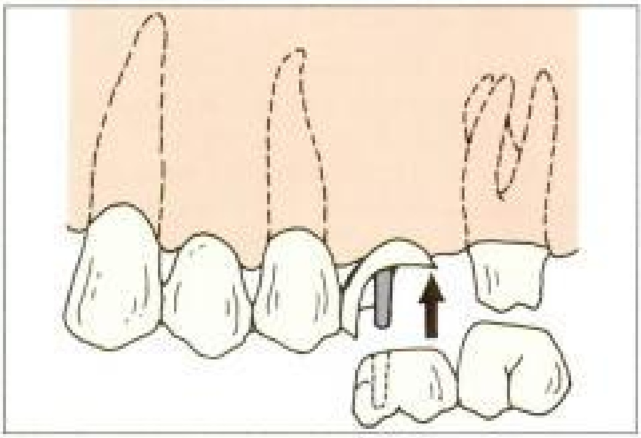


Fig. 25.44b: The distal segment of the pontic covers the mesiogingival part of the pontic when the distal retainer is cemented

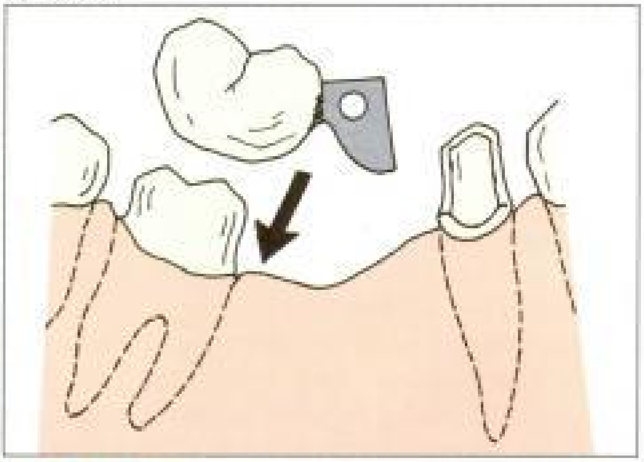


Fig. 25.45: The distal retainer and wing should be cemented first

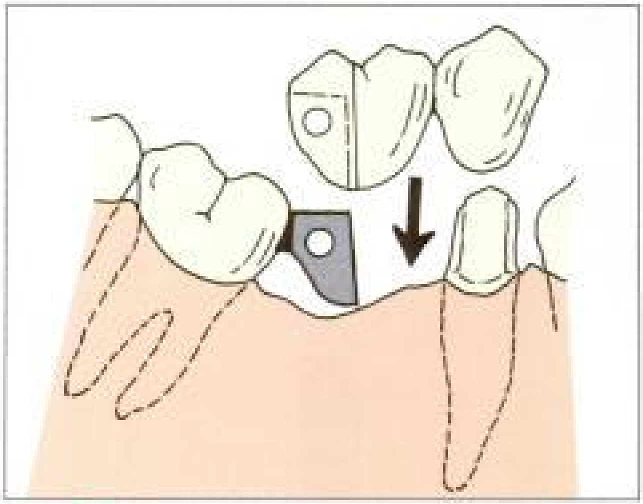


Fig. 25.46: The retainer-pontic segment is seated finally

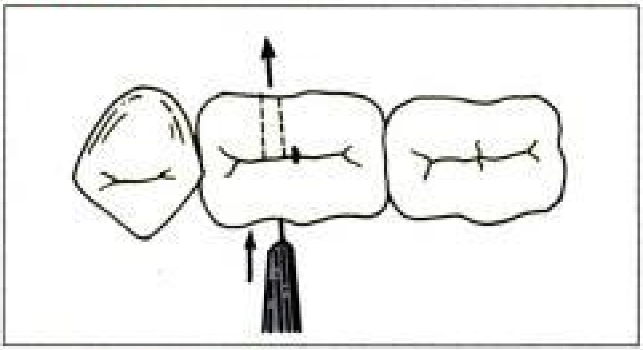


Fig. 25.47a: A tapered pin is driven through the pontic and wing

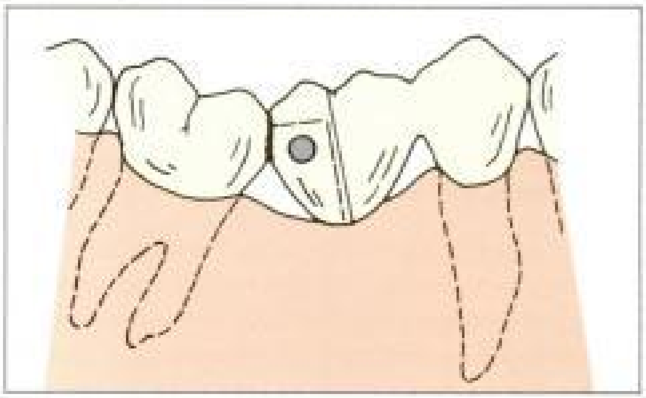


Fig. 25.47b: Cemented cross-pin and wing fixed partial denture

using the same alloy (to avoid galvanic corrosion). The pin should be seated within the pinhole created on the wing and pontic and adjusted to its exact length (Fig. 25.47).

After cementing the components, the pin is seated into the hole using a punch and mallet.

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In the following section we shall study about the properties of different materials, which affect the design of an FPD. Specific design concepts and tooth preparation should be followed for each material to improve the success of the prosthesis.

Plastic Materials

These materials require considerably less amount of tooth preparation. But their success is limited due to their poor strength, e.g. resins.

Cast Metal

The material is strong and provides a very good fit and finish. They have an excellent success rate and hence are most commonly used. Cast metals are generally classified as intracoronal and extracoronal replacements.

Intracoronal Replacements

Gold is the metal most commonly used for intracoronal restorations. It gives an excellent fit and finish. The major disadvantage is that they require extensive tooth preparation even for small lesions.

Extracoronal Replacements

They are used for teeth with extensive carious lesions. The material requires extensive tooth preparation. Since the margins are placed near the gingival margin, periodontal health may be affected.

Metal Ceramics

These materials require extensive tooth reduction, and are unesthetic due to the visible metal-ceramic junction. The junction has to be placed below the gingival margin in order to hide the unaesthetic junction; this may lead to periodontal disease.

Metal ceramics can be modified such that the facial/buccal surface is made only of ceramic for enhanced aesthetics.

Resin Veneer

This material was widely used before the arrival of porcelain. Lately, methacrylate in this material has been replaced by Bis-GMA. Bis-GMA improves strength and wear resistance.

Fibre Reinforced Resin

This is a type of fibre-reinforced composite. It provides a good fit and finish and is very aesthetic. Long-term results are yet under study.

Complete Ceramic

It has the best aesthetics but the worst marginal finish. Another major disadvantage is that it requires maximum tooth reduction. It is very brittle material (due to low elastic strain) hence, the restoration should be more bulky to attain sufficient strength. Recent systems with high strength fillers like alumina and zirconia promise to improve the tensile strength of porcelain.

BIOMECHANICAL CONSIDERATIONS

The design of a fixed partial denture is determined by the physical factors affecting the prosthesis. The major biomechanical factors which affect the design of an FPD are:

- Length of the edentulous span
- Occlusogingival height of the pontic.
- Arch curvature.
- The direction of forces acting on the FPD.

Length of the Edentulous Span and Occlusogingival Height of the Pontic

A long span fixed partial denture transfers excessive load to the abutment and also tends to flex to a greater extent. Longer the span, more is the flexion of the FPD. The flexion of an FPD varies as follows:

$$\text{Flexion} = \frac{(\text{Length of the Fixed Partial Denture})^3}{(\text{Occlusogingival Height of the Pontic})^3}$$

For example a span of two pontics will flex eight times more than a single pontic FPD (Fig. 26.1). Hence, the flexion of a long span fixed partial denture can be decreased by increasing the occlusogingival height of the pontic or by using high strength alloys like nickel chromium.

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The major criteria for choosing an abutment have been discussed below. The factors influencing the choice of an abutment are:

Location, Position and Condition of the Tooth

Teeth with the following characteristics are preferred abutments:

- Teeth adjacent to edentulous spaces.
- Teeth with grossly decayed crowns that can be restored with a full veneer crown. (Note: the periodontal support should be uncompromised).
- Modifications like dowel core and pin retained amalgam restorations may be needed to restore crown morphology in grossly destructed teeth.
- Vital teeth are preferred, though endodontically treated teeth can also be used.
- Pulp capped teeth should not be used as abutments because they are always under the risk of requiring root canal treatment.

Root Configuration

The forces acting on a tooth are transferred to the supporting bone through the root. The shape of the root determines the ability of the abutment to transfer the masticatory load to the supporting bone. Some facts to be remembered regarding the configuration of an abutment root are:

- Roots with greater labiolingual widths are preferred (Fig. 26.4).
- Roots with irregular curvatures are preferred (Fig. 26.5).
- Teeth with longer roots serve as better abutments (Fig. 26.6).

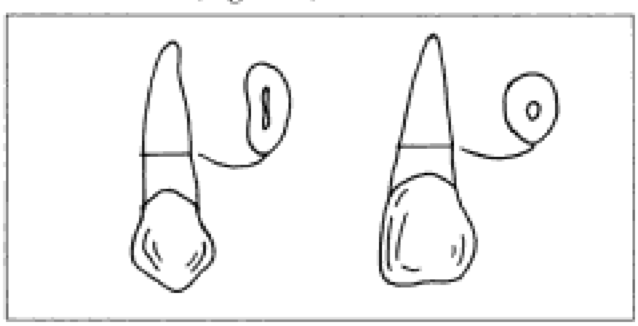

Fig. 26.4: Teeth with flat roots resist rotation and hence are preferred to as abutments

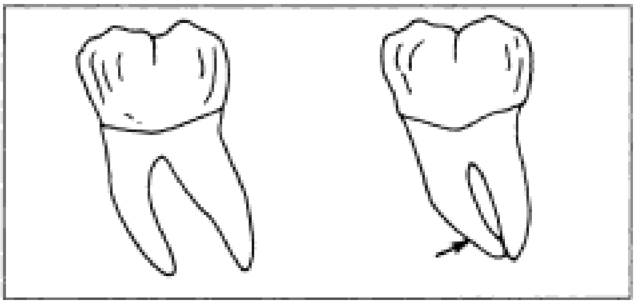

Fig. 26.5: Teeth with root curvatures are preferred as better abutments

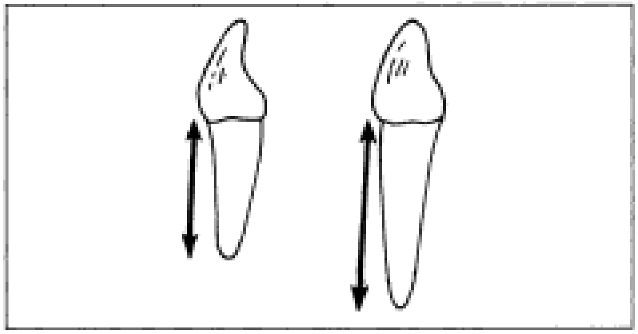

Fig. 26.6: Teeth with longer roots act as good abutments

- Teeth with conical roots can be used for short span fixed partial dentures.

Crown Root Ratio

The ratio between the length of the crown and the length of the root should always be less than one. The length of the crown in this case does not indicate the clinical or anatomic crown instead it indicates the length of the tooth structure above the crest of the alveolar bone. Teeth with alveolar defects are considered to have very long crowns. (Fig. 26.7). Ideally the crown root ratio should be 2:3 (0.66). Ratios up to 1:1(1.0) are acceptable (Fig. 26.8). Ratios above one (i.e. the length of the crown is longer than the root) are unacceptable.

Root Support

The supporting alveolar bone should be healthy. It should have good trabecular architecture and show no signs of bone defects or bone loss. Intraoral radiographs should be used to evaluate the bone architecture (Fig. 26.9). The alveolar bone

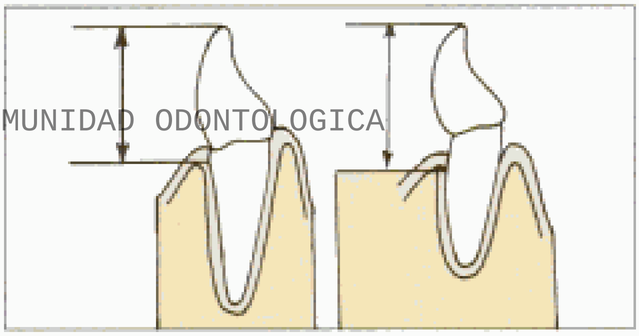

Fig. 26.7: The true 'crown length' indicates clinical crown height and not anatomical crown height

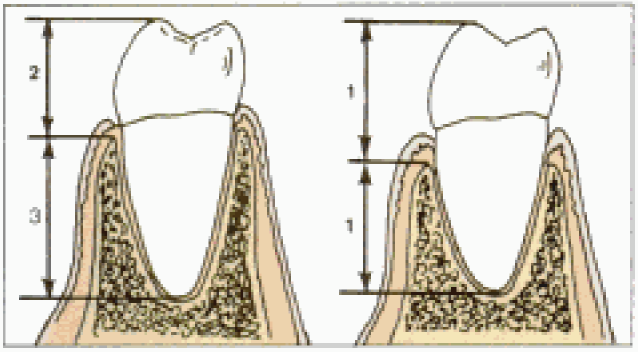

Fig. 26.8: Ideally the root should be longer than the crown (3:2) for the tooth to act as a good abutment. Ratios upto 1:1 is acceptable for a tooth to act as an abutment

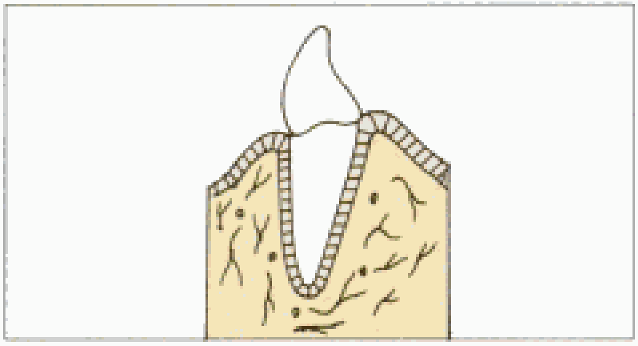

Fig. 26.9: The abutment should have sufficient bone support. The alveolar bone should show good trabecular pattern

support is one of the most important factors that aid to evaluate an abutment.

Periodontal Ligament Area

It depends upon the size and length of the root. We know that the bone support increases with an increase in the periodontal ligament area. As mentioned before, periodontally diseased teeth are unsuitable to be used as abutments. The loss of periodontal support is almost half as important as loss of bone support.

The periodontal ligament area can be used as a scale or measurement to determine the potency of an abutment. *Tylman* stated that two abutment teeth could support two pontics.

Johnston et al improvised Tylman's statement and proposed the famous *Ante's Law*. According to this law, *"The sum of the pericemental areas of abutment teeth should be equal to or surpass that of the teeth being replaced"*.

The Ante's law has been stated in the glossary as follows, *"In fixed partial denture prosthodontics for the observation that the combined pericemental area of all the abutment teeth supporting a fixed partial denture should be equal to or greater in pericemental area than the tooth or teeth being replaced; as formulated for removable partial prosthodontics, the combined pericemental area of the abutment teeth plus the mucos area of the denture base should be equal to or greater than the pericemental area of the missing teeth"*-GPT.

The pericemental area of the abutment should be calculated and if it is not sufficient then an additional tooth should be used as a secondary abutment (Fig. 26.10).

Assessment of Pulpal Health

Usually unrestored abutments are preferred. If caries is present, regular preparation can be done. If large carious lesions are present they should be scooped out and can be used for additional retention.

If the abutment tooth has a carious lesion with pulpal involvement then root canal treatment is advised. Root canal treatment is not advised for abutments with periapical lesions.

Special designs are considered in cases where the location of one or all the abutments does not advocate a conventional design. An abutment should be chosen according to the crown root ratio, biomechanical considerations, root configuration and periodontal ligament area and pulpal health.

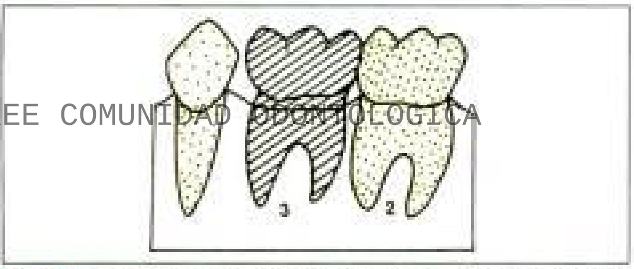

Fig. 26.10a: According to Ante's law the total pericemental surface area of the abutments (1+2) should be equal to or greater than that of the missing teeth (3)

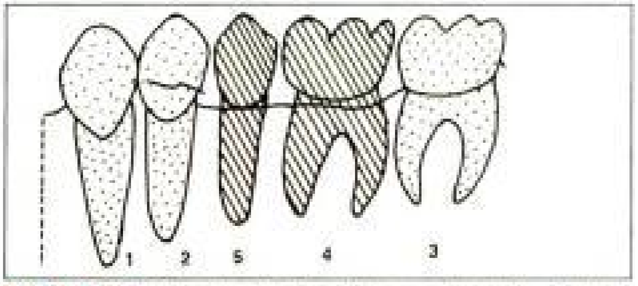

Fig. 26.10b: When two teeth are to be replaced (4 + 5), then the pericemental area of the primary abutments (2 + 3) may not be equal to that of the missing teeth (4 + 5). In such cases, support from an additional tooth (1) should be taken. So that the pericemental area of the abutments (1 + 2 + 3) is equal to or greater than the pericemental area of the teeth to be replaced (4+ 5)

SPECIAL CASES

In this section we shall discuss about certain clinical conditions, which require a unique design.

Replacement of a Single Missing Canine

In cases of a single missing canine, where a cantilever FPD is planned, support should be taken from both central and lateral incisor. It should also be remembered that the replacement of a single missing maxillary canine is considered as a complex fixed partial denture because the tooth lies outside the inter-abutment axis and the adjacent teeth like the lateral incisor and the first premolar are very weak (Fig. 26.11). This FPD will be subjected to forces acting in an outward direction.

Replacement of a Single Missing Molar

If a cantilever FPD is planned for such cases then support should be taken from both the premolars (Fig. 26.12).

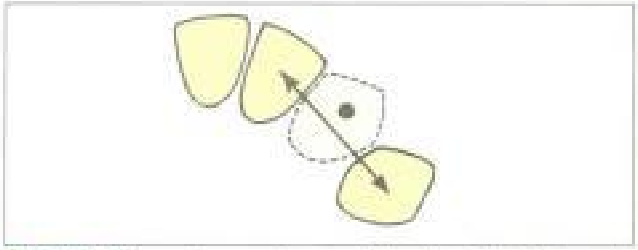

Fig. 26.11: A canine replacement fixed partial denture is subjected to more forces because the canine forms the curve of the arch and tends to lie outside the interabutment axis

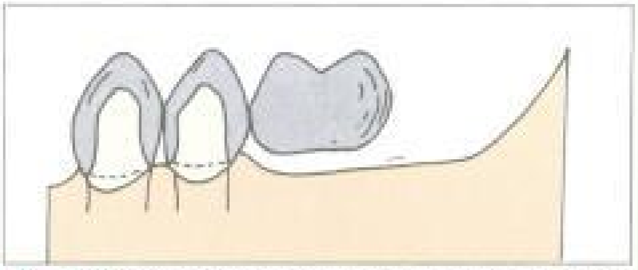

Fig. 26.12: Cantilever fixed partial dentures are not commonly used. They require support from double abutments

Tilted Molar Abutments

Even if a tilted molar abutment is adjacent to the edentulous space, the fixed partial denture should be designed such that it has a single path of placement. This can be accomplished either by up-righting the tooth or by fabricating a partial veneer crown or a telescoping crown. The management of tilted molar abutments have been discussed in detail in Chapter 28.

Pier Abutments

A pier abutment is one with edentulous spaces present on either side. In such cases, a single prosthesis is fabricated using all three abutments (Fig. 26.13). The central (pier) abutment is subjected to leverage and tortional forces acting on the different parts of the denture. In order to protect the pier abutment, specially designed fixed partial dentures using non-rigid connectors have been proposed. Refer Chapter 28 for further explanation.

CONDITION OF THE RESIDUAL RIDGE

The type and amount of destruction of the residual ridge affects the selection of a pontic

Chapter 27
Occlusion in Fixed Partial Dentures

- **Concepts of Occlusion in Fixed Partial Dentures**
- **Anatomy of the Temporomandibular Joint and Related Structures**
- **Kinematic Face-bows and Fully Adjustable Articulators**
- **Occlusal Rehabilitation**

27

Occlusion in Fixed Partial Dentures

CONCEPTS OF OCCLUSION IN FIXED PARTIAL DENTURES

Definitions

Occlusion

The static relationship between the incising and masticating surfaces of the maxillary or mandibular teeth or tooth analogues.

Centric Occlusion

The occlusion of opposing teeth when the mandible is at centric relation. This may or may not coincide with the maximum intercuspation.

Maximum Intercuspation

The complete intercuspation of the opposing teeth independent of condylar position.

Components of Occlusion

The various elements that are involved in occlusion, such as the TM joints, the associated neuromusculature, the teeth, their contacting surfaces and investing tissues and or the denture supporting structures.

Eccentric Occlusion

An occlusion other than centric occlusion.

Occlusion Plane

The average plane established by the incisal and occlusal surfaces of the teeth.

Introduction

We know that all occlusal relationships are momentary tooth contacts during functional (or Parafunctional) movements. Hence, the term "articulation" was coined to denote the relationships of opposing teeth during mandibular movement. Articulation can take place in the empty mouth and during mastication.

A normal occlusion or what is referred to orthodontically as an Angle Class I occlusion is when the mesiobuccal cups of the maxillary first molar is aligned with the mesiobuccal groove of the mandibular first molar. There is an optimum of 138 occlusal contacts in the closure of 32 teeth, which include:

- Functional or supporting cusps.
- Non-functional or guiding cusps.
- Incisal guidance.
- Condylar guidance.
- Imaginary planes and curves.
- Interference during Bennett movements.
- Overjet/overbite/tripodization

ANATOMY OFTHETEMPOROMANDIBULAR JOINT AND RELATED STRUCTURES

Temporomandibular joint (TMJ)

The major components of the joint include the cranial base, the mandible and the muscles of mastication, their innervation and vascular supply.

Each joint can be described as GINGLYMO ARTHROIDAL - Meaning: Hinging and Gliding articulation. The structure of the joint has been discussed in Chapter 10.

The articular disc separates the condylar process of the mandible from the glenoid fossa in the temporal bone (Fig. 27.1). This disc is firmly attached to the poles of the condyle; hence, the

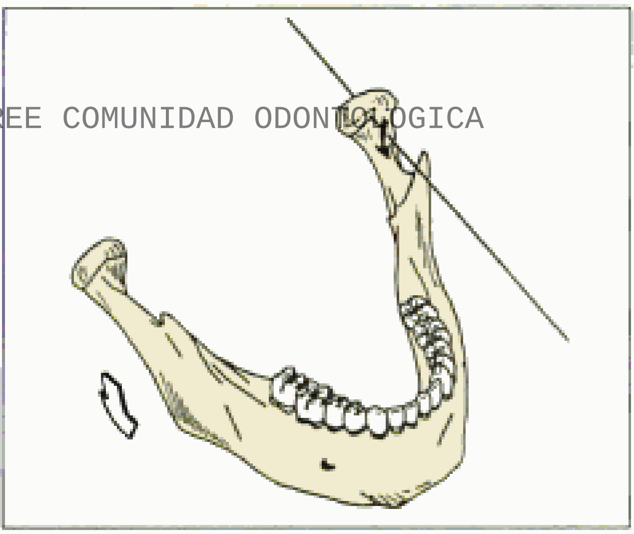

Fig. 27.6: The mandible also rotates around a sagittal axis when one side drops down during a lateral excursion

- Temporomandibular joint
- Teeth influence (occlusion)
- Neuromuscular coordination
- Hinge axis
- Muscles and ligaments that are attached to it

Determinants of Mandibular Movement

They are those anatomic structures that dictate or limit the movements of the mandible.

- Anterior determinants or anterior controlling factors of mandibular movement. E.g. Overbite and overjet and palatal surfaces of maxillary anteriors *(Incisal guidance)*.
- Posterior determinant or posterior controlling factor of mandibular movement, i.e. *condylar guidance*. (slope of the articular eminence).
- The nearness of the cusp to the controlling factors. E.g. posterior occlusal relationships are determined more by condylar guidance than the incisal guidance.

Apart from anterior determinant, posterior determinants, and nearness of the cusp, there are certain vertical and horizontal determinants that control/dictate mandibular movement.

Vertical Determinants of Occlusal Morphology

Factors that influence the heights of the cusp and depths of the fossa are the vertical determinants of occlusal morphology. (The occlusal morphology of the artificial teeth should be shaped in harmony with these factors).

Factor	*Condition*	*Effect*
Condylar guidance	Steeper the guidance	Taller the posterior cusps
Anterior guidance	Greater the vertical overlap	Taller the posterior cusps
	Greater the horizontal over lap	Shorter the posterior cusps
Plane of occlusion	More parallel the plane to condylar guidance	Shorter the posterior cusps
Curve of Spee	More acute the curve	Shorter the most posterior cusps
Lateral translation movement (Bennett)	Greater the movement (Amount)	Shorter the posterior cusps
	More superior the movement of rotating condyle (Direction)	Shorter the posterior cusps
	Greater the immediate side shift (Timing)	Shorter the posterior cusps

Horizontal Determinants of Occlusal Morphology

Horizontal determinants of occlusal morphology include relationships that influence the direction of ridges and grooves on the occlusal surfaces.

Factor	*Condition*	*Effect*
Distance from rotating condyle	Greater the distance	Wider the angle between laterotrusive and mediotrusive pathways
Distance from midsagittal plane	Greater the distance	Wider the angle between laterotrusive and mediotrusive pathways
Lateral translation movement	Greater the movement	Wider the angle between laterotrusive and mediotrusive pathways
Intercondylar distance	Greater the distance	Smaller the angle between laterotrusive and mediotrusive pathways

Theories and Concepts of Occlusion

All occlusal concepts are based on theories borrowed from the past (please do not proceed before reading the basics of occlusion in Chapter 10).

Early concepts include those of Bonwill (1858), Balkwill (1866) and Von Spee (1890). Then came the age of occlusal theories and occlusal articulators which include, Monson's spherical theory (1916), Hall's conical theory (1918), and Hanson's theory (1923) and Meyer's functionally generated path technique (1940).

The occlusal concepts proposed during this period of dental history from 1800 to 1930, can be summarized as being basically formulated for complete denture patients in whom bilateral balanced occlusion in eccentric movements was considered essential.

However, as the principles of bilateral balanced occlusion were introduced into fixed prosthodontics, there was a high rate of failure even with specific attention to detail and the use of sophisticated articulators. Failure was due to factors like occlusal wear, periodontal breakdown and temporomandibular joint disturbance. When posterior contacts on the non-working side were eliminated, these symptoms were generally relieved. Thus, the concept of a *group function* or unilateral balance was proposed.

In a unilaterally balanced articulation (dynamic occlusion), during excursive movements, contact occurs between opposing posterior teeth on the working side only. In natural dentitions, intercuspal position rarely coincided with centric relation.

In 1950's-60's, another group of researchers headed by Mc Collum believed that if the rotational centres in the condyles could be located and if the border movements of these rotational centres were recorded and reproduced on a sophisticated three-dimensional articulator, then all functional movements for the patient could also be reproduced by that instrument. (i.e.)

- Establishing the hinge axis (location of the rotational centres of condyles).
- Using a pantographic tracing to record the three-dimensional envelope of motion.
- Centric relation (CR) = Centric occlusion (CO) or intercuspal position (ICP).
- Bilateral balance with eccentric jaw movements.

These concepts became known as *gnathology*. Schuyler suggested that it is advantageous to allow a certain amount of freedom of movement in an antero-posterior direction. The concept of "long centric" or "freedom in centric" was proposed. A few years later Schuyler joined Pankey and Mann to evolve what is now known as the PMS (Pankey, Mann, Schuyler) system. This system retained the Monson spherical theory and Meyer's functionally generated path technique, however, under Schuyler's influence.

- The balancing side contacts were eliminated
- The importance of incisal guidance was elevated.
- The concept of 'long centric' was proposed.
- The Hanau occlusal instrument with arbitrary face-bow and Broadrick occlusal plane analyzer were adopted.

Mutually Protected System of Occlusion

Gnathologic researchers namely Stallard and Stuart (1960's), felt that the basic theory of collinear hinge axis and border movements was correct, but it's application was misdirected. They proposed the "*Cuspid Protection Theory*" according to which, the balancing contacts during eccentric jaw movements were eliminated by making the canines on the working side disocclude the posterior teeth. The cuspid protection theory developed into the "*Mutually protected system*" were again CR=CO. There are no posterior occlusal contacts during lateral/protrusive excursions. The relationship of the anterior teeth or anterior guidance is critical in achieving this occlusal scheme.

Rationale

The anterior teeth have a distinct mechanical advantage over the posterior teeth; the effectiveness of the force exerted by the muscles of mastication is notably less when tooth contact occurs more anteriorly. The more anterior the initial tooth contact occurs, (Class III lever) the longer the lever arm and hence, the forces exerted by the musculature will be less effective and therefore the load placed on the teeth will also be small (Fig. 27.7).

The canine with its long root, pressoreceptors in the periodontal ligament (sensitive to mechani-

Fig. 27.7: According to the principle of 3rd order levers, the distance between the initial tooth contact and point of action of the muscles is inversely proportional to the occlusal load

cal stimulation) and strategic position in the dental arch is well adapted to guiding excursive movements. Eliminating the posterior contacts during lateral excursions also reduces the amount of lateral forces to posterior teeth.

The features of a mutually protected occlusion are as follows:

- Uniform contact of all teeth when the condyles are in their most superior position.
- Stable posterior tooth contacts with vertically directed resultant forces.
- CR = CO or ICP
- No contact of posterior teeth in lateral or protrusive movements.
- Anterior tooth contacts harmonize with functional jaw movements.

Optimum Occlusion

In an ideal occlusal arrangement, the load exerted on the dentition should be distributed equally. Any restorative procedures that adversely affect occlusal stability may affect the timing the intensity of the elevator muscle activity. Loading should be parallel to the long axis of the teeth. Horizontal forces on any tooth should be avoided. There should be a cusp to fossa occlusal arrangement. During excursive movements, there should be no posterior tooth contact (decreased horizontal forces). The cusps of the posterior teeth should have adequate height to enhance masticatory efficiency.

Biological Occlusion

The flexible concept of occlusion is termed biological occlusion and its goal is to achieve an occlusion that functions to maintain health. This occlusion may include malposed teeth, evidence of wear, missing teeth and CR=CO, etc. most of these conditions may not require occlusal therapy. But when therapy is indicated, then basic guidelines for occlusal design should be followed.

Goals of Biological Occlusion

- No interferences between CR and CO.
- No balancing contacts (non-working side).
- Cusp to fossa relationship.
- A minimum of one contact per tooth.
- 'Cuspid rise' or group function occlusal scheme.
- No posterior contacts with protrusion. Eliminate occlusal contacts on inclined planes to enhance the positional stability of the teeth.
- Eliminate all possible fremitus (functional mobility of teeth).
- When the operator is able to manipulate the mandible, with little/no resistance from the patient, the muscles of mastication are considered to be in a relaxed state. This means that the occlusion is progressing towards harmony with the muscles of mastication.

Myocentric Occlusion

Bernard Jankelson (1969) reported on his myomonitor, which produces relaxation of the mandibular muscles, and then initiates controlled isotonic muscle contraction. This propels the mandible from rest position to a neuromuscularly oriented occlusal position in space. This is referred to as myocentric occlusion.

Pathologic Occlusion

A pathologic occlusion is defined as one in which sufficient disharmony exists between the teeth and the temporomandibular joint to result in symptoms that require intervention. Pathological occlusion can be accompanied by the following symptoms.

Signs and Symptoms

- Teeth may exhibit hypermobility, open contacts, abnormal wear, and chipping of incisal edges or cusp fracture. (there may also be signs of para functional activity).
- Widened periodontal ligament space (radiologically).
- Chronic muscle fatigue E.g. Bruxism can lead to muscle spasm/pain.
- Temporomandibular joint pain: Pain and clicking in the temporomandibular joints can be indicative of malocclusion.
- Myofacial pain dysfunction syndrome (MPDS).

Patient Adaptability

There may be significant differences in the adaptive response of a patient to occlusal abnormalities. Individuals with a lower threshold will be unable to tolerate even trivial occlusal deficiencies. Patients with a raised threshold may adapt to distinct malocclusions without obvious symptoms. Management of defective occlusion has been discussed under full mouth rehabilitation.

Occlusal Morphology

An ideal occlusal scheme for a restoration should be established in the wax pattern. Hence, it is necessary to know the classification based on the location of the tooth contact made by the functional cusp on the opposing tooth in centric relation, in order to carve out the scheme of the wax pattern itself.

Functional cusps: Maxillary palatal cusps (suppositing).

Non-functional cusps: Mandibular buccal cusps (guiding).

There are two types of occlusal relationships namely cusp-to-fossa and cusp-to-marginal ridge (Fig. 27.8).

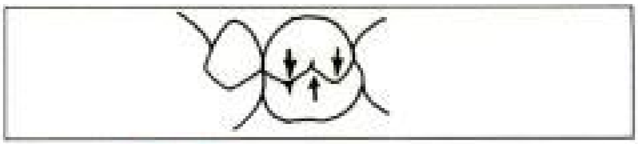

Fig. 27.8a: Cusp to fossa relationship

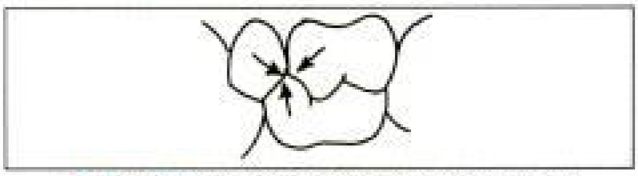

Fig. 27.8b: Cusp to marginal ridge relationship

KINEMATIC FACE-BOWS AND FULLY ADJUSTABLE ARTICULATORS

In this section we will discuss about the special equipments required to carry out full mouth rehabilitation. This face-bow/articulator have been omitted in the complete denture section (Chapter 10) because these equipments are not widely used during complete denture construction.

Kinematic Face-bow (Hinge Bow) (Fig. 27.9a)

It is a type of face-bow that locates the absolute hinge axis or true hinge axis. Hinge axis is an imaginary line passing through the centre of the

Classification of occlusal arrangements

Characteristics	Cusp-Fossa	Cusp-Marginal Ridge
• Location of contact on opposing side	• Occlusal fossa only	• Marginal ridge and occlusal fossa
• Relation with opposing tooth (teeth)	• Tooth-to-tooth	• Tooth-to two teeth.
• Advantages	• Occlusal forces are directed parallel to the long axis.	• Most natural type of occlusion (seen in 95% adults). Can be used for single tooth restorations.
• Disadvantages	• It can be used only when several contacting teeth and the teeth opposing them are to be restored.	• Food impaction and displacement of teeth may arise if the functional cusps wedge into a lingual embrasure.
• Application	• Full mouth reconstruction	• Most cast restorations done in daily practice

condyles when the mandible rotates in the sagittal plane. This rotation is within 5° to 12°. There can be multiple axes of rotation for a single patient. The axis of rotation, which coincides with the centric relation position of the mandible is called *True Hinge axis (THA)* (Fig. 27.9b). All other axes of rotation are collectively termed as *hinge axes or transverse hinge axes.*

Fig. 27.9a: Kinematic face-bow

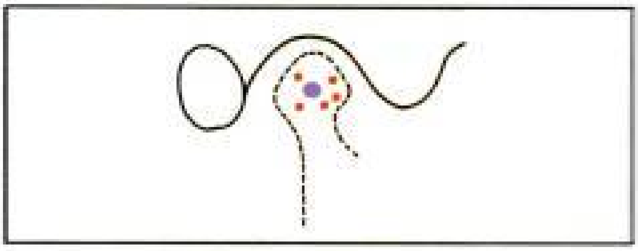

Fig. 27.9b: Terminal hinge axis
(Blue dot-THA, Red dots-hinge axes)

THA should be accurately determined during full mouth rehabilitation done either with removable or fixed partial dentures. This accuracy is not needed for restoring a mouth with complete dentures. This is because complete dentures are placed on displaceable tissues *(Realeff effect).* Realeff characteristic denotes the ability of a displaceable tissue to mould or adapt to the prosthesis. Minor errors in hinge axis rotation during the fabrication of the complete denture are overcome by the realeff effect. Hence, arbitrary face-bows are sufficient to record the orientation jaw relation for a complete denture patient. Lucia, Stuart, Stallard and many others of the gnathological society follow this concept of face-bow selection.

Face-bow Description

Arbitrary face-bows are described in chapter10. As kinematic face-bows are used for full mouth rehabilitation, it is discussed in detail here. Kinematic face-bows are similar to the arbitrary face-bows except that a pair of metal clutches replace the bite fork (Fig. 27.10). These clutches are designed such that they can either be cemented onto the dentulous maxilla / mandible or clamped onto the edentulous mandible as necessary.

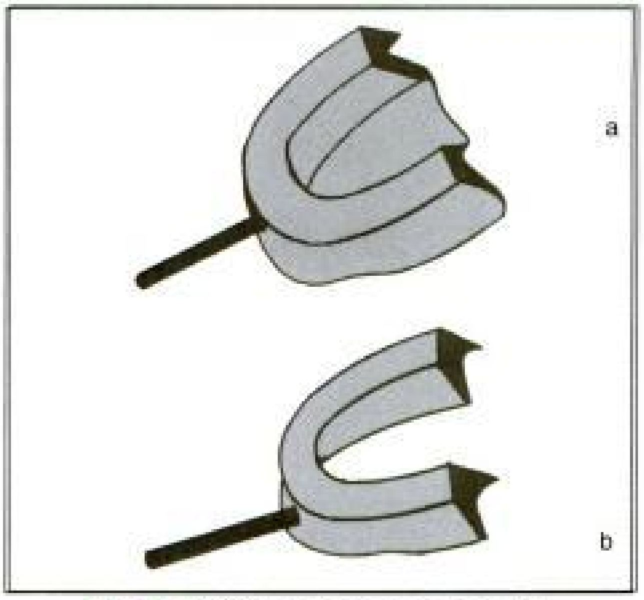

Fig. 27.10: Clutches of kinematic face-bow
(a) Maxillary (b) Mandibular

The two-piece clutch has a stem or stud extending from the centre of its labial surface. The stem of the mandibular clutch is inserted into the U-shaped frame of the face-bow. The U-shaped frame has styli (points) near its condylar end. These styli can be adjusted horizontally and vertically (Fig. 27.11).

The maxillary clutch is attached to a horizontal bar. This horizontal bar runs parallel and above the U-shaped frame and has vertically placed grids at its distal ends. When the bow is fixed on the face, the grid of the horizontal bar rests vertically in front of the tragus of the ear and the metal styli extending from the U-shaped frame will contact the vertical grid (Fig. 27.12).

When the instrument is to be used for edentulous patients, a chin clamp is provided to

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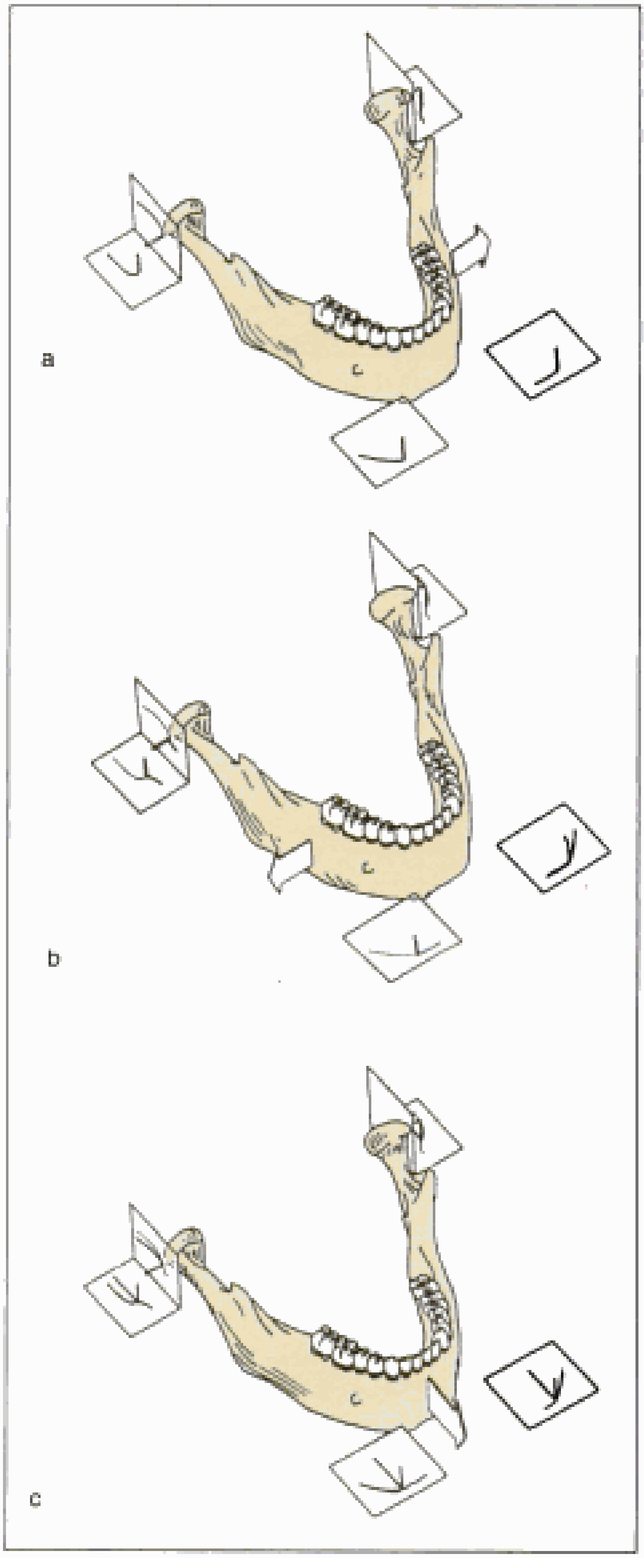
occlusion on an articulator. They record the mandibular movement in relation to an established plane in the face (a plane formed by the hinge axis along with the anterior reference points).

- A pantograph has two horizontal bars attached to metallic clutches like a kinematic face-bow assembly. But here the distal end of the upper bar has two grids (instead of one) placed perpendicular to one another. Two anterior grids are placed on the lower bar. Each grid has a separate stylus to draw the mandibular paths. The metal styli should be oriented to the tatooed hinge axis.
- The patient is made to rehearse hinge movement and translatory movement like right lateral and left lateral. A Cohen or Hitchkok trainer can be used to rehearse the mandibular movements.
- After training the patient, the grids are coated with a pressure sensitive material (pumice-ether mix). The stylus of each grid is made to contact the grid and the patient is asked to perform the trained movements. The styli will draw tracings on their respective grids when the patient moves his mandible. These tracings are thin and delicate line and are known as *pantograms* (Fig. 27.20).
- The Figure shows the tracing made on a horizontal grid. The tracings on the condylar grids will be slightly different.
- These tracings can be used to program a fully adjustable articulator, which is useful to develop the ideal occlusion for a complicated restorative case.
- Occlusion developed by such method will exhibit no posterior tooth contact when the mandible is in any eccentric position. Contact is present only between the cusp tip and the ridges around the central fossa.



Figs 27.20a to c: Pantograms: (a) Left laterotrusion (b) Right laterotrusion (c) Protrusion

Uses of a Pantograph

A pantograph records the mandibular movement in all three planes and hence, it is useful in the following treatment procedures:

- To record the envelope of motion

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mounted using the centric relation record using split-cast technique (casts are indexed with grooves so that they can be easily remounted).

- A pair of clutches are fabricated using the second set of casts to record the true hinge axis (THA) of the patient using a kinematic face-bow.
- The articulators (semi and fully adjustable) are reprogrammed according to the THA.
- The study casts are remounted according to the programming done on the articulator.
- After locating the hinge axis, the plane of orientation of the maxillary ridge (orientation jaw relation) is transferred to the articulator using a conventional face-bow (Fig. 27.21). The THA on either side form the first two reference points. The anterior reference point on the face is used as the third point of reference to orient the plane of the maxilla (Fig. 27.22).

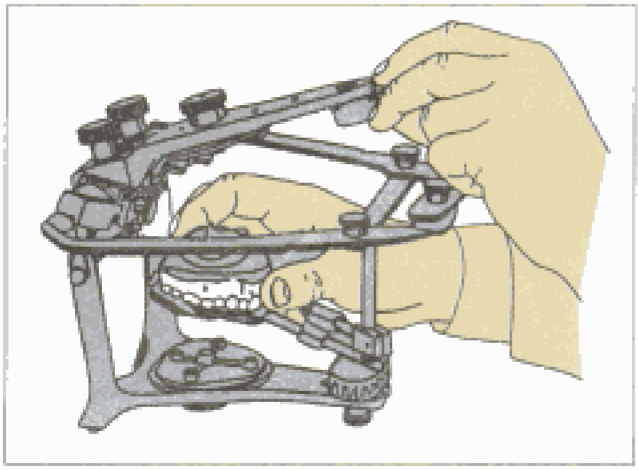


Fig. 27.21: Transferring the orientation jaw relation to an articulator

- The face-bow record is transferred to the programmed articulator and the maxillary cast is mounted.
- Next, the centric relation record is made and used to mount the mandibular cast against the maxillary cast.
- Now the casts are in opening and closing relation to the terminal hinge position. But this is not sufficient to reproduce all the mandibular movements. To reproduce other movements of the mandible in the articulator,

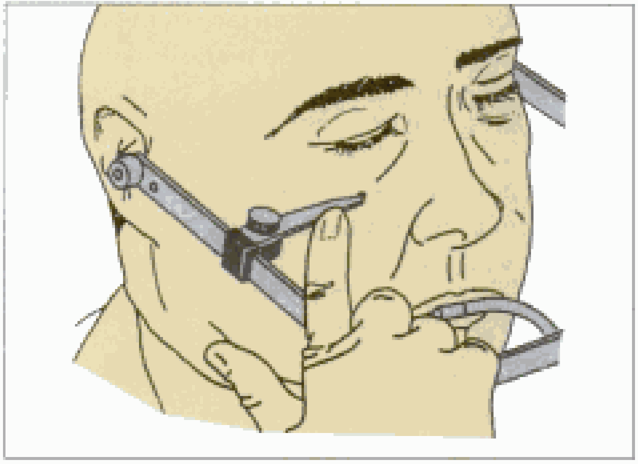


Fig. 27.22: Positioning the orbital pointer to the anterior reference point

special instruments can be used. (*Note: The casts should be accurately mounted in relation to the opening axis of the articulator. The relationship of the casts to the opening axis should be a duplicate of the relationship between the temporomandibular joint and the arches in the patient. This is crucial to develop harmonious occlusion during oral rehabilitation*).

- The centres of lateral movement should be located using a Twin Gothic Arch Tracing (needle point) (Fig. 27.23). After locating THA and the centre of lateral motion, the paths of these centres are recorded using a pantograph.
- The articulator is further programmed according to the pantographic tracings (*pantograms*).

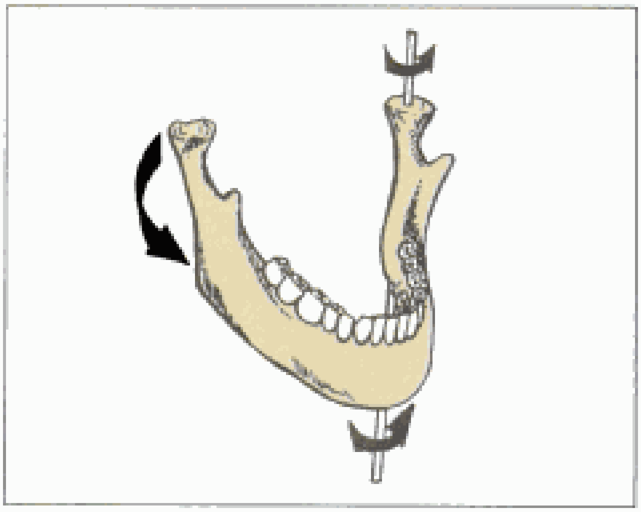


Fig. 27.23a: Centre of lateral rotation

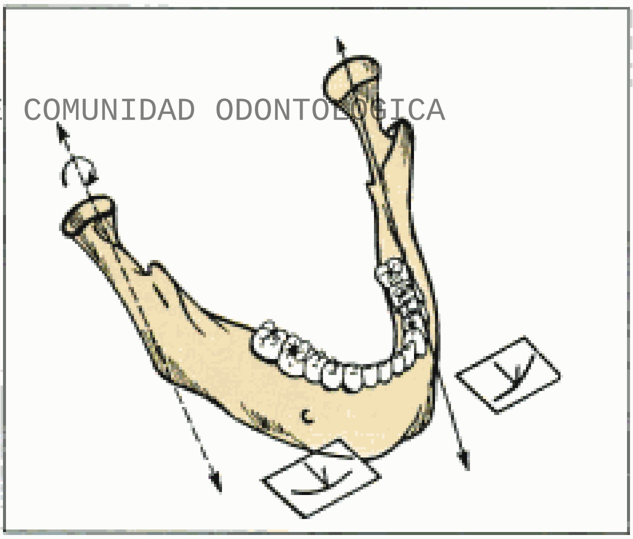


Fig. 27.23b: Twin gothic arch tracing to locate the centre of lateral rotation

Method of recording a pantographic tracing has been described alongwith kinematic face-bow.

- Finally, the casts are studied and an appropriate treatment plan is drawn up depending on the requirement of the patient.

OCCLUSAL REHABILITATION

Selective grinding is an important constituent of oral rehabilitation procedures. It is defined as, *"The intentional alteration of the occlusal surfaces of teeth to change their form"* - GPT.

Occlusal rehabilitation is done as a diagnostic procedure prior to the construction of fixed partial dentures. Ideally, these procedures are to be conducted for all patients.

Occlusal rehabilitation becomes more important when fixed partial dentures are fabricated against complete dentures and removable partial dentures. In this section, we have discussed occlusal rehabilitation procedures with regard to a maxillary complete denture opposing a mandibular fixed partial denture.

Correction of Occlusal Errors in Complete Dentures Opposing Fixed Partial Dentures (Selective grinding)

Minor processing errors frequently occur during the fabrication of complete dentures. These errors usually manifest as occlusal discrepancies. As mentioned before, these errors are corrected by selective grinding of the teeth. Selective grinding can be done in any one of the two stages, namely, during laboratory remount procedures and during denture insertion (clinical remount procedures).

Checking for Occlusal Errors

- The patient should be guided to his centric position manually. The mandible should be guided to its posterior most position.
- Now the patient is asked to close the mouth gently till he obtains a feather touch contact between the teeth. The patient should *not* move the mandible anteriorly during this procedure (Fig. 27.24).

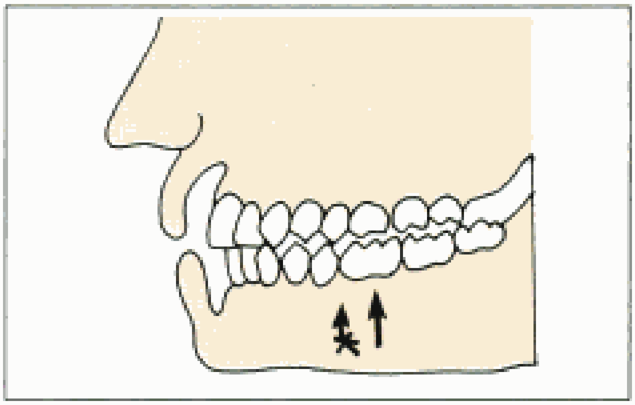


Fig. 27.24: The patient is asked to close at centric. He should stop closture once he obtains feather contact. The patient should not move his mandible anteriorly to obtain occlusion

- Once feather touch contact is established between the natural dentition and denture, the patient is asked to close the mouth tightly (Fig. 27.25).
- If the patient slides his mandible to obtain tight closure it indicates the presence of occlusal discrepancies (Fig. 27.26).

Remounting the Dentures

Remount procedure can be defined as, *"Any method used to relate restorations to an articulator for the analysis and/or to assist in the development of a plan for occlusal equilibration or reshaping"* – GPT.

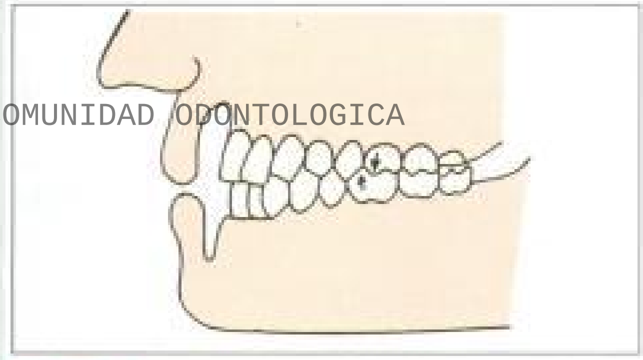
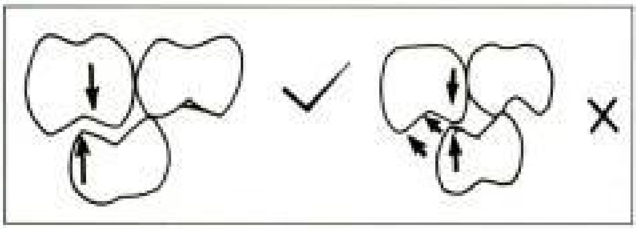


Fig. 27.25: Next the patient is asked to perform tight closure



Figs 27.26a and b: Evaluation of occlusal discrepancies

After checking for occlusal errors, the dentures should be remounted to correct these errors. Accurate location and correction of the errors can be done only using a remount procedure. Remounting can be done clinically (using inter-occlusal records) or in the lab.

- Lab remounting is preferred to clinical remounting because the following factors may produce inaccuracies in clinical remounting:
  - — Shifting of the denture
  - — Eccentric closure of the mandible.
  - — Time dislocation (patient cannot remain in the same position for indefinite periods of time).

Laboratory Remount Procedure

Laboratory remount can be used to correct only processing errors (e.g. mild tooth displacement). It cannot be used to correct errors made during impression making, jaw relation etc. The stepwise technique to be followed to re-establish occlusion during remount procedures is as follows:

- Remounting can be done using the same articulator used for teeth arrangement.
- The denture should not be separated from the cast after processing.
- Upper and lower casts are reattached to the articulator (Fig. 27.27a).

Fig. 27.27a: The casts are sealed to mounting stone with sticky wax. The cast and mounting stone should fit together accurately before sealing

- The various movements are carried out in the articulator and the occlusal interferences are identified using an articulating paper (Fig. 27.27b).

Fig. 27.27b: The occlusal interferences are identified using articulating paper

- The identified contacts are ground in relation to the opposing teeth (Figs 27.27c and d). After occlusal grinding, the denture is removed from its cast and polished.
- New centric and eccentric records should be obtained if new dentures are planned.

Clinical Remount Procedures

Clinical remount is done using inter-occlusal records. These inter-occlusal records should be

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- The condylar guidance should be altered till the maxillary denture teeth fit perfectly in to the protrusive record. The horizontal condylar guidance values should be recorded and written on the nearby mounting plaster.
- Using the horizontal condylar guidance value (H), lateral condylar guidance (L) can be calculated using the formula L=(H/8)+12.
- Now that programmed articulator with remount casts and dentures is ready to carry out selective grinding.

Correcting the Identified Occlusal Errors

Selective grinding is defined as. *"The intentional alteration of the occlusal surfaces of teeth to change their form"* – GPT. These procedures vary according to the teeth on which they are carried out. In this section, we shall discuss about selective grinding procedures in relation to anatomic and non-anatomic teeth.

Correcting the Identified Occlusal Errors in Anatomic Teeth

Selective grinding for the correction of identified occlusal interferences in the centric relation should be done first followed by the correction of identified occlusal interferences in the eccentric relation.

Correcting the Identified Occlusal Errors in Anatomic Teeth in Centric Relation

- This procedure is done on the remounted dentures.
- Articulating paper of minimum thickness should be placed between the occlusal surfaces of opposing teeth.
- The articulator is closed in centric relation.
- The articulator should be carefully opened without sliding against the teeth and the articulating paper is removed.
- The deflective contacts will be visible on the occlusal surfaces against which the articulating paper was placed (Fig. 27.32).
- These contacts should be relieved by grinding with Chayes stone No: 16, 11 and 5.
- Grinding should *never* be done on the cusps or cuspal inclines instead should be done only on the fossa (Fig. 27.33).

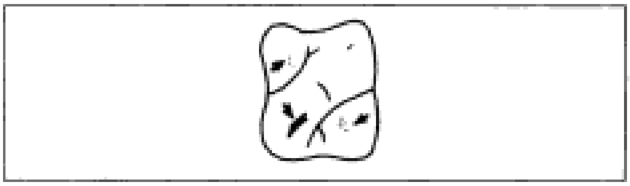

Fig. 27.32: Deflective contacts

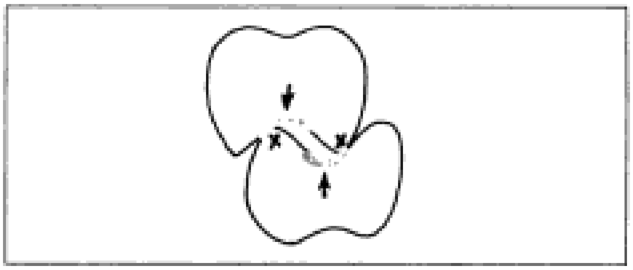

Fig. 27.33: Only fossae should be ground

Correcting the Identified Occlusal Errors in Anatomic Teeth in Eccentric Relations

- After completing occlusal reshaping in centric position, the articulating paper is placed between the teeth and the articulator is moved to lateral position (laterotrusion).
- During the lateral movement of the articulator, if the incisal pin rises away from the incisal table, selective grinding is necessary on the working side (Fig. 27.34).

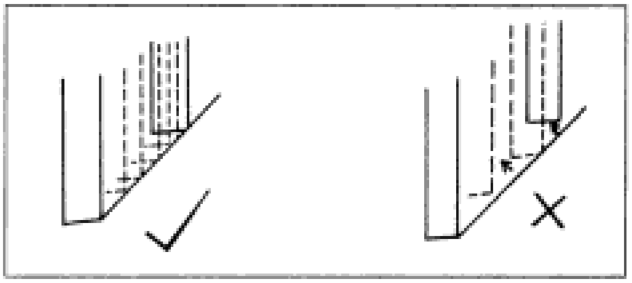

Fig. 27.34

- All contact areas are made visible by the markings of the articulating paper.
- On the non-working side, there will be contacts between the maxillary buccal and mandibular lingual cusps (Fig. 27.35). The incisors will also show contacts.
- Selective grinding on the working side should follow the BULL rule (buccal cusps of upper

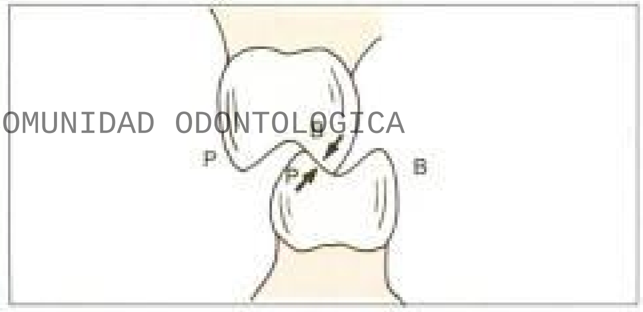

Fig. 27.35: Key: B—buccal, P—palatal

and lingual cusps of lower teeth). Grinding should be verified and repeated until the incisal pin contacts the incisal table **all along** the lateral movement.

- On the balancing side, markings of the articulator paper will appear on the maxillary palatal cusps and mandibular lingual cusps (Fig. 27.36).
- The lingual slope of the buccal cusps should be reduced during selective grinding on the balancing side (Fig. 27.37).
- After correcting the laterotrusive interferences, protrusive interferences should be corrected in the same manner.

Errors During Selective Grinding for Anatomic Teeth	
In centric occlusion	*Correction*
• Teeth too long (Fig. 27.38a)	• Fossae are deepened *not* cusps (Fig. 27.38b)
• Teeth end-to-end (Fig. 27.39a)	• Grinding cuspal inclines (lingual inclines of maxilla and buccal inclines of mandible). Cusps are *not* shortened (Fig. 27.39B)
• Too much horizontal overlap (Fig. 27.40a)	• Maxillary lingual and mandibular buccal cusps are made narrow, *not* short (Fig. 27.40b).
In working side during eccentric movements (Six types of errors require shortening of cusps)	*Correction*
• Maxillary buccal and mandibular lingual cusps are too long (Fig. 27.41a)	• Maxillary buccal and mandibular lingual cusps are shortened (Fig. 27.41b)
• Only buccal cusps contact (Fig. 27.42a)	• Shorten the buccal cusps (from the central fossa to the cusp tip) (Fig. 27.42b)
• Only lingual cusps contact (Fig. 27.43a)	• Buccal incline of the mandibular lingual cusp should be corrected in order to shorten the cusp (Fig. 27.43b)
• Maxillary cusps are mesial to the intercuspating position (Fig. 27.44a).	• Grinding should be done on the mesial inclines of the maxillary buccal and distal inclines of mandibular buccal cusps (Fig. 27.44b)
• Maxillary cusps are distal to the intercuspating position (Fig. 27.45a)	• Grinding should be done on the distal inclines of the maxillary buccal and mesial inclines of mandibular buccal cusps (Fig. 27.45b)
• No contact due to excessive contact on the balancing side (Fig. 27.46a)	• Buccal cusps of the mandibular teeth (balancing side) are altered on their inclines (Fig. 27.46b)
In the balancing side during eccentric movements	*Correction*
• The last mentioned error in the previous section is caused by an error in the balancing side (Figs 27.46a and b)	
• No contact on the balancing side (Fig. 27.47a)	• Grinding should be done on the working side as described for the previous error (Fig. 27.47b)

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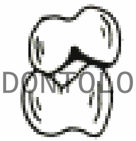

Fig. 27.47a

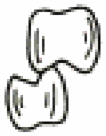

Fig. 27.47b

Correcting the Identified Occlusal Errors in Non-anatomic Teeth

- After identifying the deflective contacts with an articulating paper, grinding is done on the occlusal surface of teeth that appear to have been tipped or elongated during processing.
- During eccentric movements, grinding should *not* be done on the disto-buccal portion of the mandibular second molar. Balancing side correction is done on the lingual portion of the occlusal surface of maxillary second molar.
- Abrasive paste (carborundum paste) is placed between the teeth and the teeth are milled as eccentric movements are made on the upper member of the articulator. Carborundum paste should *never* be used on anatomic teeth as it may reduce the vertical dimension.
- *Spot grinding* can be done to correct minor discrepancies in centric relation after grinding with abrasive paste.

Chapter 28
Types of Abutments

- Introduction
- Healthy/Ideal Abutments
- Cantilever Abutments
- Pier Abutments
- Tilted Abutments
- Extensively Damaged Abutments
- Implant Abutments

28

Types of Abutments

INTRODUCTION

We know that the type of abutment determines the design of a fixed partial denture. Abutments are grouped based on their location and condition. In this chapter we will have a detailed discussion about the various abutments and the design modifications (of the prosthesis) required to manage the abutment.

HEALTHY/IDEAL ABUTMENTS

An un-restored vital tooth in its normal anatomic position is considered as an ideal abutment. Adequate tooth structure should be present to develop retention and resistance forms (discussed in tooth preparation (Fig. 28.1).

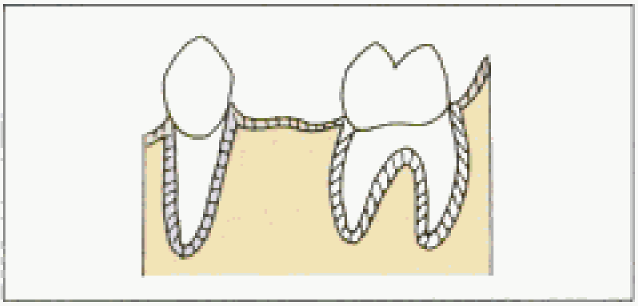

Fig. 28.1: Ideal abutment

An ideal abutment should have the following characteristics:

- Ideal crown root ratio.
- Adequate thickness of enamel and dentin.
- Adequate bone support
- Absence of periodontal disease
- Proper gingival contour

CANTILEVER ABUTMENTS

The selection of a cantilever abutment is more critical because this prosthesis is going to face/ withstand more than normal forces. Cantilever abutments were discussed to a certain extent under special designs in Chapter 26. Hence, I have enumerated the ideal requisites for a cantilever abutment here. The requisites for a cantilever abutment are:

- More than average bone support should be present.
- Sufficient amount of tooth structure should be available because the final retainer should be more retentive.
- The abutment should be selected such that its position favours the development of an ideal occlusal scheme.
- Endodontically treated teeth are not preferred. Endodontically treated teeth with excessive crown damage are contraindicated.
- Teeth with short roots are contraindicated.
- Certain ideal cantilever situations include:
  — Replacement of lateral incisor with canine support.
  — Replacement of first premolar with second premolar and first molar support.
- If strong abutments are not available, adjacent to the edentulous space, spring cantilever designs can be incorporated.

PIER ABUTMENTS

A Pier abutment is a single tooth with two adjacent edentulous spaces on either side. In this case the single tooth will have to act as an abutment for both the edentulous spaces (Fig. 28.2).

Fig. 28.2: Pier abutment

Since a single abutment supports two edentulous spaces, it will be subjected to unbalanced forces, which can lead to trauma of the periodontium. The forces acting on one end of the prosthesis will tend to lift the other end like a lever using the abutment as a fulcrum. In such conditions, the lifespan of the retainer is dramatically reduced (Fig. 28.3).

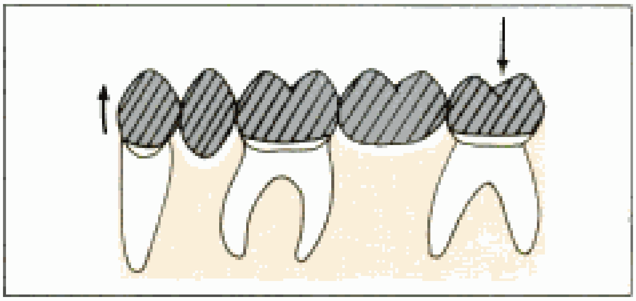

Fig. 28.3: Lever type of forces act on a prosthesis supported by a pier abutment

In order to prevent trauma to the abutment, a stress breaker should be provided near the pier abutment. The stress beaker is a non-rigid connector with a key in a keyway. The keyway is usually placed on the distal surface of the pier abutment. The male component or the key is attached to the mesial surface of the mesial pontic of the distal edentulous space (Fig. 28.4).

Normally, during occlusion, molars tend to tip mesially and hence excessive stress is transferred through the connector to the pier abutment. Forces acting on the distal end of the distal edentulous space will disengage the connector and prevent stress to the pier abutment (Fig. 28.5).

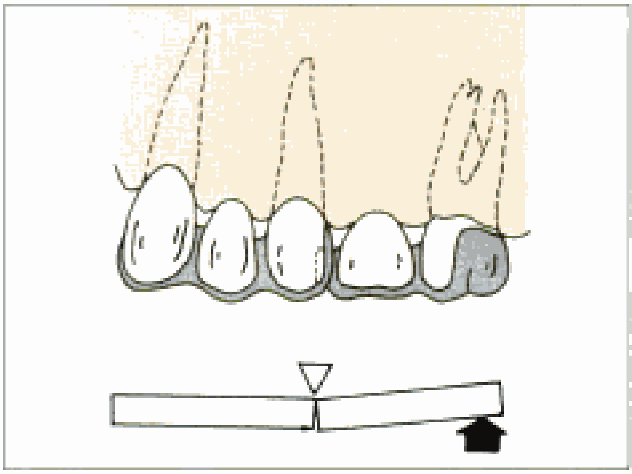

Fig. 28.5a: A nonrigid connector on the pier abutment isolates force to that segment of the fixed partial denture to which it is applied

If the pier abutment is mobile, then a rigid connector should be used instead of a non-rigid connector.

A non-rigid connector is avoided when the posterior abutment opposes an edentulous space or a removable partial denture. This is because supra-eruption of the posterior abutment will occur and unseat the key (Fig. 28.6).

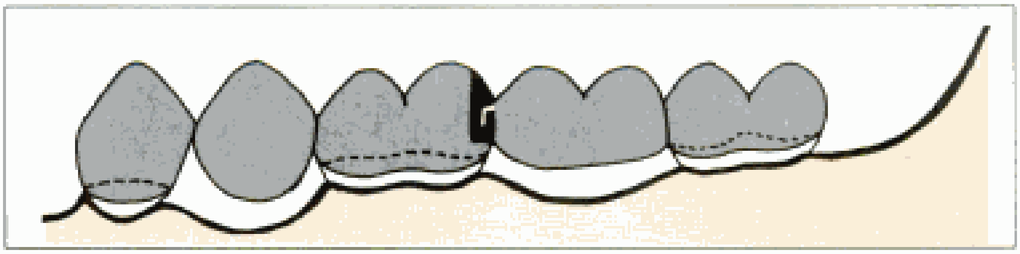

Fig. 28.4: Non-rigid connector fabricated at the junction of the pier abutment and distal pontic. The key way is placed on the pier abutment and the key is placed on the pontic

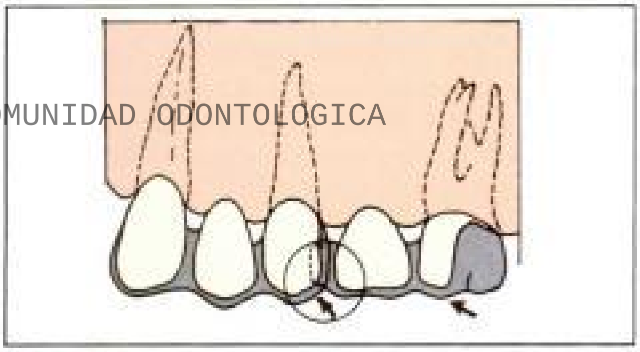

Fig. 28.5b: Mesial movement of the distal abutment will seat the key into the keyway of the pier abutment

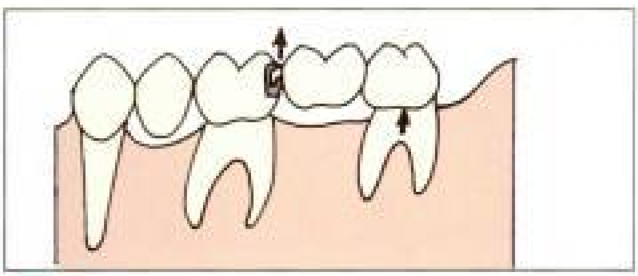

Fig. 28.6: If the posterior abutment does not have any opposing tooth, it may supra-erupt and unseat the key

TILTED ABUTMENTS

When a tilted tooth is chosen as an abutment, obtaining a single path of insertion is difficult (Fig. 28.7). Certain biomechanical considerations like path of insertion and stress distribution play an important role in the construction of the prosthesis.

Tilted abutments are generally avoided due to the complex design involved in the fabrication of the prosthesis. But if a single tooth is present distal to the prosthesis, then the operator should include that tooth as an abutment.

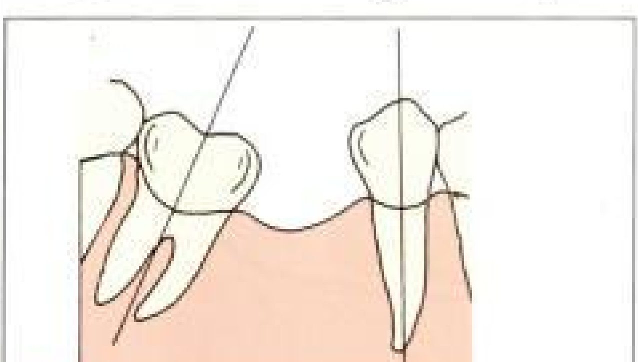

Fig. 28.7: When the abutments are tilted in relation to one another, it is difficult to obtain a single path of insertion

Tilted mandibular third molars are the most commonly encountered tilted abutments in the fabrication of a fixed prosthesis (all mandibular teeth tip mesially in the absence of adjacent teeth). Hence, we have described the different methods used to over come a tilted mandibular molar abutment during the construction of a fixed partial denture. There are five commonly used methods to overcome the disadvantages of a tilted mandibular molar abutment.

Mesial Reduction of Third Molar

Here the mesial surface of the tooth (mandibular molar) is reduced till it becomes parallel to the long axis of the other abutment(s). This is done so that it is easy to insert the crown over the second molar abutment (Fig. 28.8).

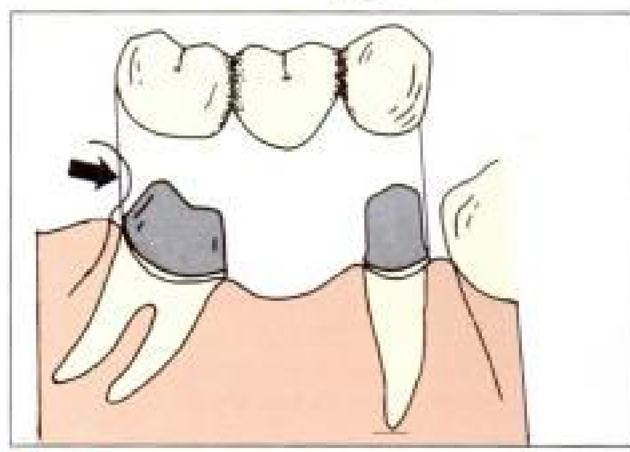

Fig. 28.8: Proximal reduction of proximally tilted teeth can aid to obtain a single path of insertion

Modified Partial Veneer Crown (Proximal-half Crown Over the Second Molar)

A modified partial veneer crown preparation can be prepared such that the mesial undercut is removed and a vertical path of insertion is obtained (Fig. 28.9a).

Orthodontic Treatment

The abutment teeth can be orthodontically altered (until it is parallel to the other abutments) so that a conventional FPD can be given (Fig. 28.9b).

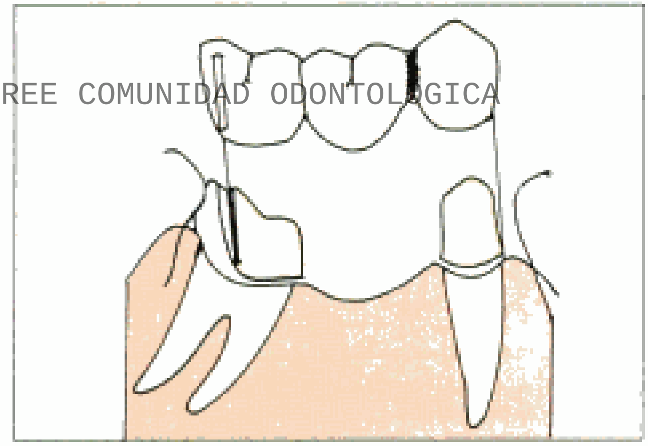

Fig. 28.9a: A modified partial veneer crown can be used when a single path of insertion is required with minimal tooth preparation

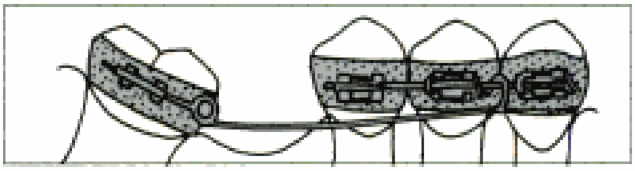

Fig. 28.9b: Orthodontic treatment to up right a tilted molar abutment

Non-rigid Connector

A non-rigid connector (key-keyway) can be prepared parallel to the long axis of the tilted second molar. Now the FPD can be inserted along the long axis of the second molar to slide into the keyway of the anterior abutment (Fig. 28.10).

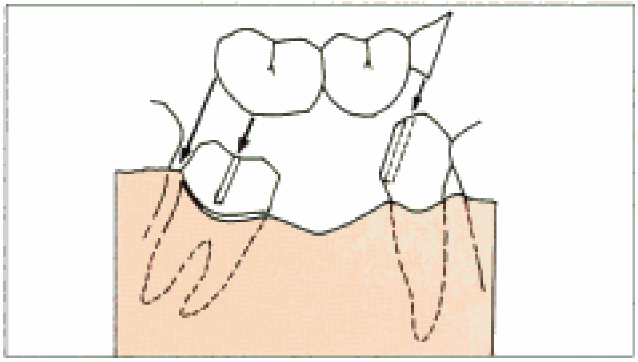

Fig. 28.10: A nonrigid connector on the distal aspect of the premolar retainer compensates for the inclination of the tilted molar

Telescopic Crown

Here, the tooth is reduced considerably. A coping or retainer is fabricated over the tooth so that it alters the contour of the crown. This crown should be fabricated with vertical slots so that it can receive a second crown (telescopic crown) in a vertical direction (Fig. 28.11).

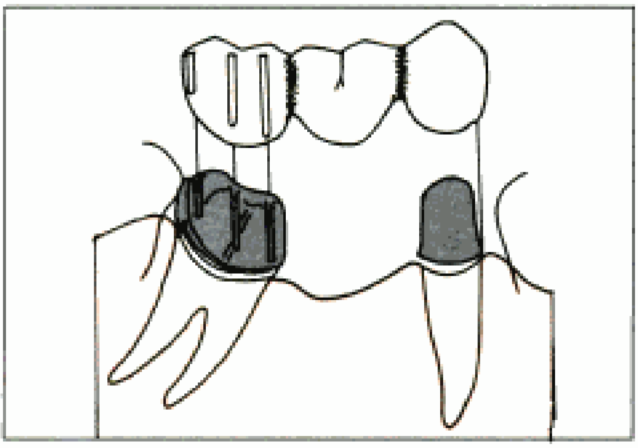

Fig. 28.11: Telescopic crowns modify the path of insertion

EXTENSIVELY DAMAGED ABUTMENTS

Sometimes, the operator will have to choose extensively damaged teeth as abutments. In such cases, the teeth should be restored such that they gain adequate retention and resistance to be used as an abutment.

The amount of restoration for a grossly destructed tooth depends upon *surface area* of the destruction. That is, a tooth with shallow superficial multiple carious lesions involving all the surfaces may require a more extensive restoration than a tooth with a deep carious lesion involving more than one surface.

Modified Restorations

Precautions

- At no point of time the tooth should be reduced beyond the central core (*the central core is a cylinder of pulp with 1mm of surrounding dentin*) (Fig. 28.12a).
- For all restorations except full veneer crowns, all the tooth surfaces should be uniformly reduced.
- If the caries extends to the central core then it should be scooped out and GIC restoration should be done in the scooped out area (Fig. 28.12b).

Figs 28.12a and b: (a) The 'Central core' of the tooth is the cylinder of pulp and 1 mm thickness of surrounding dentine (b) Any carious lesion extending beyond the central core should be restored before fabricating the retainer of the fixed partial denture

- Retentive grooves should not extend more than 1.5 mm below the cervical line.

Grooves

- A groove can be placed to provide retention to the preparation (Fig. 28.13).

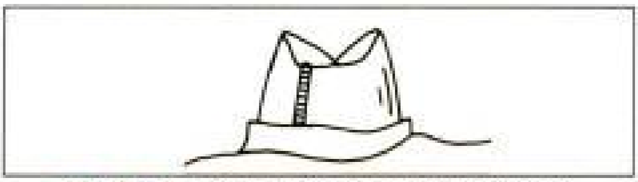

Fig. 28.13: Proximal grooves aid to improve the resistance to oblique forces

- Too many grooves may interfere with the seating of a full veneer crown.
- A groove should be at least 1 mm wide.

Pins

Pin retention has many advantages namely: It does not require vertical supragingival tooth structure for placement. It can even be used in teeth with inadequate axial wall height.

Types of Pin Retention

Based on the technique of placement of the pins, they can be classified into two types:

— *Parallel pinholes* (pin is part of the cast restoration): In this method pinholes are prepared within the dentin and a cast restoration is made which would seat into these pinholes (Fig. 28.14).

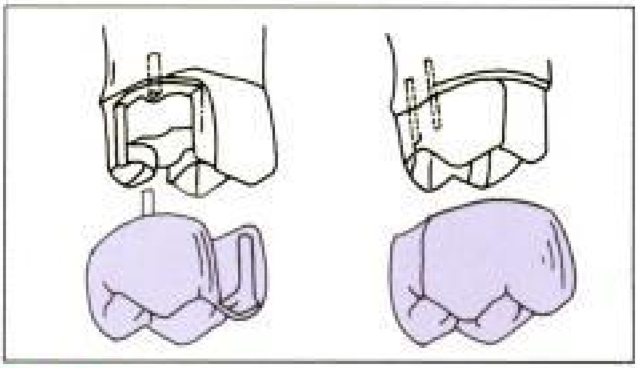

Fig. 28.14: A pin can be incorporated into a crown to augment retention and resistance (A); or pins can be used to retain a core, which in turn will help to retain a crown (B).

— *Non-parallel pins screwed into the dentin:* This technique involves the drilling of non-parallel pins into dentin to help retain an amalgam core (Fig. 28.15).

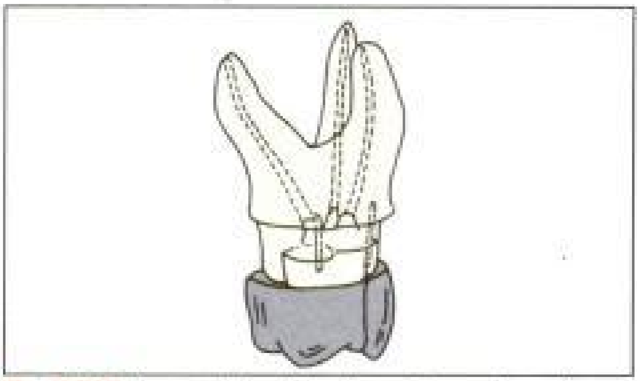

Fig. 28.15: A core retained by pins, slots, amalgampins, or extension into the pulp chamber is used to build up a molar with some coronal tooth structure

- The following guidelines should be followed while drilling pinholes:
  — They should be drilled into sound dentin
  — It should not undermine the enamel
  — They should not enter the periodontal ligament
  — Pins should not encroach the pulp.
- The most appropriate points for placement of pins on a tooth are the four corners (Fig. 28.16).

Box Forms

- A retentive box can be used if a proximal lesion on the tooth interferes with the placement of a retentive groove (Fig. 28.17).

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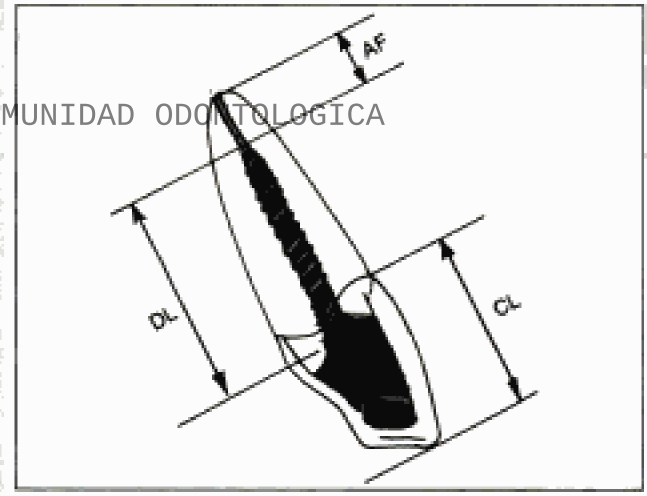

Fig. 28.20: The length of the dowel (DL) should equal the crown length (CL) or two-thrids the length of the root, whichever is greater. The length of the remaining apical fill (AF) should be at least 4.0 mm

- While preparing a dowel core for a premolar, the operator should be cautious to avoid canal perforation near the proximal root concavities, thin walled areas and other steeply tapered parts (Fig. 28.21).

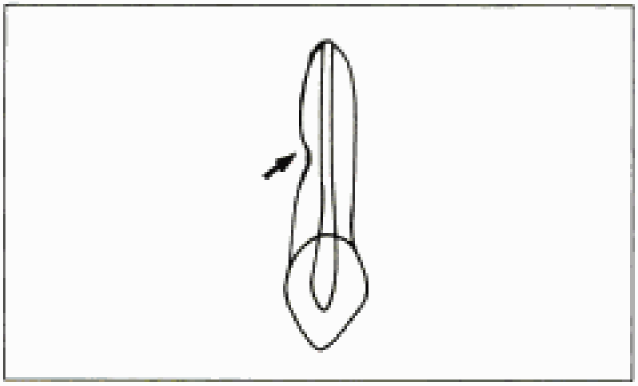

Fig. 28.21

- The coronal portion of the dowel should be encircled atleast by 1-2 mm of tooth structure to obtain a *'ferrule'* effect and protect the tooth from fracture (Fig. 28.22).
- An anti-rotational groove should be made on the wall of the canal preparation in order to prevent the dowel from rotating within the canal (Fig. 28.23a).
- Dowels are not indicated for anterior teeth unless there is complete destruction of the coronal tooth structure. This is because only lateral forces are present in relation to the long axis of these teeth and hence the dowel will not help to withstand these forces (Fig. 28.23b).

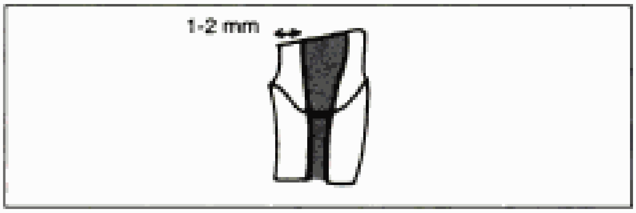

Fig. 28.22: 1-2 mm of tooth structure should encircle the dowel to provide a 'Ferrule' effect

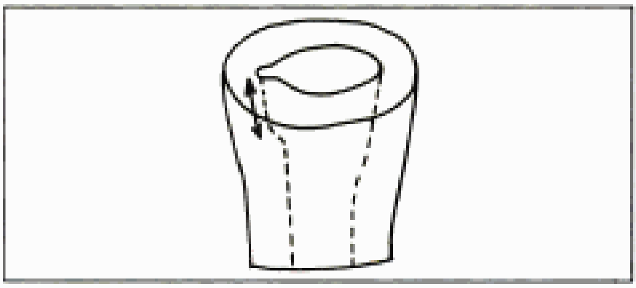

Fig. 28.23a: A key way provided on the prepared canal wall functions to guide the dowel during placement and also as an anti-rotational groove

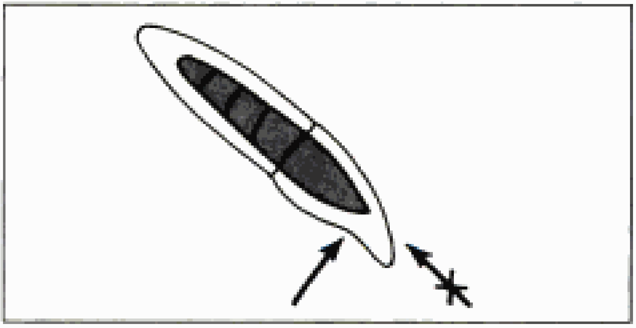

Fig. 28.23b

Types of Dowel Cores

Dowel cores are of two types namely
- Prefabricated
- Custom made.

Prefabricated dowel with amalgam or resin core
Many prefabricated dowel kits systems are available today. Most of them use either amalgam or resin core. Amalgam cores (coronal portion) are said to be more successful than composite or GIC cores. But composite cores are more popular

because they are easier to work with and require lesser bulk of material, therefore, they can be used on smaller teeth.

The most commonly used materials for making dowels are stainless steel, titanium, nickel or chromium containing alloys. Titanium, high Palladium and Cobalt Chromium Molybdenum alloys are preferred for their corrosion resistance.

Dowels can be parallel sided (cylindrical) or tapering. Dowel systems are broadly classified as passive (cemented) and active (threaded) types (Fig. 28.24). Threaded dowels are more retentive than cemented dowels.

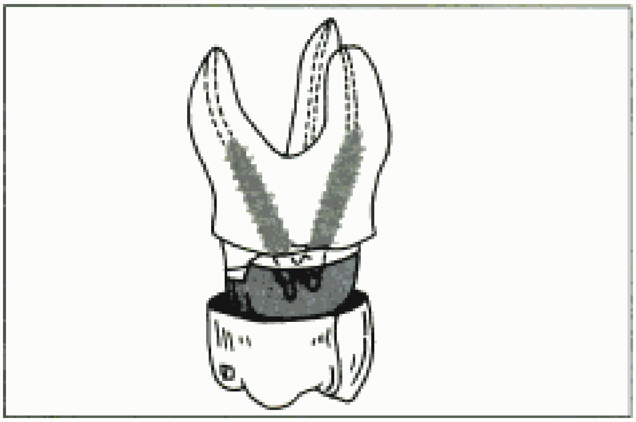

Fig. 28.24: Threaded dowel

Custom Cast Dowel Core

They are cast from the wax patterns fabricated in the canal. A brass wire or a paper clip may be used to make the wax pattern within the canal.

Types of custom made dowel core systems

Based on the technique used, custom made dowel cores can be classified in to:

- Prefabricated noble metal dowels, which are designed to accept custom-made cores.
- Resin pattern fabrication
- Wax pattern fabrication

Resin pattern is preferred over wax pattern because of increased strength and dimensional stability. If a tooth has more than one canal, only one canal is used to prepare the dowel since the second canal does not significantly increase retention. The second canal can be used as a stop to prevent rotation. E.g. dowels are usually prepared only on the distal root of maxillary premolars.

Fabrication of a custom made dowel cores

The steps in the fabrication of a dowel core are:

- Tooth preparation
- Canal preparation
- Canal pattern fabrication
- Casting
- Finishing and cementation

General considerations

We know that the design of the dowel core will vary according to the tooth on which it is to be fabricated.

- The preparation of a dowel for a mandibular premolar is similar to that of a central incisor. In a maxillary premolar with two canals, the second canal is utilised for anti rotation.
- Custom-made dowels are not used for molars because they have divergent roots.
- Sometimes parallel pins should be added as a parapost for anti-rotation and increased retention.
- Nylon bristles can be used in these pinholes while fabricating the pattern.

In the following section, we have discussed about the fabrication of a dowel core in relation to an endodontically treated maxillary anterior tooth (central incisor), for which a metal ceramic crown is planned.

Tooth preparation

- The tooth is prepared as usual (as for any crown).
- Unsupported enamel is removed.
- Only weak enamel is removed and it is not necessary to remove all of the coronal tooth structure.
- The tooth should be evaluated for residual caries (especially under previous restorations) to assess its strength. Any weak enamel wall or restoration should be removed.

Canal preparation

- Peeso reamer is the instrument of choice for removing the gutta-percha (GP) and for enlarging the canal. These instruments do not perforate the canal because they have non-cutting tips, which follow the path of least resistance (i.e. the reamer will try to move along the length of the canal instead of cutting the walls and perforating it) (Fig. 28.25).

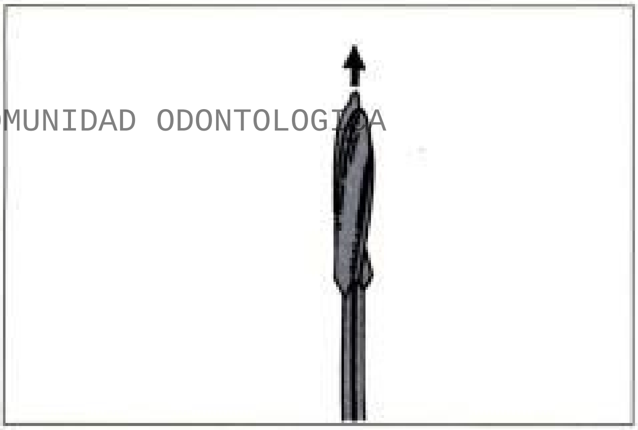

Fig. 28.25: A Peeso reamer. Notice the non cutting tip which aids the reamer to take the path of least resistance without making ledges on the canal walls

- A hot condenser can be used to remove GP remnants.
- After removing the GP, the peeso reamer should again be inserted to the required depth and used to enlarge the canal (Fig. 28.26).

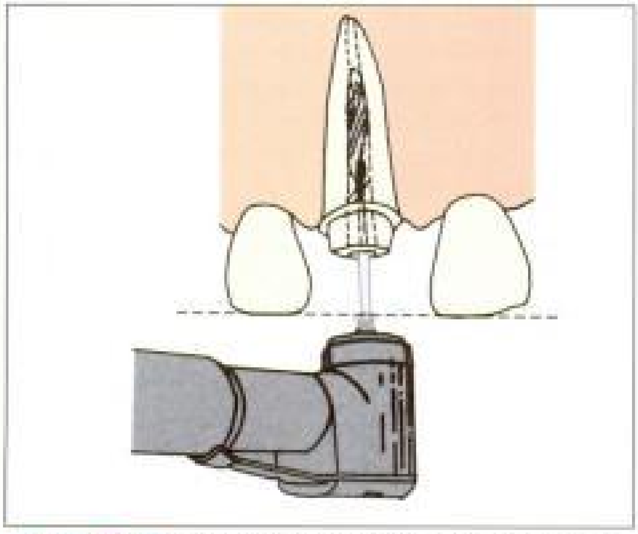

Fig. 28.26: The canal is enlarged with Peeso reamers

- A test radiograph should be taken to decide the amount of canal enlargement.
- The canal should be prepared such that there is at least 1mm of tooth structure at the apical end. The diameter of the canal should be at least 1/3rd the width of the tooth (Fig. 28.27).
- A No: 170 bur is used to prepare a keyway in the tooth along the length of the canal for a distance of 4 mm. The keyway should be equal to the width of the bur (Fig. 28.28).

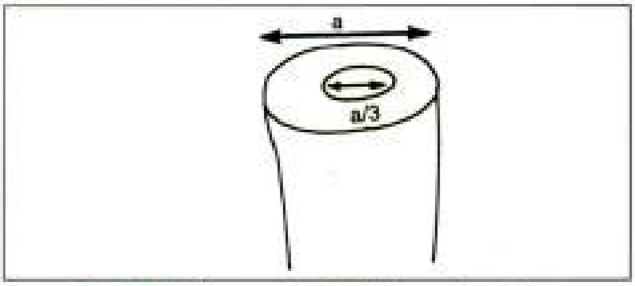

Fig. 28.27: The canal should be enlarged to a third of the root width

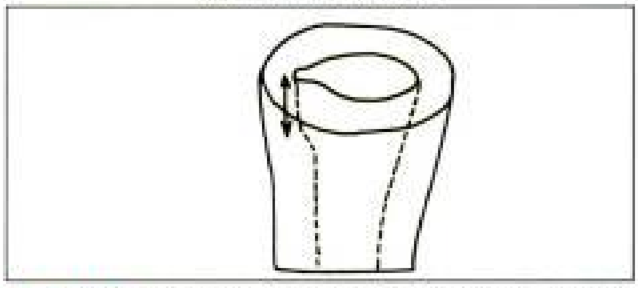

Fig. 28.28: A key way provided on the prepared canal wall functions to guide the dowel during placement and also as an anti-rotational groove

- A contrabevel is placed around the occluso-axial line angle so that a metal collar is formed during casting which will embrace the remaining coronal tooth structure and protect it from fracture (Fig. 28.29).

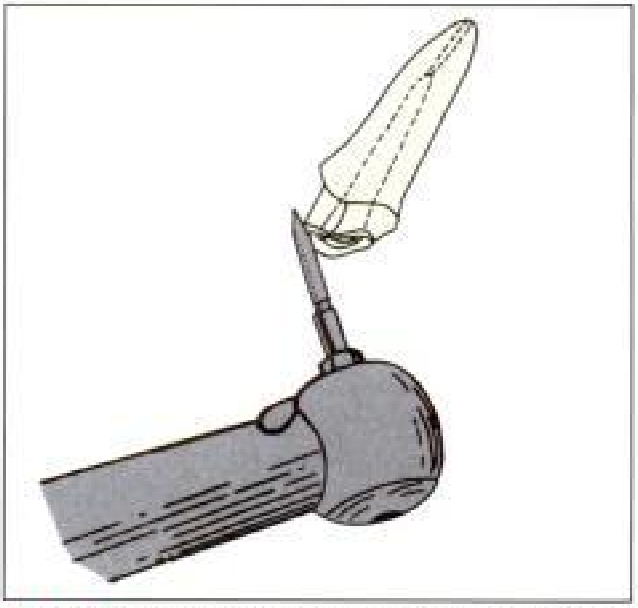

Fig. 28.29: A flame diamond is used to place the contrabevel

Resin pattern fabrication

- A 14 gauge plastic sprue is trimmed so that it slides easily in and out of the canal. The plastic sprue should not bind to the canal.

- A notch is cut on the facial side of the sprue so that it can easily be oriented.
- The canal and the sprue are coated with petrolatum jelly.
- Next, the canal is filled with fluid resin (Duralay fluid resin).
- Now, the plastic sprue should be inserted into the canal.
- The external bevel (on the tooth) should be covered with acrylic before the acrylic in the canal has set.
- After the acrylic becomes doughy, the pattern should be pumped/shed in and out so that it does not lock into any undercut.
- Once the resin polymerises, it should be removed from the canal and inspected for voids (Fig. 28.30).

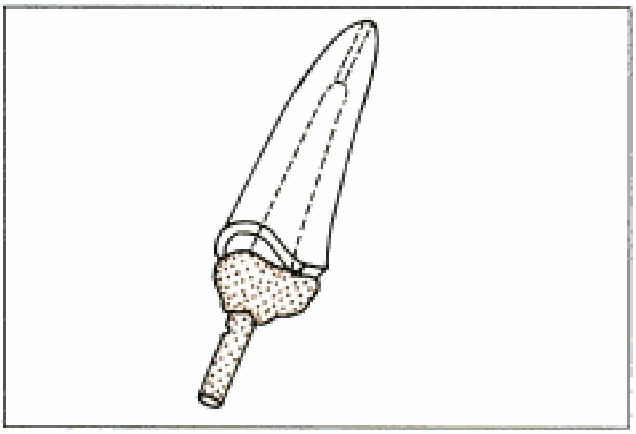

Fig. 28.30: The first mix of resin in the canal should cover the contrabevel

- A second mix of acrylic is used for core build-up.
- The core should be moulded with the hand to resemble a prepared tooth (Fig. 28.31).
- Green stone and Garnet disks should be used to smoothen and shape the coronal pattern.

Casting

- The dowel core pattern should be wiped with alcohol to remove all the lubricant.

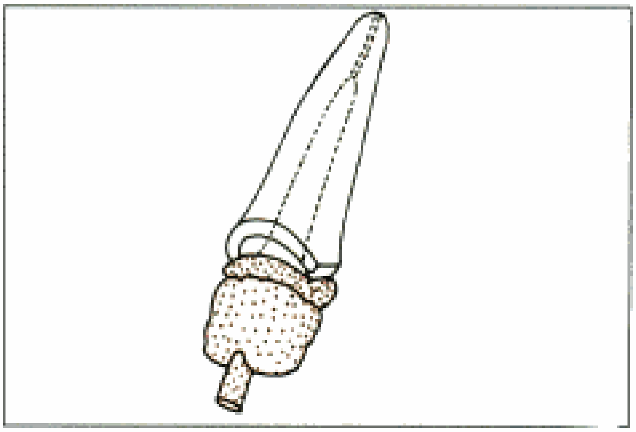

Fig. 28.31a: A second mix is added to build up the coronal portion of the dowel core

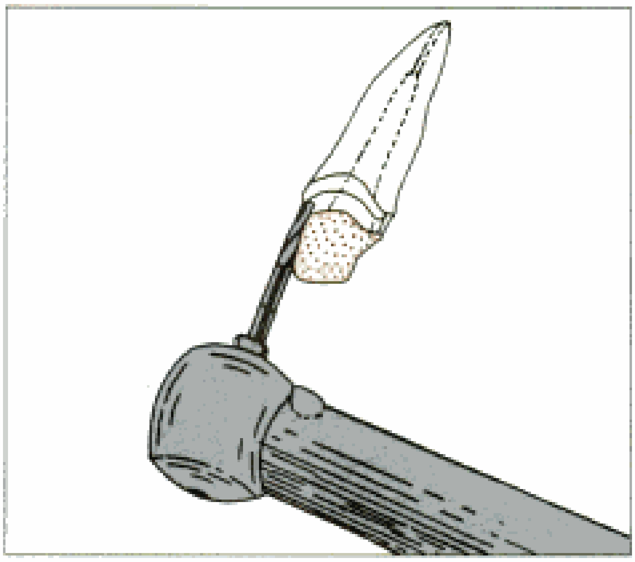

Fig. 28.31b: Coronal portion of the resin pattern is prepared to receive the final restoration

- The pattern should be sprued at the cingulum. (Fig. 28.32).
- 1 to 2 cc of extra water should be added to the investment and a casting liner should *not* be used so that there is shrinkage of the dowel. A smaller dowel is preferred because it will not bind to the canal.
- Burnout should be done for an additional 30 minutes to ensure complete elimination of wax.

Finishing and Cementation

- After casting, the sprue is cut off using a carborundum disc.

Fig. 28.32: Sprued resin pattern in a ring ready for investing

- The dowel should be checked for proper fit.
- If it binds to the canal, air abrasion should be done till the shiny spots are removed.
- The coronal portion should be polished to a satin finish using a Burlow wheel.
- A groove should be cut along the length of the dowel from the apical end to the contra bevel to act as an escape way for the luting cement (Fig. 28.33).

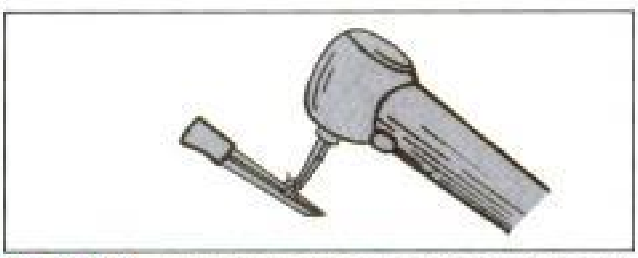

Fig. 28.33: A groove is cut in the side of the dowel to allow cement escape during cementation

- The cement is loaded into the canal using a lentulospiral.
- The dowel should be inserted till it seats properly.
- Final impression is made after cementation of the dowel and the temporary crown is prepared.
- The permanent crown is cemented later.

IMPLANT ABUTMENTS

Indications for Implant Placement

- In a partially edentulous patient who is unable to wear a removable partial denture or complete denture.
- For long-span fixed partial dentures with poor prognosis.
- Unfavourable number and location of potential tooth abutments.
- Single tooth loss that would necessitate preparation of undamaged teeth for a fixed prosthesis. E.g. missing single lateral incisors.

Contraindications

- Acute and Terminal illness.
- Pregnancy.
- Uncontrolled metabolic disease.
- Tumoricidal radiation given at the implant site.
- Unrealistic patient expectation.
- Improper patient motivation and poor oral hygiene.
- Lack of operator experience.
- Inability to restore with a prosthesis.

Treatment Planning

Treatment planning for an implant is carried out successive to diagnosis. Diagnosis for implant cases is similar to the procedures explained in Chapter 2. However, we have enumerated the important factors that are to be considered while placing an implant.

After diagnosis, the diagnostic data is analysed and an appropriate treatment plan is derived.

Clinical Evaluation

Clinical evaluation for implant cases include the evaluation of the following structures:

- Adequate bone for implant placement. Can be evaluated by inspection and palpation.
- Anatomic structures that could interfere with implant placement.

Radiographic Evaluation

The following radiographic studies should be carried out prior to implant placement.

- Orthopantomograph: to evaluate the width and height of the bone.
- Cephalometric analysis: To evaluate the bone in the anterior maxilla and mandible.

- Specialised CT scan: to locate the mandibular alveolar canal.

Evaluation of Diagnostic Casts

Diagnostic casts used to study:
- The remaining dentition.
- Evaluate the contour of residual ridge (to select the site of implant placement).
- Analyse maxillomandibular relationship (to determine the load pattern for the patient).
- For bone mapping (Refer Chapter 39).

Principles of Implant Location

The following factors should be considered while determining the location of an implant.

Anatomic Limitation

- Implant should be completely surrounded by bone.
- The implant should not encroach onto any anatomic structure.
- Minimum distance between implants and natural teeth should be maintained.

Restorative Consideration

- Superior or inferior positioning of the implant may affect the contour of the crown and pocket depth of the peri-implantal tissues.
- The body of the implant should be atleast 2-3 mm above the residual ridge to obtain a good emergence profile (contour of the proximal surface adjacent to the free gingiva). The body of the implant should not be placed more than 4 mm above the level of the alveolar bone else it will lead to the deepening of the gingival sulcus.

Parts of an Implant

Implant Body

- The implant body is the component that is placed within the bone during first stage of surgery. It could be threaded or non-threaded (Fig. 28.34).

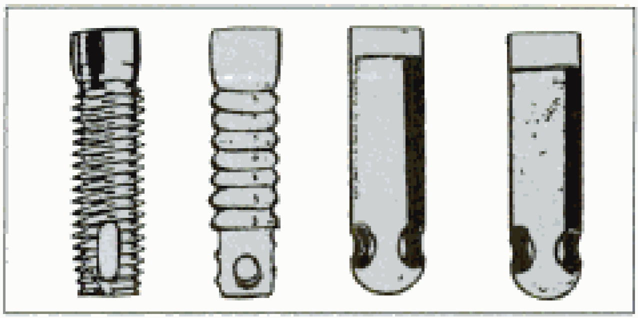

Fig. 28.34: Four main categories of two-staged osseo-integrated implants. Left to right: titanium screw, hydroxyapatite-coated screw, hydroxyapatite-coated cylinder, titanium plasma-sprayed cylinder

- Threaded implant bodies are available in commercially pure (cp) Titanium or as Titanium alloys. The Ti or Ti alloys may be with or without hydroxyapatite coating.

Healing Screw

During the healing phase, this screw is normally placed in the superior surface of the body (Fig. 28.35). The functions of this component are:
- Facilitates the suturing of soft tissue.
- Prevents the growth of the tissue over the edge of implant.

Healing Caps

Healing caps are dome shaped screws placed over the healing screw after the second stage of surgery and before insertion of the prosthesis. They may

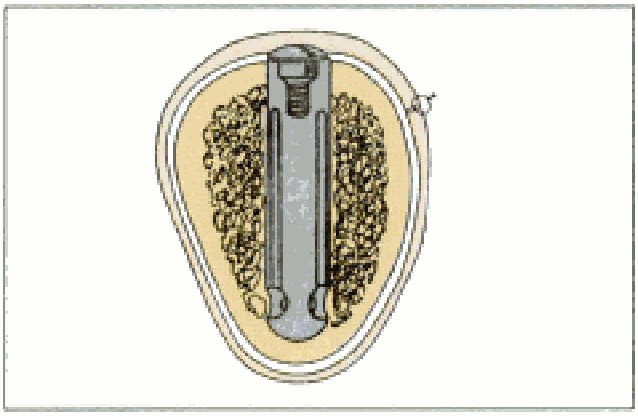

Fig. 28.35: Healing screw in place during the initial implant healing phase. Soft tissue is sutured over the implant. A removable prosthesis can be worn over this area during healing

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- To delineate the embrasures that would occur between two adjacent implants.
- Locate the implant on the ridge.

- Align implants along with the long axis of the completed restoration.
- To identify the level of cemento-enamel junction (CEJ) or tooth emergence profile of the implant.

Single Stage Surgery

- Surgical access and implant placement is done as a single procedure.

Two Stage Surgery

- During the first stage of surgery, the surgical site is exposed and the implant is placed and is allowed to osseointegrate.
- The second stage is done after six months (time varies according to the site), here the implant site is re-exposed and a super structure placed

Both these procedures are described in a greater detail under section V (implants).

Biomechanical Factors Affecting Long-term Implant Success

Implant Occlusion

- All masticatory forces should be directed along long axis of the implant.
- Lateral forces on the implant should be minimized.
- If lateral forces are unavoidable they should be directed as far anteriorly in the arch as possible.
- When it is impossible to minimize or move the lateral forces anteriorly, atleast they should be distributed over as many teeth and implants as possible.

Connecting Implants to Natural Teeth

Implants do not show any movement under occlusal forces but the natural teeth (due to the cushioning effect of the periodontal ligament) show mild displacement under the same occlusal load.

The most common difficulties that occur in connecting the implant to the natural teeth are:

- Intrusion of natural teeth.
- Implant fractures.

Intrusion of Natural Teeth

When an implant is connected to a natural tooth, it may get intruded. This is because the implant is tightly integrated to the bone and do not show any movement during occlusion. Where as the natural tooth which is in the same plane will be subjected to tissueward movement. This consistent downward force will lead to intrusion.

Methods to Prevent Intrusion

- Ideally a natural tooth should never be combined along with an implant in any prosthesis.
- A T-block type of stress relief attachment with a transverse retaining screw can be used to prevent migration or separation of teeth.
- More implants should be placed to convert a long multiunit restoration into many short single unit restorations.
- Using at least two implants, if only one tooth is available to support three pontics.
- Intra-coronal connectors (precision attachments) should not be used to fix the partial denture, unless they are necessary for path of insertion.
- The following design guide lines should be followed to prevent intrusion:
  - — Telescopic crowns can be placed to orient the stress. These crowns help to distribute stress and prevent intrusion.
  - — Avoid using setscrew implants because these implants do not show any movement and thereby concentrate stresses on the natural teeth.
  - — Composites can be used to cement the retainers so that the natural teeth are held tightly by the fixed partial denture against apical movement.

Complications of Implant Abutments

Bone Loss

One of the most important and primary complication with dental implants therapy is bone loss around the implant. Any loss exceeding 0.2 mm per year requires attention.

Factors Associated with Bone Loss are

- Inappropriate size and shape of implant.
- Inadequate number and/or positioning of the implants.
- Poor quality/inadequate amount of available bone.
- Initial instability of the implant.
- Compromised healing phase (trauma during the healing phase, etc).
- Inadequate fit of the prosthesis.
- Improper design of the prosthesis (e.g. large cantilevers, poor access for maintenance, etc).
- Excessive occlusal force.
- Deficient fit of abutment components (i.e. gaps between the implant parts that allow bacterial colonization)
- Inadequate oral hygiene
- Other environmental factors like tobacco chewing/smoking, diabetes, etc.

Prosthesis Fracture

This may occur due to:
- Biomechanical overload.
- Improper fabrication in the laboratory.
- Improper designing of the prosthesis.

Chapter 29
Tooth Preparation

- **Principles of Tooth Preparation**
- **Preparations for Full Veneer Crowns**
- **Preparation for Partial Veneer Crowns**

29

Tooth Preparation

PRINCIPLES OF TOOTH PREPARATION

Before we go into the details of how tooth preparation is done, it is necessary for us to know why certain characteristics, features are incorporated into a preparation. The basic principles on which tooth preparation is done are:

- Preservation of tooth structure
- Retention and resistance
- Structural durability
- Marginal integrity
- Preservation of periodontium

Preservation of Tooth Structure

"Muller De Van stated that the perpetual preservation of what remains is more important than the meticulous replacement of what is lost". Care should be taken to prevent excessive tooth preparation. There should be minimal possible reduction done to obtain the required characteristics. Grossly decayed teeth should be retained with the help of dowel cores, cast posts and onlays, etc.

Retention and Resistance Forms

Retention prevents the removal of the restoration along the path of insertion on the long axis of the tooth. It can be defined as, *"the ability of the preparation to prevent displacement of the restoration in a direction opposite to the path of insertion."* One of the major sources of retention in a fixed partial denture is *tensofriction*. Retention can be of classified as follows:

- ***Primary Retention***
  - *Sleeve retention* provided by the opposing vertical surfaces of the tooth preparation.
  - *Wedge type retention* seen in intracoronal restorations.
- ***Secondary retention:*** Retention obtained by retentive features like pins, boxes and grooves, etc. is known as secondary retention.

Resistance is the ability of the prosthesis to resist displacement by forces directed in an apical or oblique direction. This prevents any movement of the restoration under occlusal forces.

Retention and resistance are reciprocative to one another; hence, an optimal balance between these factors should be established during any preparation.

The following features in a preparation should be designed to strike the balance between retention and resistance forms.

Taper

The degree of taper is inversely proportional to the retention form. Zero degree taper is the most retentive but it is almost impossible to obtain. The sum of the degree of taper is called as *degree of convergence*. For optimum retention, 4°-10° convergence is sufficient (Fig. 29.1). Mandibular premolars are lingually tilted by 9° degrees, hence, reduction should not be prepared perpendicular to the occlusal plane instead the entire preparation should be lingually inclined (Fig. 29.2).

A tapering fissure diamond is ideal to produce the required taper for any preparation. This diamond is designed with a three-degree taper. Hence if the operator aligns the diamond parallel to the long axis of the tooth during tooth preparation, a six-degree convergence will be produced (Fig. 29.3).

Freedom of Displacement

- Limiting the freedom of displacement from torquing and twisting forces aid to increase the resistance of the restoration.

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Substitution of Internal Features

Internal features like proximal grooves, boxes and retention pinholes can be incorporated in the preparation to improve retention.

Indications

Substitution of internal features should be done for the following cases where retention is difficult to achieve.

- Over tapered preparations.
- Partial veneer crowns.
- Absence of two opposing walls (due to caries, etc.).

Retention can be improved in faulty preparations by the placement of internal features, which are accurate and easy to prepare.

Path of Insertion

"It is an imaginary line along which the restoration will be placed onto or removed from the preparation."

It should be accurately determined using a surveyor as minor undercuts in the preparation tend to be hidden by the human binocular vision (Fig. 29.6).

Fig. 29.6: If both eyes are open when the preparation is viewed undercuts may remain undetected

- Intraorally the preparation can be evaluated/ surveyed by viewing the preparation on a mouth mirror using one eye, 30 cm (12 inches) away from the preparation (Fig. 29.7a).
- A facial path of insertion is generally avoided because it forms a prominent unaesthetic cervical margin.
- The mesiodistal inclination of prepared tooth should be parallel to the proximal inclinations of adjacent teeth (Fig. 29.7b).

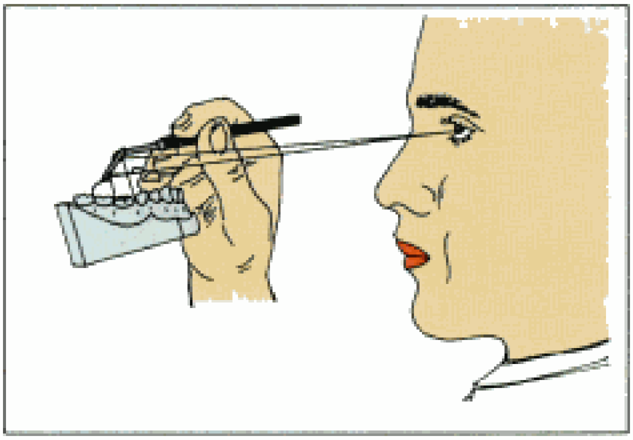

Fig. 29.7a: Intraorally, preparations are viewed through a mouth mirror using one eye

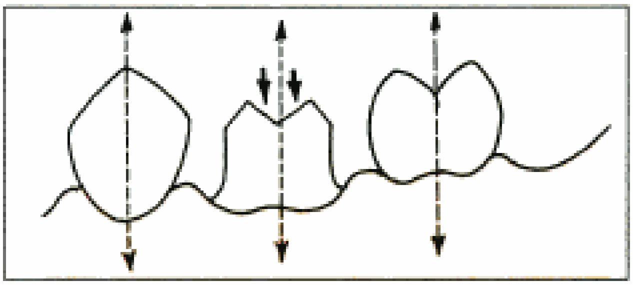

Fig. 29.7b: The path of insertion of the preparation should be parallel to the adjacent teeth

Structural Durability

Durability comes with the thickness of the restoration. A restoration should contain sufficient bulk to withstand forces. *The ability of the restoration to withstand destruction due to external forces is known as structural durability.*

Adequate reduction during preparation is mandatory to obtain adequate thickness of the restoration. The amount of reduction required for structural durability depends on the type of restorative material being used and the design of the restoration. Here, I have discussed about the amount of preparation required for the commonly used restorative materials.

Occlusal Reduction

Occlusal strength is the most vital as most of the forces affecting the restoration, act directly on the occlusal surface. Inadequate clearance may lead to a weaker restoration, which is prone to fracture or perforation (Fig. 29.8). Additional reduction (about 1 mm) should be done while preparing malposed teeth. The amount of occlusal reduction required for commonly used materials is:

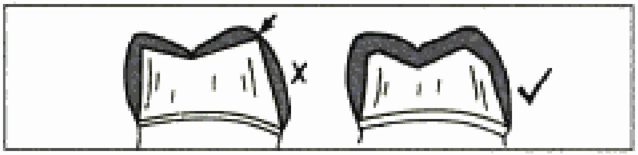

Fig. 29.8: Inadequate occlusal reduction wil not provide the required space for a cast restoration of adequate thickness

- Gold alloys require 1.5 mm clearance for the functional cusp and 1.0 mm clearance in the nonfunctional cusp.
- Metal ceramic restorations require 1.5 to 2.0 mm reduction in the functional cusp (2 mm if it is to be veneered with porcelain) and 1.0 to 1.5 mm reduction in the nonfunctional cusp.
- All ceramic restorations require a minimum of 2 mm reduction throughout.

Functional Cusp Bevel

- It is provided to increase the thickness of otherwise thin occluso-axial junction of the restoration (Fig. 29.9).

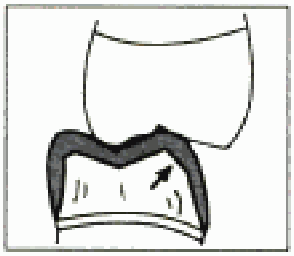

Fig. 29.9a: The functional cusp bevel is an integral part of occlusal reduction

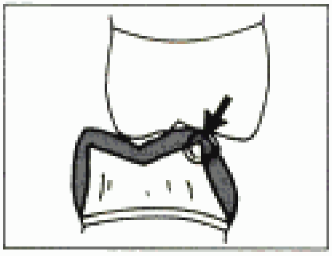

Fig. 29.9b: Lack of a functional cusp bevel can cause a thin area or perforation in the casting

- Additional thickness in this region is necessary because the functional cusp of the tooth is the one, which bears the maximum load during mastication.
- It is prepared on the palatal cusps of maxillary and buccal cusps of mandibular posterior teeth.

Axial Reduction

Adequate axial reduction is necessary for structural durability. Inadequate axial reduction may lead to over-contoured proximal surfaces, which can lead to periodontal problems (Fig. 29.10). The required taper should be obtained, during axial reduction. Over-reduction will lead to loss of retention. Usually the axial reduction is done such that it aligns the abutments parallel to one another. But in mandibular premolars, the tooth is inclined by 9°; hence, the preparation is also inclined in the same angle to avoid excessive tooth reduction.

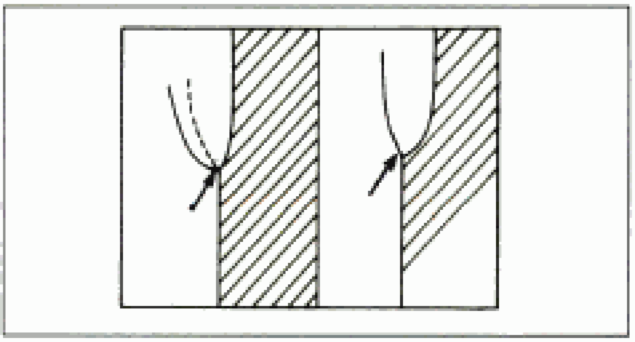

Fig. 29.10: Inadequate axial reduction will require over-contoured restorations

Other features, which increase durability, are:
- Offset
- Groove
- Occlusal shoulder
- Isthmus
- Proximal box

Marginal Integrity

Marginal adaptation and the seating of the restoration affect marginal intergrity. Poor marginal adaptation will lead to percolation of oral fluids (marginal leakage) and secondary caries. Casting shrinkage may lead to marginal discrepancy. The most accepted discrepancy is around 10 μ. The luting agent usually compensates for this discrepancy by completing the marginal seal.

The margin of a restoration should be preferably placed supra-gingivally because it has the following advantages:

- It can be easily finished.
- Easy to maintain.
- Easy to identify and reproduce during impression making.
- Easy to examine during future visits.

Sub-gingival margins may be required for certain restorations (Fig. 29.11).

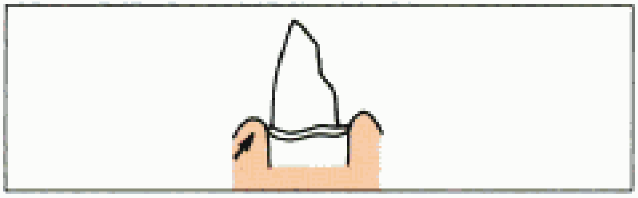

Fig. 29.11: Subgingival finish line

The indications for a sub-gingival margin are:

- For teeth with short clinical crowns.
- Teeth affected by sub-gingival caries or cervical erosion where crown lengthening cannot be performed.
- If the contact area is present at or below the gingival crest.
- Where aesthetics is of concern (e.g. gummy smile).
- For cases with unmanageable root sensitivity.
- When the axial contours should be modified (Fig. 29.12).
- When additional retention is required.
- To conceal the metal ceramic margin behind the labio-gingival crest.

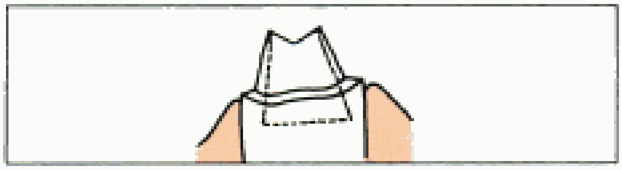

Fig. 29.12: Overtapered preparation can be corrected by moving the finish line subgingivally

Finish Line Configurations

A finish line should have the following characteristics:

- Shallow bevels nearly parallel to the cavosurface should be avoided because the restoration will be too thin at this area and may chip easily. The discrepancy decreases with the increase in angulation of the bevel (Fig. 29.13).
- The bevel should not produce a very acute margin, which can lead to fracture of the wax pattern during removal.

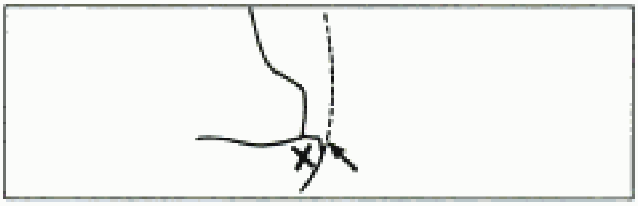

Fig. 29.13: Shallow cavosurface bevels may lead to chipping of the restoration

During finish line preparation, the tooth should not be reduced more than half of the width of the diamond. Over-reduction may lead to the formation of a lip of unsupported enamel (*lipping*) (Fig. 29.14).

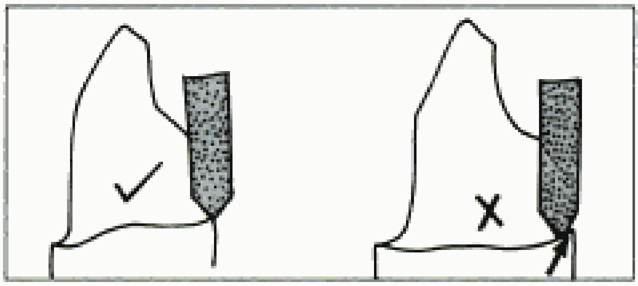

Fig. 29.14: Improper instrumentation can lead to lipping

Chamfer

This finish line possesses a curved slope from the axial wall till the margin (Fig. 29.15). It can be produced using a torpedo diamond point. The same diamond point when used to reduce more tooth structure will form a deep chamfer finish line. It is the finish line of choice for cast metal restorations and lingual margins of metal

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- It is used as a gingival finish line on the proximal box of inlays and onlays.
- In occlusal shoulder preparation, a contra-bevel will prevent the need for overcontouring the restoration.

- It can be used as the facial finish line of metal ceramic crowns where aesthetics is not of concern.
- Generally bevels are indicated when a ledge or step is present at the margin which is caused due to existing restoration or cervical erosion/ caries.

Advantages of a finish line bevel

- Aids in contouring the restoration.
- Improves burnishability.
- Minimizes the marginal discrepancy (Fig. 29.19).
- It prevents unsupported prepared margins from chipping.

Shoulderless or Feather Edge Preparation

- It is similar to a knife-edge preparation but is marginally thinner (Fig. 29.20).
- It has the same disadvantages as knife-edge preparations.
- Chisel-edge preparations are similar to feather-edge margins but it is marginally thicker.

Knife-edge

It is an extremely thin finish line. It is similar to a sloping shoulder with a very thin margin (Fig. 29.21).

- Difficult to wax up and cast.

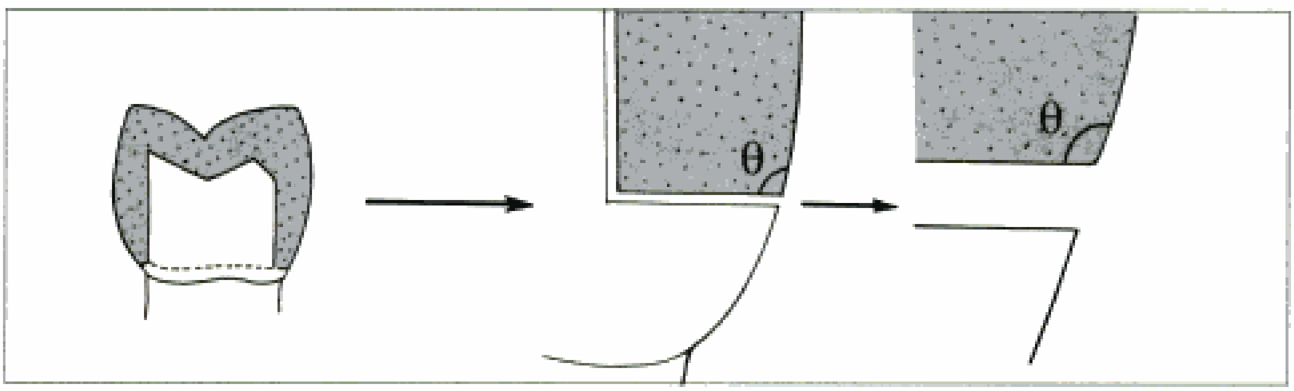


Fig. 29.19a: Unbevelled preparations have an even perpendicular marginal discrepancy because the angle of the margin (θ) is around 90°

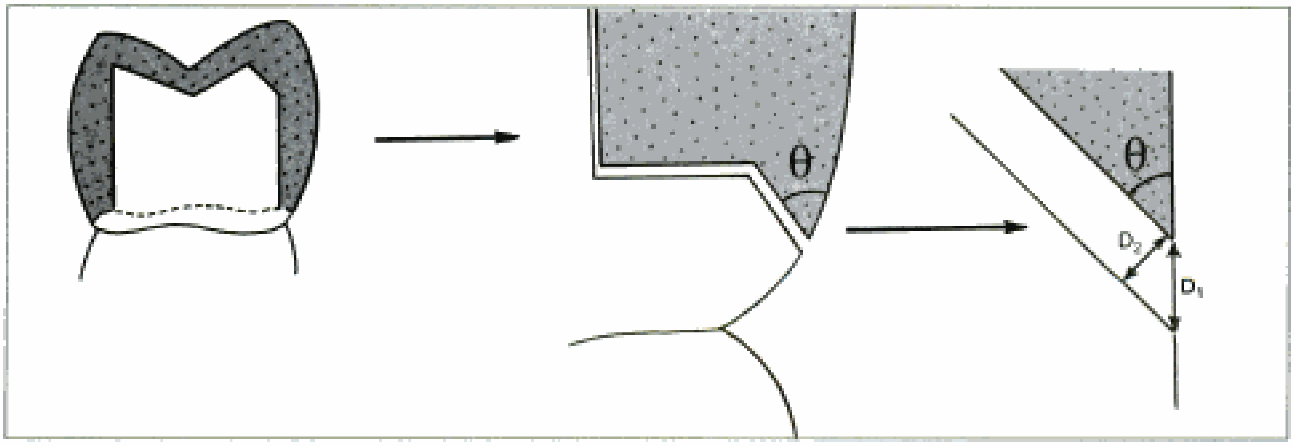


Fig. 29.19b: In bevelled preparations, the marginal discrepancy (i.e. the effective distance between the tooth and the restoration) decreases from D_1 to D_2 because the angle of the margin (θ) is reduced. Theoretically, if θ decreases to 0°, the marginal discrepancy will also decrease to zero

Fig. 29.20: Feather edge preparation

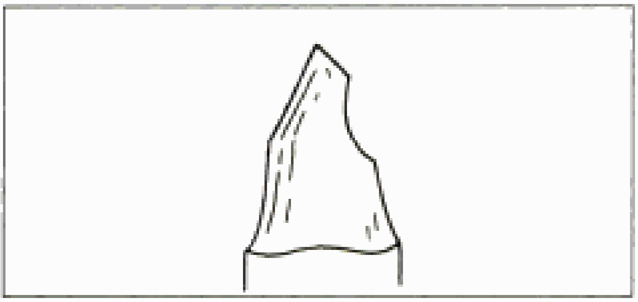


Fig. 29.21: Knife edge preparation

- Difficult to produce a smooth margin.
- Susceptible to distortion.
- Overcontoured restorations may result while building the bulk of the margins.

Indications

- Lingual surface of mandibular posterior teeth.
- Very convex axial surface.
- For the undercut surface of tipped teeth.

Preservation of Periodontium

- The placement of finish lines influences the fabrication of the restoration and the final outcome of the treatment.
- The finish lines should be placed in an accessible region so that the margins of the restoration can be easily finished by the dentist and effectively cleaned by the patient.
- The finish lines should be such that it can be reproduced in the impression
- It should also facilitate the easy removal of the impression without any tear or deformation.
- The finish line should be in enamel whenever possible.
- Most preferable finish line is a supra-gingival finish line.
- Sub-gingival finish lines predispose to periodontitis.
- If the distance between the finish line and the alveolar crest (combined width of epithelial and connective tissue attachments) is less than 2.0 mm, the restoration may lead to gingival inflammation, loss of alveolar crest and pocket formation (Fig. 29.22). A crown lengthening procedure should be done to move the alveolar crest to a location about 3.0 mm away from the finish line to preserve the periodontal health.

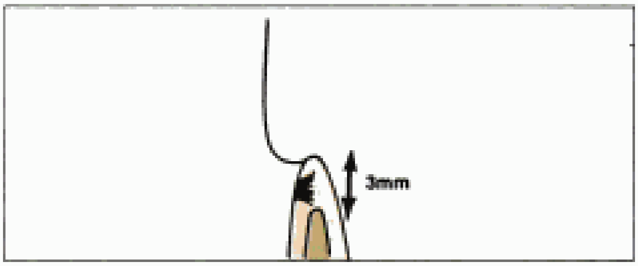


Fig. 29.22: The finish line should be atleast 3 mm away from the alveolar crest to preserve the periodontium

- If an extensive inter-proximal bone reduction is required during the preparation of a proximal finish line in order to ensure the placement of a deep proximal finish line, it is better to extract the abutment rather than affecting the adjacent healthy tooth.
- The cavosurface finish line should be smooth and continuous to fabricate a restoration with well-adapted margins.

Instrumentation

The following instruments should be used during tooth preparation (Fig. 29.23).

- Hand chisels can be used to accentuate the facial and lingual walls of proximal boxes
- Torpedo diamonds followed by torpedo carbide burs can be used to prepare a chamfer finish line.
- Flat end tapered diamonds followed by H158 carbide-finishing bur can be used for radial shoulders.
- Flame diamonds followed by flame finishing burs can be used for gingival bevels and conservative proximal flares.
- Abrasive paper discs can be used to smoothen the finish lines of vertical flares. It should be

Fig. 29.23: Dental diamond points

used alongwith a rubber dam to avoid damage to soft tissues.

- Grooves, boxes, offsets and isthmus can be smoothened with No: 169L, 170C and 171L non-dentate tapered burs.
- Cross cut or dentate burs are used to remove old restorations but they produce horizontal ridges on the tooth surface. Hence, they cannot be used for planing tooth surfaces.
- Small diamond points with air-water spray in a high-speed hand piece can precisely remove tooth structure and also produce a smooth finish when compared with conventional procedures.

PREPARATIONS FOR FULL VENEER CROWNS

A full veneer crown is one, which encompasses the entire crown structure. These crowns cover all the tooth surfaces. Hence, they require extensive tooth reduction.

Indications

It is indicated when:

- The abutment tooth is small
- The edentulous span is long
- When the partial veneer crown lacks in retention, resistance, coverage or esthetics
- When the abutment is extensively decayed or decalcified or previously restored
- For endodontically treated teeth.

Contraindications

A full crown is not given for patients with uncontrolled caries

Procedure

The steps to be followed for preparing a posterior tooth are as follows:

- Occlusal reduction
- Axial reduction
  - — Buccal reduction
  - — Lingual reduction
  - — Proximal reduction
- Establishing the Finish lines

The above-mentioned procedures vary according to the choice of material for the restoration.

Commonly used full veneer crowns include:

- Full metal or all metal crowns
- Metal ceramic crowns
- All ceramic crowns

In the following section we shall discuss about these procedures in relation to the selected restorative material.

All Metal Full Veneer Crowns

It is usually given for posterior teeth.

Armamentarium

- Handpiece
- No: 171L bur
- Round-end tapered diamond
- Short needle diamond
- Torpedo bur
- Red utility wax

*Note: The term "**bur**" is usually used to denote a (TC) Tungsten Carbide rotary cutting instrument. Diamond rotary cutting instruments are called "**Diamond points**" or "**Diamonds**".*

Occlusal Reduction

- The principle of occlusal reduction is to achieve an occlusal clearance of 1.5 mm for the functional cusps and 1.0 mm for the non-functional cusps. (Fig. 29.24). This provides adequate metal thickness to resist fracture under occlusal load.

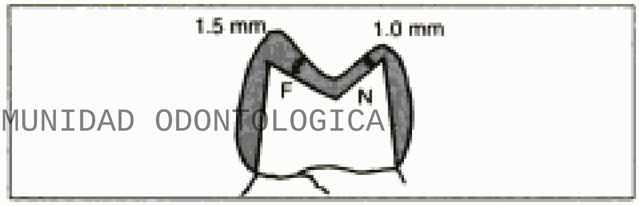
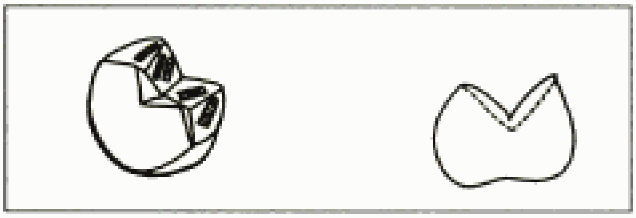


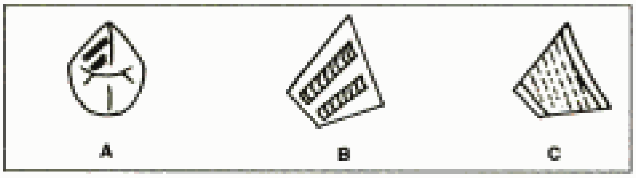
Fig. 29.24: Occlusal reduction should be such that there is 1.5 mm clearance at the functional cusps (F) and 1 mm clearance at the non-functional cusps (N)

- Fractured or malposed teeth may require lesser tooth reduction.
- Depth orientation grooves should be placed on the occlusal surface to act as a reference guide for the required amount of occlusal reduction (Fig. 29.25).



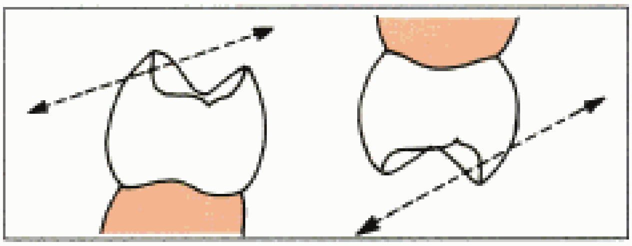
Figs 29.25a and b: Depth orientation grooves placed along the cuspal inclines to guide reduction

- A round-end tapered diamond is used to place grooves on the cuspal inclines and the primary grooves of the occlusal surface.
- The tooth structure between the orientation grooves are removed following the occlusal cuspal inclines of the abutment tooth. The reduction should be smooth without any rough spots (Fig. 29.26).



Figs 29.26a to c: (a and b) depth orientation grooves placed along the inclines (c) Tooth structure between the grooves should be reduced to a smooth even plane

- A functional cusp bevel is placed using a round-end tapered diamond, on
  — The buccal inclines of mandibular buccal cusps (Fig. 29.27a).
  — The palatal inclines of maxillary palatal cusps (Fig. 29.27b).



Figs 29.27a and b: (a) Functional cusp bevel of the mandibular buccal cusps (b) Functional cusp bevel of the maxillary palatal cusps

A thin casting or a restoration with poor morphology may be fabricated without this bevel.

- The angulation of the bevel should be parallel to the inner inclination of the opposing cusps (Fig. 29.28).

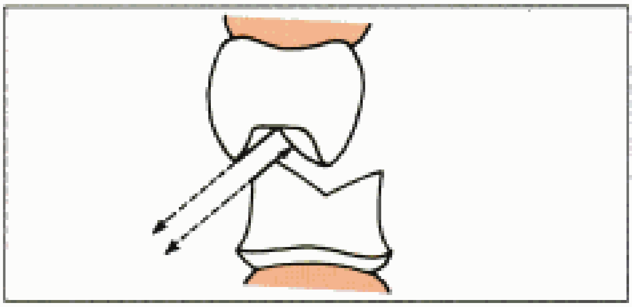


Fig. 29.28: The functional cusp bevel should be parallel to the inner inclines of the opposing tooth

- The occlusal clearance is verified by asking the patient to close on a 2.0 mm thick red utility wax. Insufficient clearance can be detected as a thin spot on the wax and it is reduced accordingly until there are no spots on the wax (Fig. 29.29).
- The occlusal reduction and the functional cusp bevel are smoothened with a No: 171L bur. The sharp angles and uneven ridges should be removed.

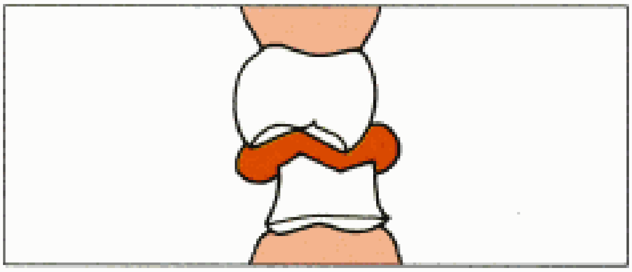


Fig. 29.29: Occlusal clearance is evaluated using red utility wax

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- If the reduction is done without these grooves, more time will have to be wasted in checking for reduction with the index.

- The labial grooves should be atleast 1.2 mm in depth to provide adequate thickness of ceramic. Insufficient reduction will lead to:
  — A poorly contoured restoration that lacks in aesthetics and it may affect the health of the surrounding gingiva.
  — The shade and translucency of the restoration will not match the adjacent natural teeth.
- The labial grooves are prepared as two sets in order to obtain a two-plane reduction:
  — One set should be parallel with the gingival half of the labial surface (Fig. 29.36).

Fig. 29.36: Placing depth orientation grooves in two planes to produce a two plane labial surface

  — Other set should be parallel with the incisal half of the labial surface (Fig. 29.36).
- After completing the depth orientation grooves, islands of enamel formed between the depth orientation grooves should be reduced to the depth of the grooves using the same bur (Fig. 29.37).
- Facial reduction should be done in two planes namely incisal and gingival planes with a flat-end tapered diamond point. A single plane reduction is avoided because:
  — If the reduction is done following the gingival plane, it will result in a protruded incisal edge leading to an over-contoured restoration or poor aesthetics.
  — If the reduction is done following the incisal plane, the labial surface will be over-tapered and will be in close proximity to the pulp.

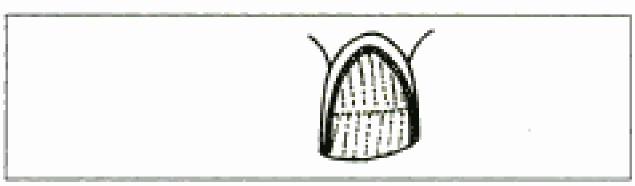

Fig. 29.37: Completed two plane labial reduction

- The amount of reduction can be verified by placing the corresponding halves of the index over the prepared tooth (Fig. 29.38).

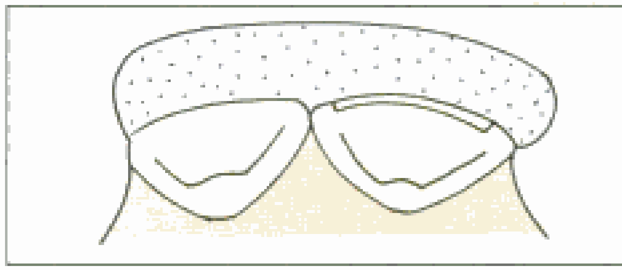

Fig. 29.38: The corresponding half of the putty material index is used to verify the tooth preparation

- The labial reduction is extended across the labio-proximal line angles and the proximal contacts to a point about 1.0 mm lingual to the proximal contacts. This region where the labial and lingual reduction meet (labial reduction is 1.2-2.0 mm deep and the lingual surface is 0.7-1.0 mm deep), is described as a wing preparation (Fig. 29.39).
- This wing formation conserves tooth structure. Care should be taken such that the labial face of the wing is in same inclination as the gingival portion of the labial surface.

Incisal Reduction

- After the labial reduction, incisal grooves (2.0 mm deep) should be made across the incisal edge. The bur should be held at a direction perpendicular to the incisal half of the labial reduction (Fig. 29.40).

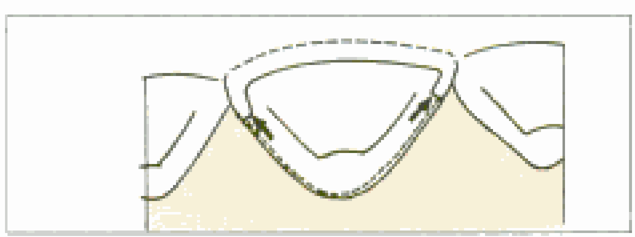

Fig. 29.39: Wing formation at the junction of the labial and lingual reduction

Fig. 29.40: The bur should be held perpendicular to the incisal half of the labial surface

- The incisal reduction is done using a flat-end tapered diamond following the plane of the unprepared incisal edge. The incisal reduction is useful in:
  — Improving the instrument's access near the axial surfaces
  — Improving the access for placement of the gingival finish line
  — Improving the incisal translucency in the finished restoration.

Lingual Reduction

- The cingulum should be reduced with a small wheel diamond to obtain a minimum clearance of 0.7 mm with the opposing teeth. 1.0 mm clearance is needed if a ceramic veneer is given. (Fig. 29.41).
- The junction between the lingual wall and the cingulum should not be over-reduced. A short lingual wall will have reduced retention.
- The lingual wall of the reduced lingual surface should be parallel to the gingival half of the labial surface (Fig. 29.41). It can also be reduced along with proximal reduction.

Proximal Reduction

- A long needle diamond point is used to break the contact and gain access into the proximal region without damaging the adjacent teeth.

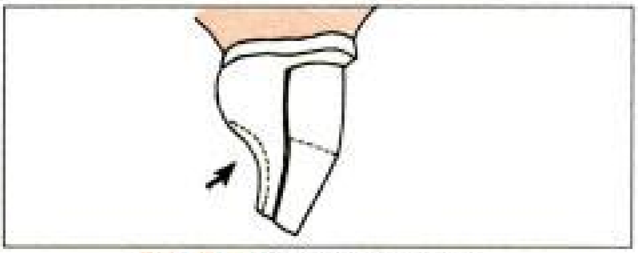

Fig. 29.41: Cingulum reduction

- Most of the proximal surface would have been reduced during the wing preparation (a part of labial reduction).
- The lingual aspect of the proximal surface and the remaining lingual wall are reduced using a torpedo diamond point (Fig. 29.42).
- The axial surfaces and the chamfer finish line are smoothened with a torpedo bur.

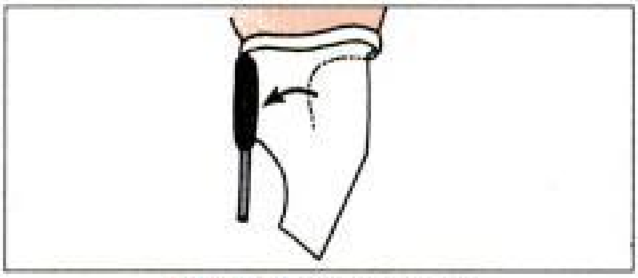

Fig. 29.42: Lingual reduction

- An H158-012 radial fissure bur is used to smoothen the labial surface. All the angles and edges are rounded with the sides of the bur and the end of the bur is used to form a radial shoulder finish line (Fig. 29.43).
- RS-1 Binangle chisel with rounded corners can also be used to finish the radial shoulder finish line. It can also be used to remove the unsupported lip of enamel along the cavo-surface angle (Fig. 29.44).

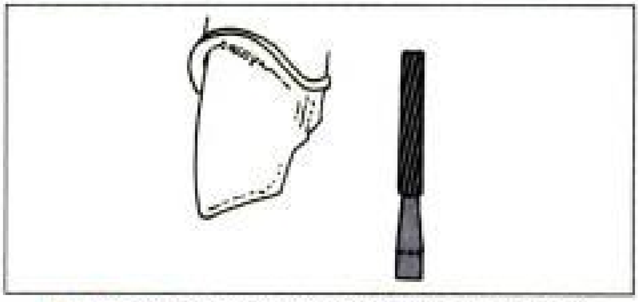

Fig. 29.43: Axial shoulder finishing is done using: Radial fissure bur

Features	*Their functions*
• Radial shoulder:	Structural durability and Periodontal preservation
• Chamfer:	Marginal integrity and Periodontal preservation.
• Axial reduction:	Retention, Resistance and Structural durability
• Incisal reduction:	Structural durability
• Wing:	Retention, Resistance and Preservation of tooth structure.

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Fig. 29.55: Half moon fracture or notching of the restoration

It usually occurs in the labio-gingival area of the restoration due to stress concentration in that region.

Next we shall read about the steps in the preparation of an all ceramic crown.

Armamentarium

- Handpiece
- Flat-end tapered diamond
- Small wheel diamond
- H158-012 radial fissure bur
- RS-1 Binangle chisel

Labial Reduction

- Depth orientation grooves are prepared using a flat end tapered diamond
- The grooves should be 1.2 to 1.4mm deep on the labial surface and 2.0 mm on the incisal surface.
- The first set of three labial grooves is made parallel to the gingival third of the facial surface.
- A second set of two grooves is made parallel to the incisal two-thirds of the uncut labial surface.
- This two-plane reduction on the facial surface provides adequate aesthetics without affecting the pulp.
- The tooth structure left between the grooves is removed following the morphology of the tooth to a depth of 1.2 to 1.4 mm.
- The facial reduction should extend around the facio-proximal line angles and fade out on the lingual aspect of the proximal surfaces.
- The end of the flat end tapered diamond forms the shoulder while the sides of the bur reduces the axial surface.

Incisal Reduction

- It is done alongwith the preparation of the labial surface.
- Depth orientation grooves should be made across the incisal edge. They should be about 2.0 mm deep.
- Islands of enamel between these grooves should be reduced using a flat end tapering diamond bur.
- The incisal reduction should be perpendicular to the plane of the incisal half of the labial reduction.

Lingual Reduction

- Cingulum should be reduced with a small wheel diamond (Fig. 29.56).
- Care should be taken to prevent over reduction at the junction between the cingulum and lingual wall. A short lingual wall reduces the retention of the restoration.
- The reduction of lingual axial surface is done with a flat end tapered diamond
- The lingual wall should be parallel to the gingival portion of the labial wall.

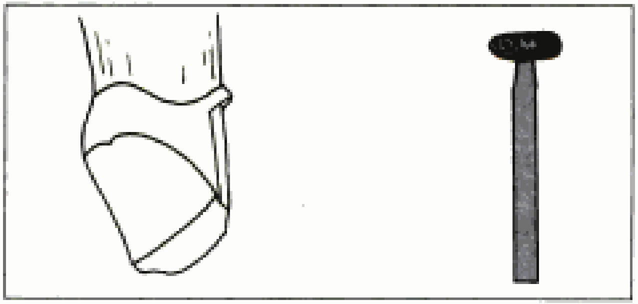

Fig. 29.56: Lingual reduction done using a small wheel diamond

Proximal Reduction

- Its preparation is similar to anterior metal ceramic crown except that a radial shoulder finish line is provided along the entire preparation (Fig. 29.57).
- The shoulder should be atleast 1.0 mm wide and should be in uniform contour along the line angles of the restoration.

Fig. 29.57: Axial wall and radial shoulder prepared using a finishing radial fissure bur

- The axial walls are smoothened with a H158-012 radial fissure bur.
- RS-1 Binangle chisel is used to smoothen the shoulder.
- Care should be taken to avoid any undercuts at the junction of axial walls and the shoulder finish line.

Features	*Their functions*
• Axial reduction:	Structural durability, Resistance and Retention
• Rounded angles:	Structural durability
• Concave Cingulum: reduction	Structural durability
• Radial shoulder:	Periodontal preservation, Resistance, Structural durability and Marginal integrity
• Vertical Lingual wall:	Retention and Resistance

PREPARATION FOR PARTIAL VENEER CROWNS

The partial veneer crown is a conservative restoration. They are used in cases where minimal retention is sufficient and the abutment tooth is healthy. Here, crown does not cover the entire abutment and facial surface of the abutment is left intact for superior aesthetics.

Advantages

- Conservation of tooth structure
- Improved access for finishing by the dentist and for cleaning by the patient
- Improved periodontal health, as there is limited contact between the margins of the restoration and the gingiva.
- The partial veneer crown can be completely seated during cementation. (A full veneer crown acts as a hydraulic cylinder containing a highly viscous fluid and cannot be seated completely).
- The marginal fit of the partial veneer crown can be easily verified.
- The unveneered portion of the enamel can be used for electric pulp testing which is not possible in a full veneer crown

Partial veneer crowns usually lack retention. The retention can be enhanced by placement of retention grooves. These restorations are usually indicated for single restorations and short span fixed partial dentures.

Maxillary Posterior Three-Quarter Crowns

It is usually a partial veneer crown with an intact buccal surface. It is usually used in maxillary posterior teeth where aesthetics is not a major concern. We have described the following procedure in relation to a maxillary premolar.

Armamentarium

- Handpiece
- Round-end tapered diamond
- Short needle diamond
- Torpedo diamond
- Torpedo bur
- No: 169L bur
- No: 171L bur
- Flame diamond
- Flame bur
- Enamel Hatchet

Occlusal Reduction

- Depth orientation grooves should be made using a round end tapered diamond bur (Fig. 29.58).
- The grooves should be 1.5 mm deep on the functional cusps, 1.0 mm deep on the non-functional cusps (Fig. 29.58)
- The grooves should be only about 0.5 mm deep on the occluso-buccal line angle to minimize the display of metal (Fig. 29.58).
- Reduction is done by removing the tooth structure between the grooves.

Fig. 29.58: Placing depth orientation grooves for planar occlusal reduction

- A functional cusp bevel is placed on the palatal or outer incline of the palatal cusp. It should be at 45° to the long axis of the preparation (Fig. 29.59).

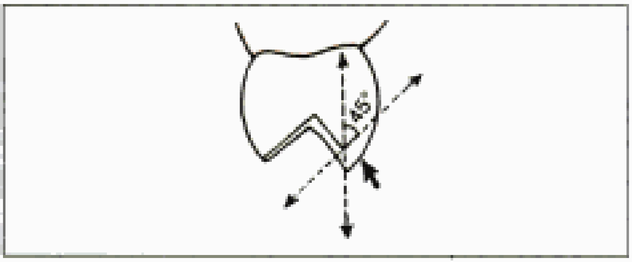

Fig. 29.59: Functional cusp bevel placed in the outer incline of the palatal cusp at an angle of 45° to the long axis

- A functional cusp bevel should be prepared using a round end tapered diamond point. Three to five depth orientation grooves may be necessary. These grooves are 1.5 mm deep at the cusp tip and fade out near the base of the cusp. The bevel should extend from the central groove on the mesial side to the central groove on the distal side (Fig. 29.60). This provides space for bulk and strength of the metal on the palatal incline of the palatal cusp.
- The occlusal reduction and the functional cusp bevel are smoothened with a No: 171L bur.

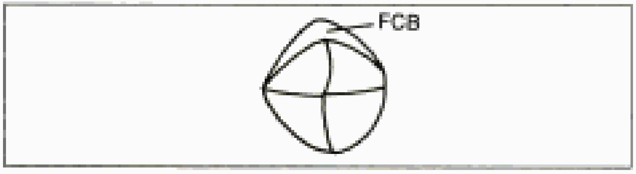

Fig. 29.60: Occlusal view of the functional cusp bevel (FCB)

Axial Reduction

- All axial surfaces are usually reduced using a torpedo bur.
- It is started by reducing the lingual surface with a torpedo diamond point
- Care should be taken to avoid over-inclination of the lingual wall.
- The reduction should be extended into the proximal surfaces without damaging the adjacent teeth.
- A chamfer finish line is established during the reduction.
- All sharp angles should be rounded.
- Proximal access can be obtained by breaking the contact using a short needle diamond point in an up-down sawing motion. A flame shaped diamond should be used in teeth with minimal proximal clearance.
- After breaking the contact, proximal reduction is carried out. Proximal reduction should also be done with a torpedo diamond.
- The facial extension of the axial reduction should be done using a short needle diamond point or an enamel hatchet.
- The gingivo-facial angle should not be under-extended as it may lead to failure of the restoration.
- The axial wall and chamfer are finished with a torpedo bur.

Placement of Additional Features

Proximal Grooves

- Grooves are usually placed to increase the retention.
- It is usually done with a No: 171L or No: 169L bur aligned to the path of insertion.
- An outline of the preparation should be drawn on the occlusal surface using a sharp pencil (Fig. 29.61).
- Using the outline as an index, a small 1 mm deep groove is formed on the proximal surface. This depression is also known as the template (Fig. 29.62).
- This template is used as a guide to extend the groove to half its length.
- After examining the alignment and direction, the groove is extended up to a point 0.5mm occlusal (above) to the finish line.
- The grooves should be placed as facial as possible without undermining the facial

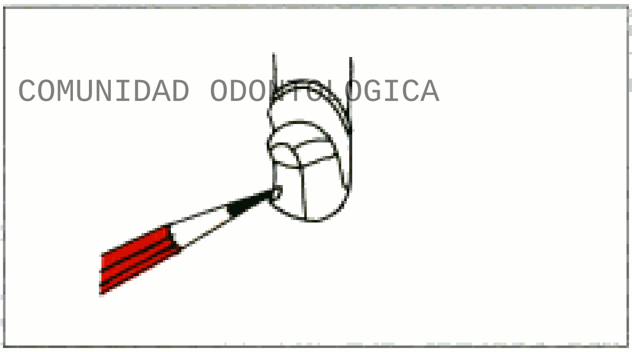

Fig. 29.61: The outline of the pxoximal groove is drawn on the occlusal surface of the tooth

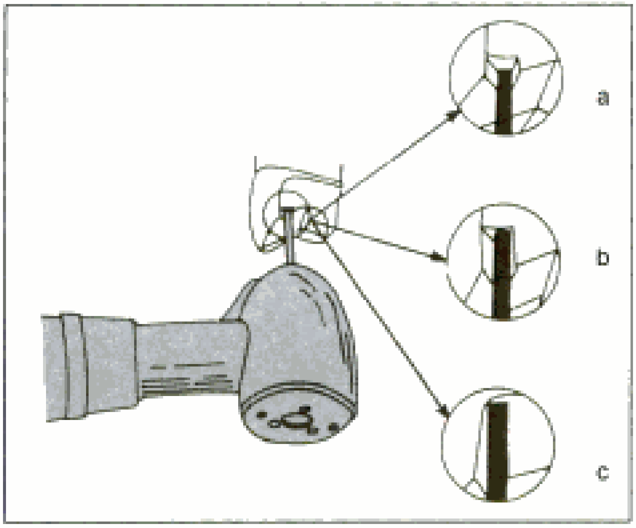

Fig. 29.62: The proximal groove is prepared in 3 stages: (a) First a shallow occlusal template or index is prepared (b) Next it is extended to half it's length (c) Finally it is completed to its full length

enamel. The grooves should be parallel to the long axis of the abutment (Fig. 29.63)

- Grooves are first placed on the inaccessible areas like the distal surface of the molars and on the aesthetically critical areas like the mesial surfaces of premolars. This is done because grooves in these areas are more difficult to orient. Hence, a groove in an accessible area, which can be easily reoriented, is placed later.

Proximal Flare

- Flare is a flat plane on the facial wall of a groove. The facial wall of the proximal groove should be extended such that it forms a line angle with the facial surface. This produces a proximal flare (Fig. 29.64).

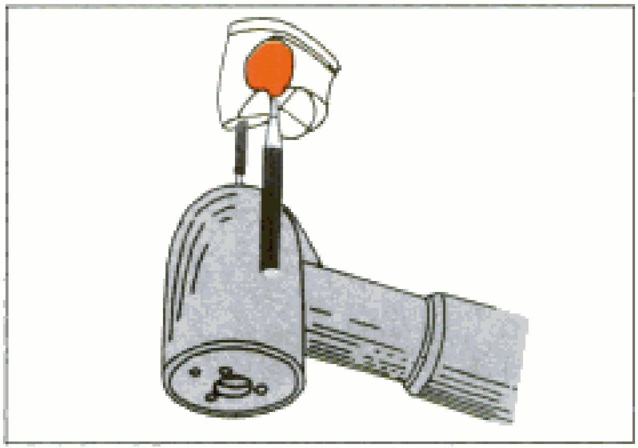

Fig. 29.63: In order to align the second groove, a bur should be held in the first groove with utility wax

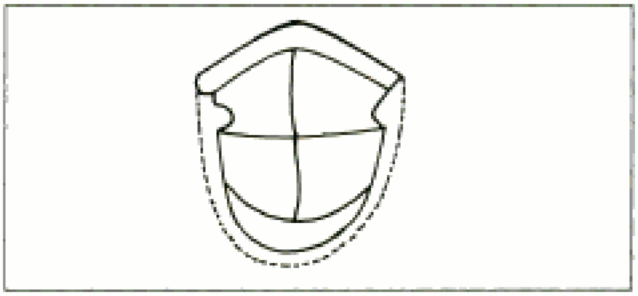

Fig. 29.64a: Proximal flare preparation completed on the right side. (occlusal view)

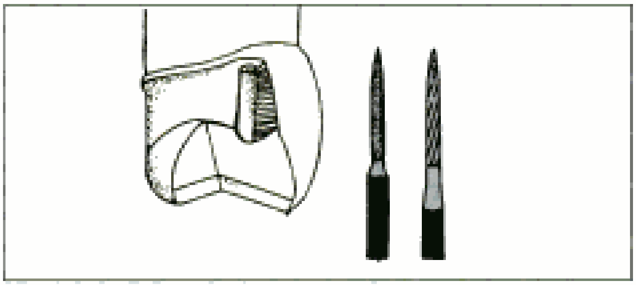

Fig. 29.64b: A Proximal flare prepared using: Flame diamond and bur (diagonal view)

- It is cut using the tip of a flame diamond in an outward direction from the groove. This is done in order to avoid over-extension. It can also be made with a wide enamel chisel.
- The flare is smoothened with a carbide bur using short and crisp strokes to avoid roundening of the finish line.

Occlusal offset

- It is a 1.0 mm wide ledge on the lingual incline of the facial cusp. It should connect the two proximal grooves (Fig. 29.65).

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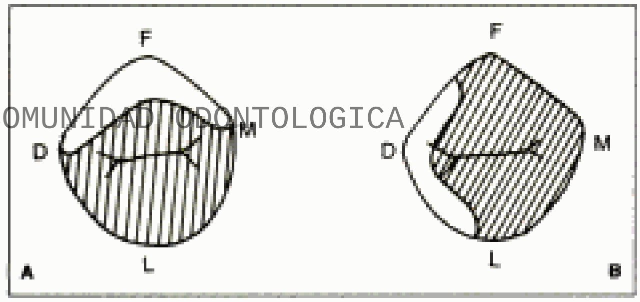

Figs 29.74a and b: (a) Normal three-qurter crown with an intact facial surface (b) Proximal half crown. Here, the distal surface is left intact

- The mesial surface of the preparation should be parallel to the path of insertion of the mesial abutment of the prosthesis.
- Occlusal reduction terminates at the distal marginal ridge with little or no reduction on the mesial cusps.
- Grooves parallel to the mesial surface should be placed on the distal end of the buccal and lingual axial walls (Fig. 29.75).

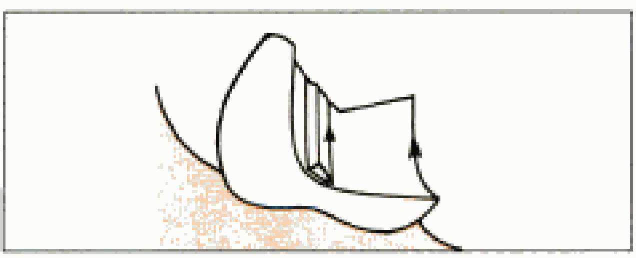

Fig. 29.75: Axial grooves placed parallel to the mesial surface

- An occlusal offset connecting the axial grooves should be prepared. It functions to strengthen the disto-occlusal margin, improve the retention and resistance of the restoration, and acts like a countersink and prevents the mesial displacement of the restoration (Fig. 29.76).

Anterior Three-quarter Crowns

It is a restoration which does not cover the facial surface. The main disadvantage is the unaesthetic display of metal near the incisal edge.

It can be used as a retainer for short span fixed partial dentures with caries free abutments. It is usually placed on well aligned, thick, square anterior teeth with adequate facio-lingual bulk

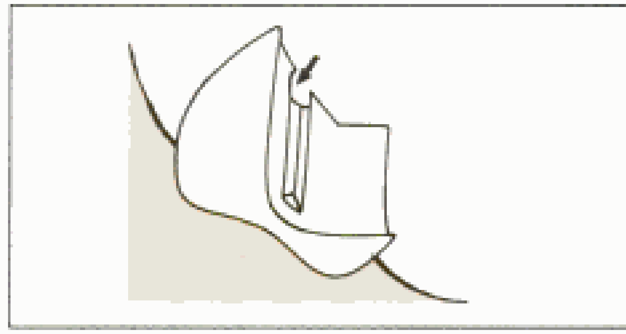

Fig. 29.76: An occlusal offset is prepared such that it connects the axial grooves

Design considerations

The factors to be considered to avoid metal display are:

Path of insertion and placement of grooves

The path of insertion should be parallel to the incisal one-half to two-thirds of the labial surface. This path requires a slight lingual inclination to the grooves (Fig. 29.77). This type of placement not only increases the length of the groove, but also helps to provide a more apical and labial placement for the base of the groove.

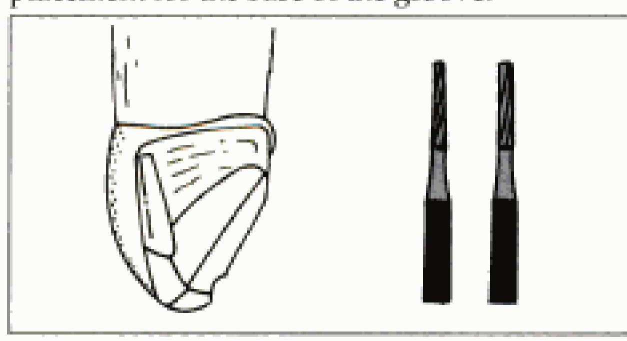

Fig. 29.77: Proximal grooves prepared using: No. 169L and 170L burs

If the groove is placed labially, the labio-incisal corners are over-reduced leading to display of metal. If the base of the grooves is moved too lingually, the length is reduced leading to a loss of retention (Fig. 29.78).

Placement and Instrumentation of Extensions

The proximal extensions should be done with thin diamond points or hand instruments using a lingual approach to minimize metal display. Use of a larger instrument or labial approach is

- The junction between the lingual wall and the cingulum should not be over-reduced, as a vertical lingual wall is essential for retention. Over-reduction may lead to loss of retention

- In a tooth with short lingual wall, the following modifications can be done to enhance retention:
  — A lingual beveled shoulder.
  — Pins can be placed on the cingulum for retention.

Incisal Reduction

- It is done using a small wheel diamond
- The reduction should follow the contour to the uncut incisal edge.
- The reduction should be about 0.7 mm deep at the junction between the incisal edge and the lingual surface.
- The reduction forms a flat plane on the incisors, but it follows the mesial and distal cuspal inclines on the canine.

Proximal Reduction

- It is started with a lingual approach using a long needle diamond in an up-down sawing motion.
- Care should be taken to avoid damage to the adjacent teeth.
- The contacts can also be broken, using an enamel hatchet.
- The chamfer finish line is placed using a torpedo diamond point during the axial reduction.
- A long tapered diamond point can be used prior to the torpedo diamond to prevent binding of the instrument between the proximal walls of the adjacent teeth.
- The axial wall and the chamfer are finished using a torpedo carbide bur.

Placement of Additional Features

Proximal grooves

- These grooves are placed as far labially as possible without caving or undermining the labial enamel (Fig. 29.83).
- An outline of the grooves should be marked on the linguo-incisal area of the preparation with a pencil.

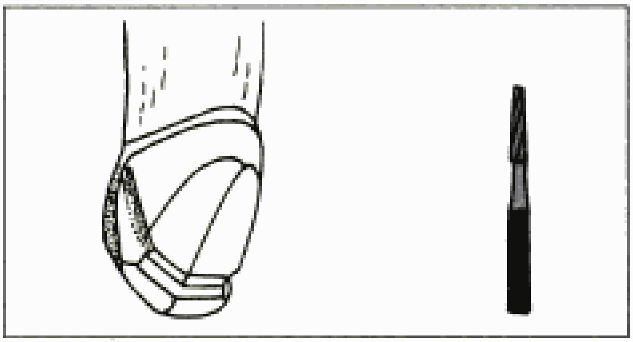

Fig. 29.83: Incisal offset prepared using a No. 171L bur

- A 1.0 mm deep template for the first groove is prepared within the outline using a No: 170L bur.
- Then the groove is extended gingivally in increments to its full length.
- The second groove is prepared in a similar manner.
- These grooves should be parallel to the path of insertion.
- Boxes may be prepared instead of grooves in teeth with proximal caries or restorations. The boxes should be narrow as the lingual wall of the box decreases in height as it moves lingually. (Fig. 29.84). Hence, if the proximal box is wide, the average height will be reduced leading to a decrease in retention.

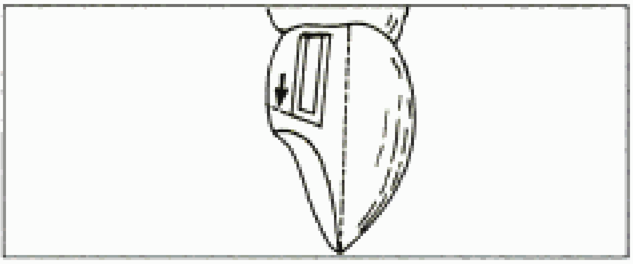

Fig. 29.84: The proximal box should be narrow because widening it lingually will produce a short lingual wall

Proximal flare

- The flare should be prepared to make the labial wall of the groove meet the labial surface in a sharp line angle (Fig. 29.85).
- A flare should be started in the gingival end with the thin tipped flame diamond.
- It is finished using a flame bur to form a smooth flare with a sharp, definite finish line.

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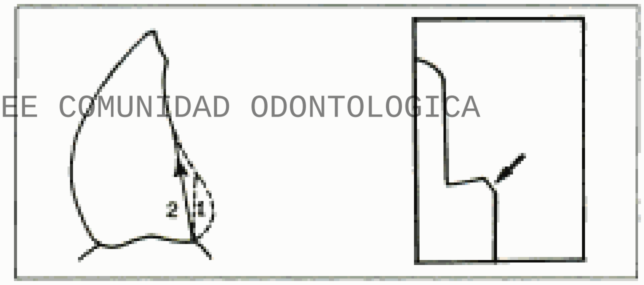


Figs 29.90a and b: (a) For a tooth with a short cingulum, the height of the lingual wall should be increased by altering the angulation of the wall. For example: as shown in diagram lingual wall (1) should be converted to lingual wall (2) (b) Bevelled shoulder finish line should be used on the lingual surface for a teeth with small cingulum

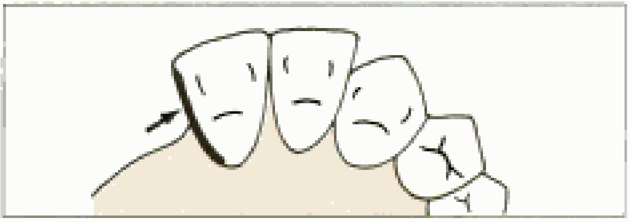


Fig. 29.91: Only the proximal surface adjacent to the edentulous area is prepared

- It is done using long needle diamond and torpedo diamond points.
- The preparation is similar to the conventional three-quarter crown preparation.
- The axial reduction should be extended as far labially as possible closer to the labio-proximal line angle. Inadequate facial extension will lead to an undersized, weak connector and poor access to the margins of the restoration (Fig. 29.92).
- The axial reduction and the chamfer finish line are smoothened using a torpedo carbide bur

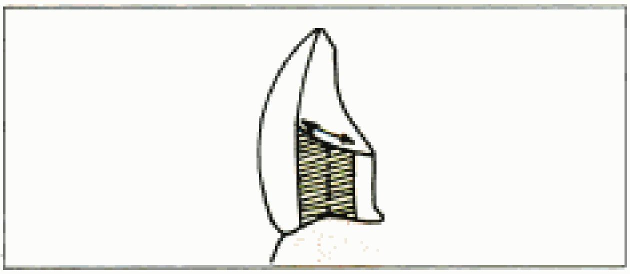


Fig. 29.92: The thickness of the connector is determined by the amount of facial extension

Preparation of Additional Features

Proximal grooves

- A proximal box may be given if there is proximal caries or restoration.
- Placement of two grooves is more retentive than a box form in anterior teeth because the two grooves have two lingual walls. The wall of the facially positioned groove will be longer and more retentive than the short lingual wall of a box (Fig. 29.93).

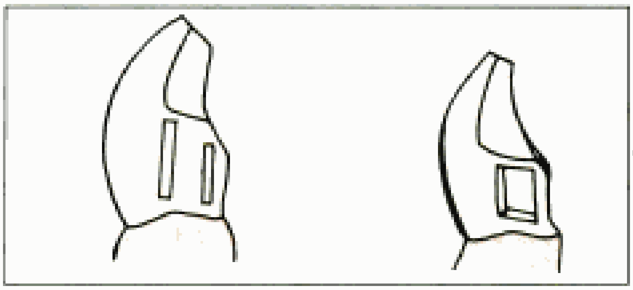


Fig. 29.93: A pair of proximal grooves offer better retention when compared to a proximal box

- Two proximal grooves (one facial and one lingual) should be placed on the prepared proximal surface (remember one proximal surface is preserved).
- A third groove should be placed on the opposite proximal side (away from the edentulous space). It should be placed more lingually compared to the first two grooves. It helps to provide retention, resistance to the restoration. It also provides some anti rotational property to the restoration (Fig. 29.94).

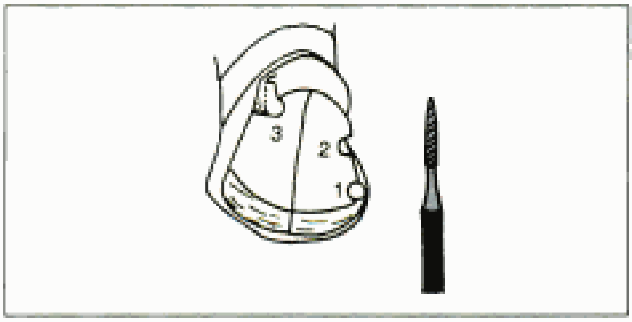


Fig. 29.94: Proximal grooves prepared using 169L bur
Key: (1) Facial proximal groove (2) Lingual proximal groove (3) Third proximal groove or the opposite side groove

Facial proximal groove

- It is prepared using a No: 170L bur
- Shallow pilot grooves are made to determine the location and direction

- The bur is then moved along the track of the trial grooves to deepen it.

Lingual proximal groove

- It is placed parallel to the facial groove
- It is made with a No: 170L bur

Cingulum proximal groove

- A third, short groove is made on the opposite side on the cingulum near the vertical finish line of that surface
- This groove enhances the resistance and reinforces the tooth margin

Proximal flares

Proximal flares should be prepared on the labial wall of the most facially placed grooves (first and third) (Fig. 29.95).

- It is prepared using a flame diamond
- It should be wider in the incisal aspect. This configuration nearly eliminates the facial wall of the groove at its incisal end.
- A slight flare should be placed on the mesial groove also.
- The distal and mesial flares are smoothened with a flame carbide bur
- Care should be taken to maintain the sharpness of the finish line

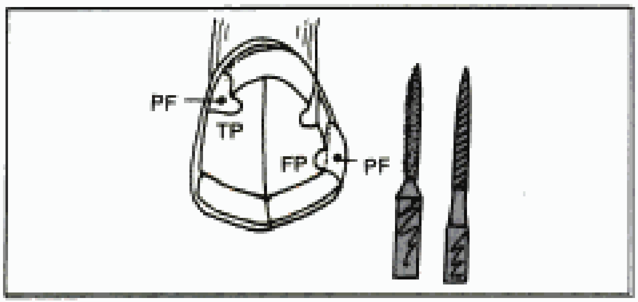


Fig. 29.95: Proximal flares (PF) done using : Flame diamond and bur. The flares are provided on the facial proximal (FP) groove and the third proximal (TP) groove

Counter-sink

- It is a flat ledge prepared in the incisal corner opposite to the site of the proximal grooves
- It is prepared using with No: 170L bur (Fig. 29.96).

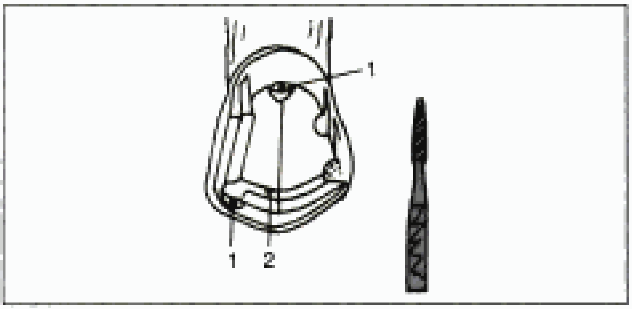


Fig. 29.96: Counter sink (1) and offset (2) prepared using a 171L bur

- It must be placed in dentin
- It is placed lingual to the finish line and gingival to the incisal edge of the restoration.
- A ledge is also placed in the middle of the cingulum.
- These flat areas on the sloping lingual surface act as starting points for accurate pin placement. (Fig. 29.97).

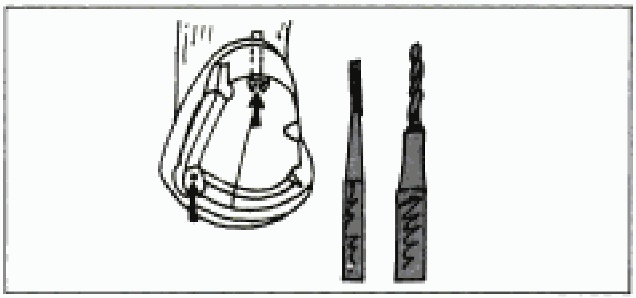


Fig. 29.97: Pin holes placed on prepared counter sinks: No. ½ bur and 0.6 mm drill

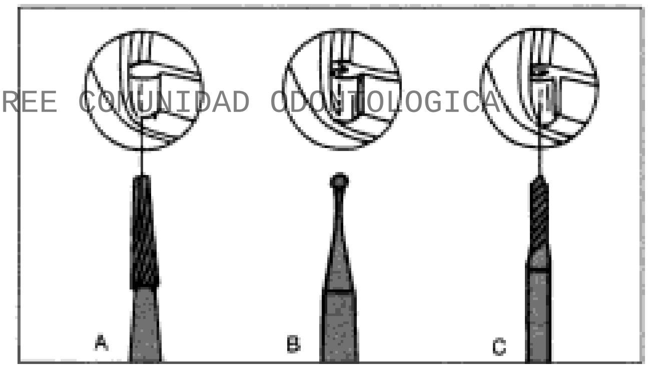
- They also create space for a reinforcing bulk of metal at the base of the pins

Incisal offset

- It is made using a No: 170L bur
- It runs across the tooth connecting the incisal ledge to the facial proximal groove.
- A V-shaped trough is prepared along the non prepared side of the lingual surface from the incisal ledge to the cingulum groove (inciso-cingular trough)
- The metal in the trough helps to strengthen and reinforce linguo-proximal line angles

Preparation of pin holes

- A shallow depression is prepared on the center of each flat ledge (countersink) with a No: 1/2 round bur (Fig. 29.98) as described before.



Figs 29.98a to c: Instrument sequence for preparing pin holes: Form the ledge with a tapered fissure bur (a); start the pin hole with a small round bur (b); and finish the pin hole with a twist drill (c)

- A low-speed contra-angle 0.6 mm (0.024 inch) drill is carefully aligned over the depression.
- The drill should be held parallel to the proximal grooves.
- The handpiece is started before it contacts the tooth and should not be stopped while preparing the pin hole.
- The pinhole should be atleast 3.0 mm in depth.
- The hand piece is withdrawn and a nylon bristle is inserted into the pinhole.
- Using the bristle and the groove as index, a 3.0 mm deep pinhole is prepared on the other ledge.

Bevels

- The angle formed between the facial wall of the offset and the incisal edge of the uncut tooth structure should be bevelled.

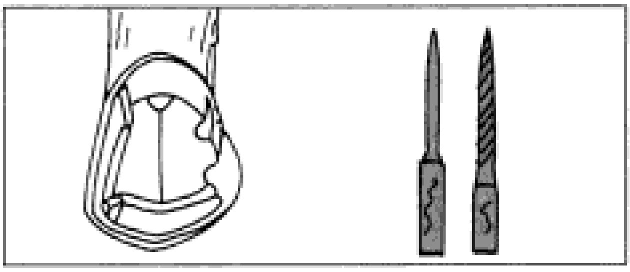


Fig. 29.99: Incisal bevel prepared using: Flame diamond and bur

- This bevel should not be over-extended facially as it may lead to metal display
- An Incisal bevel (finishing bevel) is placed on the functional area of the incisal edge with a flame diamond. The incisal bevel should blend with the proximal flares (Fig. 29.99).
- It is redefined on the marginal ridge next to the inciso-cingular trough.
- The sharp angles and the additional features are smoothened with a carbide flame bur.

Features	*Functions*
• Axial reduction:	Structural durability, Periodontal preservation, Resistance and Retention
• Proximal grooves:	Structural durability, Retention and Resistance
• Lingual reduction:	Structural durability
• Incisal bevel:	Marginal integrity
• Incisal trough:	Structural durability
• Pin Hole/Ledge:	Retention and Resistance
• Incisal offset:	Structural durability
• Chamfer finish:	Marginal integrity and Periodontal preservation
• Proximal flare:	Marginal integrity

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SUMMARY CHART 2: PARTIAL VENEER CROWN PREPARATION FOR POSTERIOR TEETH

Indications	*Contraindications*	*Advantages*	*Disadvantages*
• Sturdy clinical crown of average length or longer • Intact buccal surface that is not in need of contour or modification and that is well-supported • No conflict between axial relationship of tooth and proposed path of withdrawal of the FPD	• Short teeth • High caries index of tooth • Extensive destruction • Bulbous teeth • Thin teeth • Poor alignment	• Conserves of tooth structure • Easy access to margin • Less gingival involvement than with complete cast crown • Easy escape of cement and good seating • Verification of seating is simple • Electric vitality test feasible	• Less retentive than complete cast crown • Limited adjustment of path of withdrawal • Some display of metal

Preparation steps	*Recommended Armamentarium*	*Criteria*
• Depth orientation grooves for occlusal reduction	• Tapered carbide fissure bur or tapered round-tipped diamond	• 0.8 mm on noncentric cusps 1.3 mm on centric cusps
• Occlusal reduction	• Round-tipped diamond	• Clearance of 1 mm on non-centric cusps, 1.5 mm on centric cusps
• Depth orientation grooves for axial reduction		• Chamfer depth of 0.5 mm (no more than half the width of diamond)
• Axial reduction Chamfer finishing	• Round-tipped diamond Large, round-tipped diamond	• Axial reduction parallel long, smooth and continuous to minimize marginal length and facilitate finishing; distinct resistance to vertical displacement by periodontal probe
• Proximal groove	• Tapered carbide fissure bur	• Distinct resistance to lingual displacement by probe. Parallel to path of withdrawal of restoration; 90-degree angle between prepared axial wall and buccal or lingual aspect of groove
• Buccal and occlusal bevel (maxilla), chamfer (mandible)	• Round-tipped diamond	• Maxillary teeth: bevel extends just beyond cusp tip but remains within curvature of cusp tip Mandibular teeth: minimum of 1 mm of Mandibular clearance for cast gold in area of centric stops
• Finishing	• Large, round-tipped (except diamond or carbide	• All sharp internal line angles and grooves rounded to smooth transitions

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SUMMARY CHART 4: PINLEDGE PREPARATION			
Indications	*Contraindications*	*Advantages*	*Disadvantages*
• Undamaged anterior teeth in caries-free mouth • Alteration of lingual contour of maxillary anterior teeth or alteration of occlusion • Anterior splinting	• Large pulps • Thin teeth • Nonvital teeth • Carious involvement • Problems with proposed path of withdrawal of FPD	• Minimal tooth reduction • Minimal margin length • Minimal gingival involvement • Optimum access for margin finishing and hygiene • Adequate retention	• Less retentive than complete coverage • Alignment can prove difficult • Technically demanding • Not usable on nonvital teeth

Preparation steps	*Recommended Armamentarium*	*Criteria*
• Reduction of marginal ridge and contact area adjacent to edentulous space	• Round-tipped, tapered diamond	• Should provide space for adequate bulk of metal in area of connector
• Lingual reduction	• Football-shaped diamond	• Should provide for clearance at least 0.7 mm
• Ledges	• Straight carbide fissure bur	• Ledges must be parallel to one another when viewed from lingual and from incisal; maximum width 1 mm
• Indentations	• Straight carbide fissure bur	• Indentation should provide at least 0.5 mm of space for metal reinforcement around opening of pinhole
• Pilot channels and pinholes	• Tapered carbide bur	• Pinholes must be between 2 and 3 mm deep; minimal width of ledge around pinholes is 0.5 mm
• Finishing	• Finishing stones or carbides	• All surfaces must be as smooth as possible (obtain with finegrit rotary instruments) to facilitate removal of the delicate wax pattern from die

SUMMARY CHART 5: ALL-CERAMIC CROWN PREPARATION			
Indications	*Contraindications*	*Advantages*	*Disadvantages*
• High esthetic requirement • Considerable proximal caries • Incisal edge reasonably intact • Endodontically treated teeth with post-and-cores • Favorable distribution of occlusal load	• When superior strength is warranted and metal-ceramic crown is more appropriate • High caries index • Insufficient coronal tooth structure for support • Thin teeth faciolingually • Unfavorable distribution of occlusal load • Bruxism	• Esthetically unsurpassed • Good tissue response even for subgingival margins • Slightly more conservative of facial wall than metal ceramic	• Reduced strength compared to metal-ceramic crown • Proper preparation is extremely critical • Among least conservative preparations • Brittle nature of material • Can be used as single restoration only

Preparation steps	*Recommended Armamentarium*	*Criteria*
• Depth grooves for incisal reduction	• Tapered diamond	• Approximately 1.3 mm deep to allow for additional reduction during finishing, perpendicular to long axis of opposing tooth
• Incisal reduction	• Tapered diamond	• Clearance of 1.5 mm; check excursions
• Depth grooves for facial reduction	• Tapered diamond finishing	• Depth of 0.8 mm needed for additional reduction required
• Facial reduction	• Tapered diamond	• Reduction of 1.2 mm needed; two planes, as for metal-ceramic crown preparation
• Depth grooves and lingual reduction	• Tapered and football-shaped diamonds	• Initial depth 0.8 mm; recreate concave configuration; do not maintain any convex configurations (stress)
• Depth grooves for cingulum reduction	• Tapered diamond	• Parallel to cervical aspect of facial preparation; 1 mm of reduction; shoulder follow the free gingival margin
• Lingual shoulder preparation	• Flat-tipped diamond	• Rounded shoulder 1 mm wide; minimize "peaks and valleys", 90-degree cavosurface angle
• Finishing	• Fine-grit diamond or carbide	• All surfaces smooth and continuous; no unsupported enamel;90-degree cavosurface angle

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Types of Fixed Partial Dentures

INTRODUCTION

In Chapter 24, we studied the classification of fixed partial dentures based on multiple factors. In this section we shall have a detailed discussion about the various types of fixed partial dentures that were enumerated there. Since the classification is based on different factors (design, material used, etc), the denture designs described here are independent and may over lap in certain aspects.

CONVENTIONAL FIXED PARTIAL DENTURES

They are the most commonly used type of fixed partial dentures. The design involves fabrication of a fixed partial denture, which takes support from abutments on either side of the edentulous space. The design may vary according to the condition of the abutments but the abutments on either side should be able to support the fixed partial denture (Fig. 30.1).

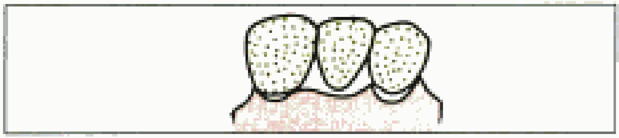

Fig. 30.1: A conventional fixed partial denture

CANTILEVER FIXED PARTIAL DENTURES

A cantilever fixed partial denture is used when support can be obtained only from one side of the edentulous space. These dentures have compromised support. The abutment teeth on the supporting side should be strong enough to withstand the additional torsional forces. Support can be obtained from more than one tooth on the same side of the edentulous space (Fig. 30.2).

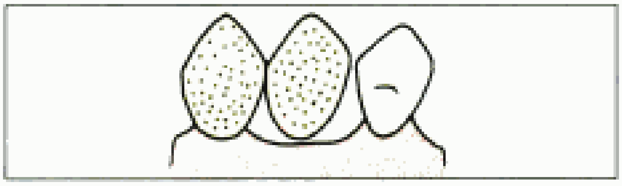

Fig. 30.2: A cantilever fixed partial denture

Advantages

- Very conservative design especially when a single abutment is involved.
- When secondary abutments are used, parallel preparation can be easily obtained because the abutments are adjacent to one another.
- Easy to fabricate.

Disadvantages

- Produces torquing forces on the abutment
- Cannot be used to restore long span edentulous spaces
- Minor design errors can affect the abutments in a large scale.

SPRING CANTILEVER FIXED PARTIAL DENTURES

This is a special cantilever bridge exclusively designed for replacing maxillary incisors but these dentures can support only a single pontic. Support is obtained from posterior abutments (usually a single molar or a pair of splinted premolars). A long resilient bar connector is used to connect the posterior retainer to the anterior pontic. The bar is designed to adapt closely and extend over the soft tissues of the palate. The bar should be slightly thin and resilient so that it distributes the masticatory forces to the soft tissues all along its path. The connector should not be very thin as it may undergo permanent deformation under masticatory load (Fig. 30.3).

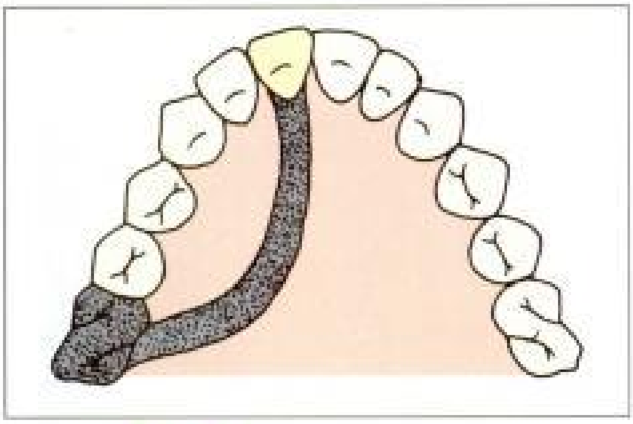

Fig. 30.3: Spring cantilever FPDs

Advantages

- Can be used for diastema cases.
- Metal crown retainers that require minimal tooth preparation, can be used in posterior teeth to replace missing incisors.

Disadvantages

- The connector bar may interfere with speech and mastication
- Deformation of the connector bar may produce coronal displacement of the pontic.
- There may be food entrapment under the connector bar, which may lead to tissue hyperplasia.

FIXED FIXED PARTIAL DENTURES

The term denotes fixed partial dentures with rigid connectors. The design of these dentures is more conventional (Fig. 30.4). Since the connectors are rigid, there can be no movement between the connected components. These are the most commonly used fixed partial denture designs.

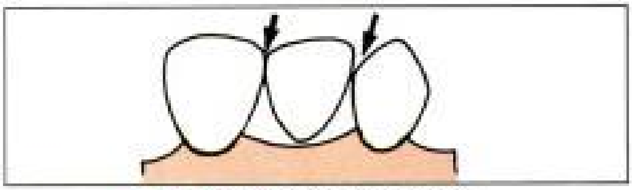

Fig. 30.4: Fixed partial denture

Advantages

The major advantages of these partial dentures include:

- Easy to fabricate
- Economical design
- Strong
- Easy to maintain
- Robust design provides maximum retention and strength
- Helps to splint mobile abutments
- Can be used for long bridges alongwith periodontally weak abutments.

Disadvantages

- Since the connectors are rigid, unwanted stress and lever forces are directly transferred to the abutment producing considerable damage.
- Requires excessive tooth preparation to achieve a single path of placement.
- Difficult to cement on multiple abutments
- Contraindicated for pier abutments (Fig. 30.5).

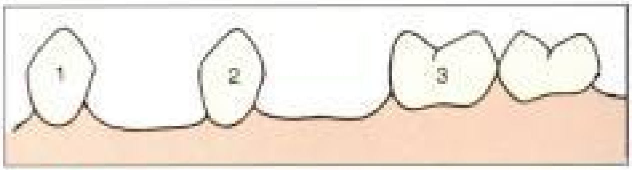

Fig. 30.5: A fixed partial denture constructed over these abutments will produce rotational forces around the pier (2) abutment

Procedure

A rigid connection can be fabricated by casting or soldering. In casting, the pontics and retainers are fabricated with a connection as a single unit pattern. In soldering, multiunit wax patterns are cast separately. Next they are approximated against one another and soldered together using a different soldering alloy. Sometimes a single unit wax pattern is cast and sectioned using a saw and then soldered.

Each technique has its own advantages. Casting is preferred because it avoids galvanic corrosion. Soldered connectors are more uniform, flat and parallel because the flow of the solder alloy is easily controllable.

FIXED MOVABLE PARTIAL DENTURES

It is defined as, *"A fixed partial denture having one or more non-rigid connectors"* – GPT.

Here, a non-rigid connector is used / fabricated to connect the components of the fixed partial denture. Non-rigid connectors have been described in Chapter 25. These partial dentures are designed to have any one of the non-rigid connectors described there. Commonly used non-rigid connectors include Tenon Mortis connectors (TMC), loop connectors, split pontic connectors and cross pin and wing connectors (Fig. 30.6) (Refer Chapter 25).

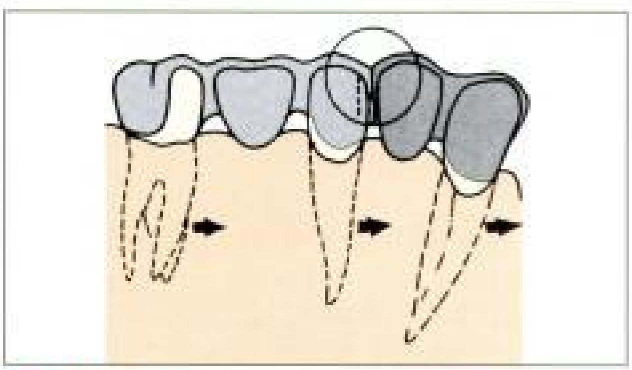

Fig. 30.6: If a nonrigid connector is placed on the mesial side of the middle pier abutment, mesially directed movement will unseat the key

Advantages

- They act like stress breakers while transmitting unwanted leverage forces.
- The abutment is pressurized only during occlusal loading.
- Improves the health of the abutment.
- The tooth preparations need not be parallel to one another. Each abutment tooth can be prepared independently according to its requirements.
- Allows minor movements between the components of the prosthesis.
- Parts of the prosthesis can be cemented separately.

Disadvantages

- Complex design.
- Prefabricated connector components are very expensive.
- Difficult to maintain.
- Movable parts tend to wear out under constant usage.
- Cannot be used for long span bridges
- Complicated laboratory procedures
- Difficult temporisation

The methods of fabrication of non-rigid connectors have been briefed in Chapter 25.

FIXED REMOVABLE PARTIAL DENTURES/ REMOVABLE BRIDGES

One of the major disadvantages of long span fixed partial dentures is that if one abutment fails, the entire prosthesis has to be sacrificed. To overcome this disadvantage, fixed removable bridges were introduced. These dentures cannot be removed by the patient but can be easily removed by the dentist.

Design

Individual cast gold copings are cemented over the abutments. Threaded sleeves are incorporated into the copings of few abutments. The bridge is retained over the copings by using weak cements and screws, which pass through a hole in the retainer into the threaded sleeves of the coping (Fig. 30.7).

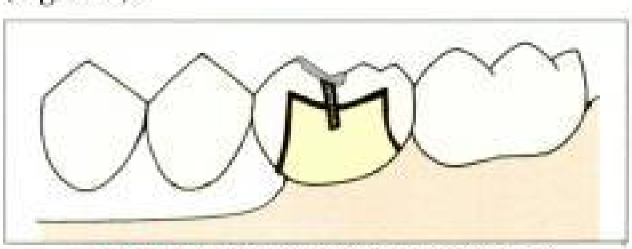

Fig. 30.7: A fixed removable partial denture

MODIFIED FIXED REMOVABLE PARTIAL DENTURES

These dentures have an interesting design. They were developed by Andrew, hence they are also known as *Andrew's bridge systems*. These dentures are indicated for edentulous ridges with severe vertical deficit. The prosthesis consists of a fixed component and a removable component.

Fixed Component

The fixed component is fabricated completely in metal and consists of two copings connected by a load-bearing bar. The two copings are designed to be cemented on to the prepared abutments on either side of the edentulous ridge (Fig. 30.8).

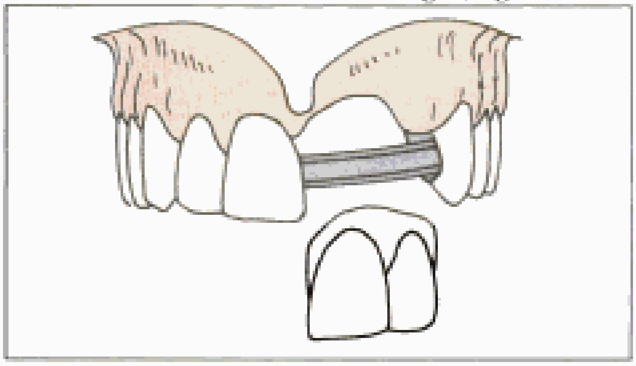

Fig. 30.8: Andrews' bridge system: A modifed fixed removable partial denture

Biomechanics

The bar is usually rectangular in cross section with the height more than the width. It follows the concept of simple bridges wherein the distance between the action of compressive and tensile forces determine the strength of the bridge. Hence, the height of the bar is more important than its bulk (Fig. 30.9).

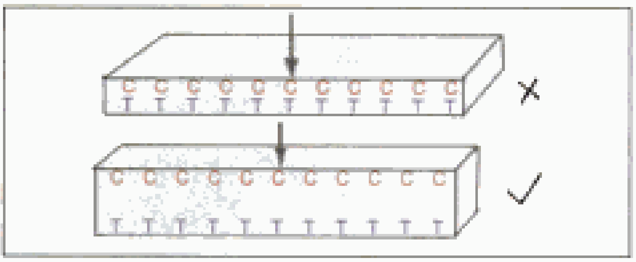

Fig. 30.9: The bar of an Andrew's bridge should be taller and not broader to enhance rigidity. C—Compressive stress, T—Tensile stress

Removable Component

The removable component consists of the artificial teeth and a denture flange that is designed to fit or clasp the bar. The teeth appear more natural as they arise from the denture base instead of being suspended freely. The denture base also serves to hide the vertical ridge defect. The main advantage of this system is that it is easier to maintain without compromising the comforts of a fixed prosthesis (Fig. 30.10).

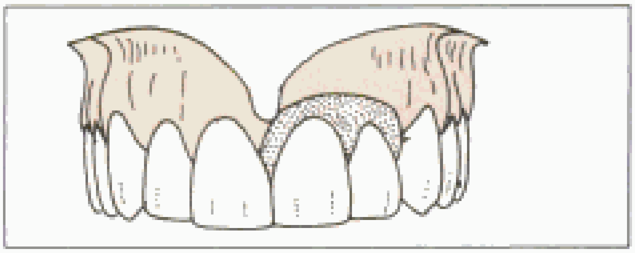

Fig. 30.10: A small amount of pink gingival porcelain can be added to the removable component to hide the ridge defect

In cases with few remaining teeth, all the teeth are prepared for copings and a removable component is designed over these copings.

ALL METAL FIXED PARTIAL DENTURES

These dentures are fabricated using only metal.

Characteristics

- They are indicated for replacing maxillary and mandibular posterior teeth.
- They are not aesthetic.
- They have the maximum strength and durability.

METAL-CERAMIC FIXED PARTIAL DENTURES

Here, metal is used to fabricate the core of the prosthesis. The external surface is fabricated using ceramic. The metal is bonded to ceramic chemically, mechanically and ionically. Metal ceramic fixed partial dentures can be of two types. In the first type, the metal is surrounded by porcelain on all the surfaces (Fig. 30.11). In the second type the lingual and occlusal surface is

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Type of Veneers

Ceramic

It is the most ideal veneering material when used with metal substructure or in all ceramic restorations.

Acrylic

Tooth colored acrylic can be used with metallic restorations as a veneer. They are not considered as a permanent material due to poor wear resistance. Recent advances include use of *indirect composite resins* as veneer materials.

SHORT SPAN BRIDGES

These are simple fixed partial dentures, which replace one or two teeth, and the teeth on either side are ideal abutments. These dentures are considered ideal because they have minimal torquing forces. For example First molar replacement (Fig. 30.13).

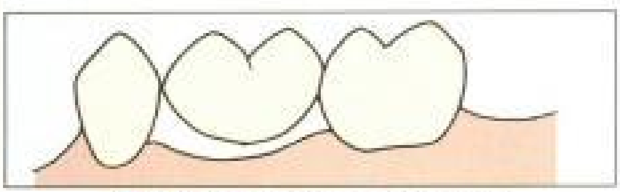

Fig. 30.13: A short span 3-unit FPD

LONG SPAN BRIDGES

Long span bridge denotes a condition where two or more teeth have to be replaced and more than one abutment has to be taken for support on either side. Long span bridges have the potential for producing more torquing forces on the bridge and the weaker abutment (especially weak abutments are adversely affected) (Fig. 30.14).

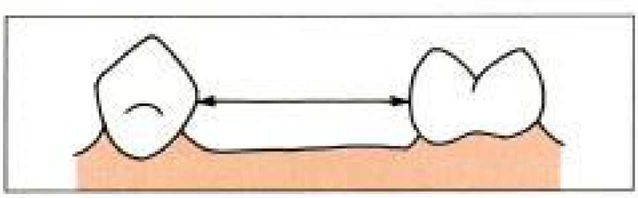

Fig. 30.14: Long span FPD replacing more than one tooth (here two premolars)

Torquing forces in these dentures can be minimized by:

- Modifying the tooth preparation to produce greater resistance and structural durability. E.g. Proximal boxes can be created instead of proximal grooves (Fig. 30.15).

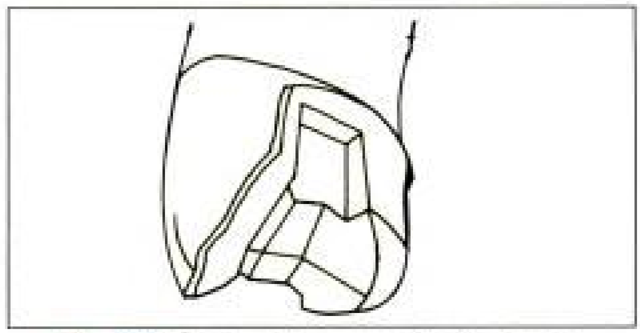

Fig. 30.15: Proximal box preparation to enhance retention in long span FPDs

- *Double abutments:* The additional secondary abutment should at least have the same root surface area and the crown root ratio as the primary abutment (Fig. 30.16).

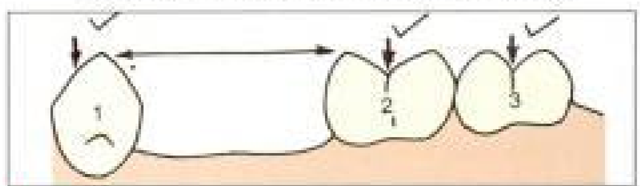

Fig. 30.16: Using double abutments to enhance retention and support for a long span FPD. Abutment No. 3 is termed as the secondary abutment

- When there is increased force (due to arch curvature) additional retainers can be placed on the opposite direction of the lever arm. E.g. First premolars are usually used as secondary abutments in case of a canine-to-canine bridge (Fig. 30.17).

PERMANENT OR DEFINITIVE PROSTHESIS

This term denotes all conventional fixed partial dentures inserted as definitive or final treatment. Most fixed partial dentures made of metal-ceramic, all metal or all ceramic are considered permanent restorations. They are placed at the final phase of a rehabilitative procedure. They

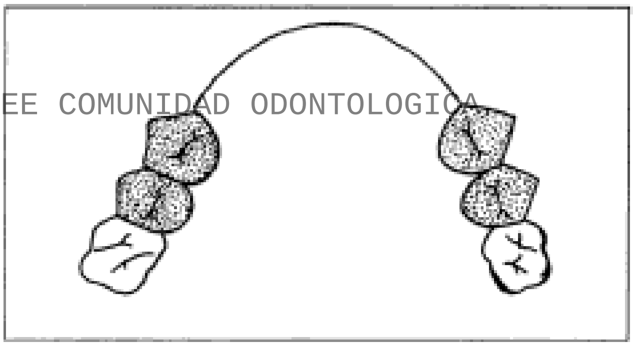

Fig. 30.17: Dual premolar abutments on either side are required to support a long span FPD replacing all the anterior teeth

usually last a few years until failure due to tooth structure or material occurs which warrants replacement.

LONGTERMTEMPORARY BRIDGES

These dentures are usually made of acrylic resin. They are designed to be used for a few weeks to months.

Indications: These restorations may be given for the following conditions:

- During the interim period of treatment when the patient is undergoing extensive occlusal rehabilitation. (E.g. Intruding a supra-erupted tooth).
- In patients undergoing periodontal therapy these restorations may be inserted to act as splints.

FIXED PARTIAL DENTURE SPLINTS

Principle

Splinting either on the same side or on both sides is a necessary adjunct to the treatment of periodontally involved teeth. Splinting several single rooted teeth transforms them into a single multi-rooted unit.

Purpose of Splinting

The purpose of the splint should be to distribute and direct the functional forces, to bring them within the tolerance of the remaining supporting tissues and to eliminate any mobility that may be present.

Primary Purposes of Splinting

The primary purposes of splinting include stabilization and reorientation of forces.

Stabilization

We have to increase the resistance of the tooth against any force. When a tooth is splinted using a fixed bridge, the splinted teeth become one and react as a single unit against any force. The resistance pattern of the teeth against mesial, buccal, lingual and distal vectors of force is increased because:

- Root surface area of resistance is increased.
- There is distribution of force patterns over a wide area.

Reorientation of Force and Stress

As mentioned before, splinting contributes to increase the resistance of a tooth against a particular force. Since the resistance per unit area is increased, the forces are rerouted/diverted, decreasing the potential damage of the weakened teeth.

Secondary Purpose of Splinting

- To improve form and function of teeth.
- To modify occlusal contact patterns.
- To adjust jaw relations
- To improve the masticatory efficiency.

Classification of Splints

Based on the extent of the prosthesis across the midline, fixed partial denture splints can be classified as:

- Unilateral splints
- Bilateral or cross-arch splints

Based on the duration of use, fixed partial denture splints can be classified into:

- Temporary or provisional splints
- Permanent splints

Unilateral Splints

Unilateral splinting denotes the joining of two or more teeth in one plane of an arch segment. These splints are more resistant to mesio-distal forces. They show poor resistance to bucco-lingual forces (Fig. 30.18).

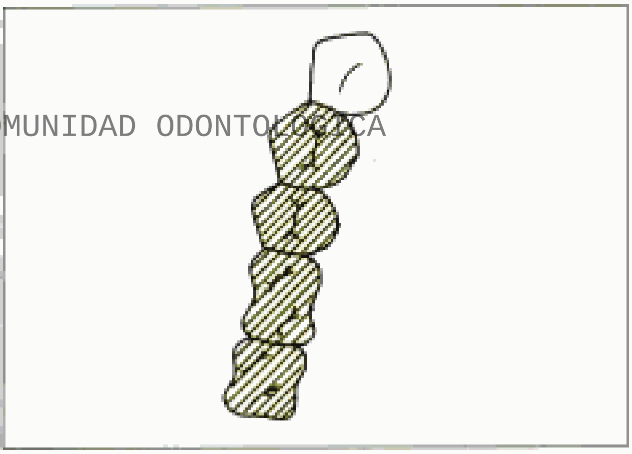

Fig. 30.18: Unilateral splint

Bilateral Splints

A bilateral or cross-arch splint is a splint, which crosses the midline. It may involve two or more segments of an arch or involve the entire arch. Here the splinting action is resistive to forces in all directions (Fig. 30.19).

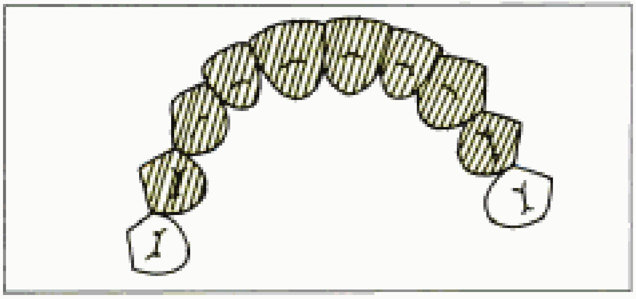

Fig. 30.19: Bilateral splint

Temporary Splints

Temporary or provisional or healing splints are employed for a limited period of time. They are indicated for the following conditions:

- To aid in healing by limiting the mobility of healing tissues.
- To immobilize and relieve the periodontium prior to periodontal surgery.
- To assist in determining the prognosis of periodontally weak teeth.

Fabrication

Tooth preparation is completed as usual, a conventional fixed partial denture (splint) constructed in heat-cured tooth colored acrylic resin and cemented with zinc oxide eugenol cement. Usually they are used for a period of few weeks to few months.

Permanent Splints

Permanent splints serve as constant adjuncts to the maintenance of periodontal health. They help to prevent further progression of periodontal disease. (*Note: Splints can never improve the periodontal status. They can only prevent or slacken the progression of the disease*). Complete fixation is necessary for proper stability of the splint.

The following prosthesis can be used as permanent splints:

- Resin-bonded retainers or Maryland bridges can be used.
- Fiber reinforced composite resin bridges can also be used.

These dentures are described in detail separately.

Telescopic Copings in Fixed Partial Denture Splints

Peeso introduced telescopic crowns as abutment retainers in 1916. Here the teeth included in the splint are reduced and covered with thin gold copings which are permanently cemented in place. The copings are designed to receive a retainer that telescopes into them.

Advantages

- A common, parallel path of insertion is achieved with minimal tooth preparation.
- Widely spaced and severely tipped teeth can be incorporated into a single design
- Full arch splints with multiple smaller segments can be fabricated.
- The design is flexible as a crown superstructure can be converted into pontics when the abutment is extracted.
- Teeth are protected by the permanently cemented metal copings.
- Additional retention can be obtained by incorporating pin-groove systems between the coping and the superstructure.

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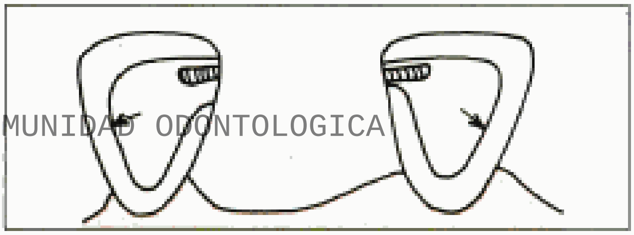

Fig. 30.20c: A completed preparation for a fibre reinforced bridge

- Silicone is adapted over the pattern and is used as an index or mold.
- Next, the silicone mold is removed and the wax pattern is *resinized*.
- During cementation, the silicone mold is used to contour the reinfored resin used to bond the prosthesis to the tooth.

Hand Fabricated Technique

Here a single layer of opaque body particulate composite is adapted over the prepared tooth surface area in the cast. The polymerized pontic bar made of unidirectional reinforced composite is placed on the proximal grooves of the prepared teeth. Additional resin is added in increments, contoured and cured.

Procedure

- After tooth preparation, an impression is made of the prepared teeth and a cast is poured.
- Special separating medium (similar to a varnish) is applied over the cast.
- The glass fibers are placed on the groove in the cast (Fig. 30.21).
- The pontic is built in indirect composite resin. Indirect composites are laboratory composites, which are more viscous than clinically used (direct) composites.
- The prepared prosthesis is finished and polished.

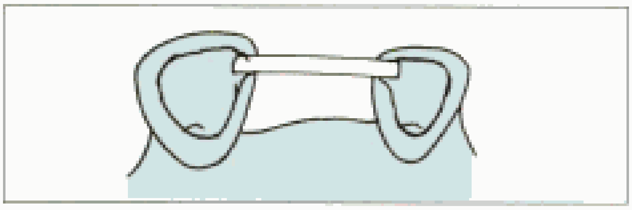

Fig. 30.21

- The bridge is then cemented on to the prepared teeth. (The glass fiber will form a projection, which fit into the grooves on the prepared teeth) (Fig. 30.22).

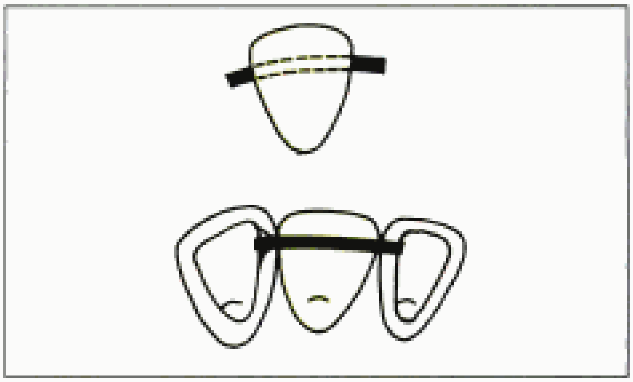

Fig. 30.22: Cementation of a fibre reinforced bridges

RESIN-BONDED FIXED PARTIAL DENTURES

As the name implies, these are fixed partial dentures, which are cemented onto the abutments using special resins. Composite resin bonded/retained fixed partial dentures were developed from non-invasive, micro-retentive techniques used in restorative dentistry.

Introduction

Buonocore was the first person to introduce acid etching. Bowen in 1962 developed the BIS-GMA composite resins. A technique for splinting mandibular teeth using a resin bonded fixed partial denture was described by Rochette in 1973. Since then, resin-retained fixed partial dentures have gained considerable popularity in the field of prosthetics.

Basically these dentures consist of one or more pontics supported by thin metal retainers placed only on the lingual and/or proximal surface of the abutments. Retention in these prostheses relies on the adhesive bonding between etched enamel and the metal casting (retainer). They are held in place by resin, which locks mechanically into

a. The microscopic undercuts present on etched enamel
b. Undercuts present in the casting.

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retention. This was one of the most widely accepted designs. Etched retainers coated with pyrolized silane showed upto 47% superior retention. The major disadvantage of Rochette Bridge is that the resin exposed through the metal perforations is subjected to external stress, abrasion and marginal leakage.

Maryland Bridges

Many scientists developed different designs to overcome the shortcomings of Rochette bridges;

- Dunn and Reisbick used electrochemical pit corrosion to study ceramic bonding to base metals.
- Tanaka *et al* studied the retention of acrylic resin on metal copings.
- Finally, Livaditis and Thompson from University of Maryland School of dentistry used Dunn's study and developed Maryland bridges.

Here mechanical retention was developed by the micro-porosities present on the tissue surface of the retainer. Micro-porosities are created by etching the tissue surface of the retainer (Fig. 30.24).

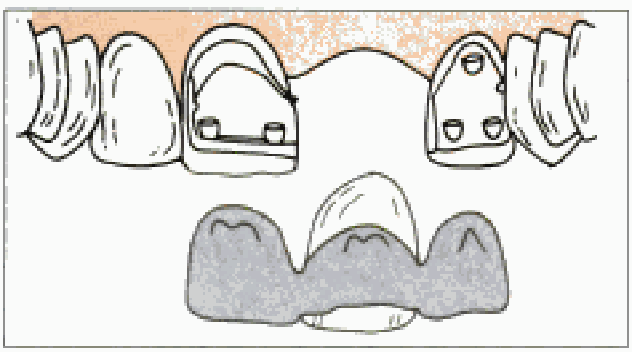

Fig. 30.24: The Maryland resin-bonded fixed partial denture

Etching Techniques

The suggested etching techniques that can be employed while fabricating Maryland bridges can be broadly divided into:

- Electrochemical etching.
- Non-electrochemical etching.

Electrochemical etching Here etching is done using a chemical electrolyte in the presence of an electrical gradient. Before etching, the retainer is coated using paraffin wax. The wax should cover the entire retainer except for the area to be etched. Commonly used electrochemical techniques include:

- For non-Beryllium Nickel Chromium alloys: Etching is done in two stages. In the first stage, the retainer is immersed in 3.5% nitric acid under a current of 250 mA/cm^2 for 5 minutes. Next the retainer is cleaned by immersing it in 18% HCl in an ultrasonic cleaner for 10 minutes.
- For Beryllium containing Nickel Chromium alloys: It is also a two-step technique. During the first step, retainer is immersed in 10% H_2SO_4 under a current of 300 mA/cm^2. The second step is similar to the one described for the previous technique.
- Mc Laughlin technique or One-step technique: It is a single step technique. Here the alloys are etched by immersing the retainer in a beaker with a mixture of HCl and H_2SO_4. The beaker with the retainer is directly placed in an ultrasonic cleanser for 99 seconds under an electrical field. This technique increases the speed of etching.

  Disadvantages is electrochemical etching:

  - Expensive.
  - Very technique sensitive. Tedious procedure, difficult to control the area to be etched.

Non-electrochemical Etching Commonly used non-electrochemical etching techniques include:

- Livaditis proposed a technique wherein Nickel-Chromium-Beryllium alloys were successfully etched in a etching solution placed in a water bath for one hour at 70°C.
- Doukoudakis proposed the use of stable aqua regia gel to etch enamel.

  Advantages of non-electrochemical etching

  - Does not require special equipments.
  - Etching is comparable to more expensive techniques.
  - The prosthesis can be fabricated and bonded in two stages.

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Fig. 30.29: Vertical stops or countersinks or rest seats prepared to prevent gingival displacement of the prosthesis

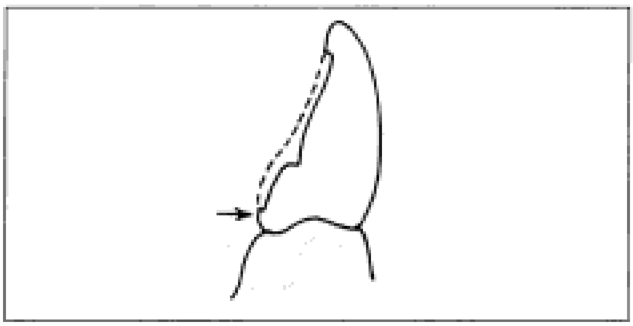

Fig. 30.30: A distinctive supragingival finish line

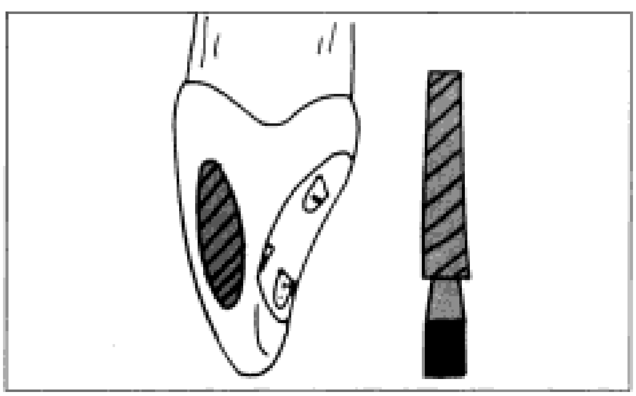

Fig. 30.31: Facial segment of the proximal reduction done using a flat end tapered diamond

- Any design modification, which is incorporated into the prosthesis, should be harmonious with the predetermined path of insertion.

Design of a Posterior Resin Bonded Fixed Partial Dentures

Posterior resin bonded fixed partial dentures should be designed to withstand more occlusal forces. Here, aesthetics is not a major concern.

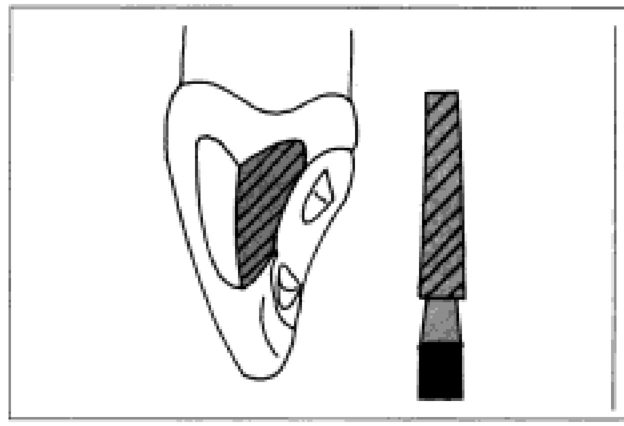

Fig. 30.32: Lingual segment of the proximal reduction done using a flat end tapered diamond

Principles of Posterior Tooth Preparation

Posterior tooth preparation consists of preparing three major components namely:
- The occlusal rest (for resistance to gingival displacement)
- The retentive surface (for resistance to occlusal displacement)
- The proximal wrap (for resistance to torquing forces)

Occlusal rest Seat

It should be spoon-shaped and placed on the proximal marginal of the abutment adjacent to the edentulous area (Fig. 30.33).

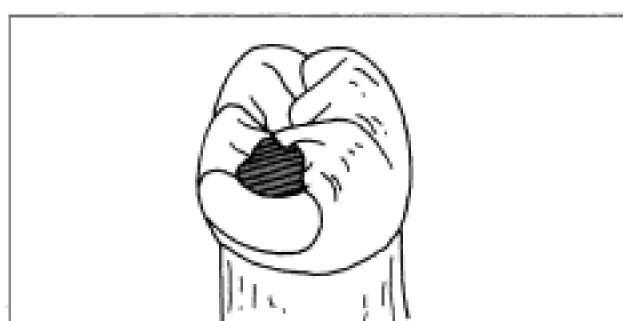

Fig. 30.33: Spoon-shaped posterior occlusal rest seat

The Retentive Surface

Proximal and lingual axial walls should be reduced to move their height of contour more cervically (Fig. 30.34). The height of contour should be about 1mm above the crest of the free

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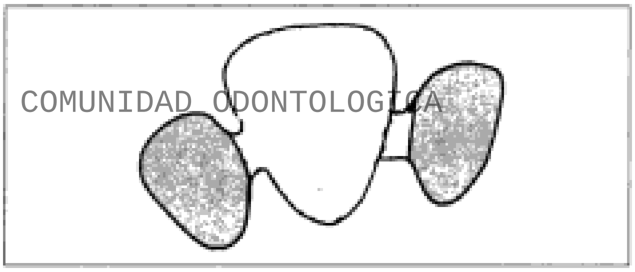

Fig. 30.36: Before acid etching, all the areas that should not be etched are covered with wax

- The etched surface must not be handled (touched) after this stage.

Macroscopic retention

This can either be done by Rochette's method of perforation or by fabricating the pattern with macroscopic surface porosities. We have already described Rochette's design previously. Hence in the following section, we will discuss only about creating macroscopic porosities.

Creating Macroscopic Porosities

This can be done by two methods discussed below. The advantage of both these techniques is that any alloy can be selected.

Altering the design of the wax pattern: A special wax pattern with a plastic mesh on the tissue surface and a polished external surface is fabricated and cast. The cast retainer will have a meshwork on the tissue surface, which aids in mechanical interlocking of the resin. Dentures fabricated using this technique are called cast mesh fixed partial dentures (described before).

Incorporating water soluble salt crystals "Lost salt technique": Here water-soluble salt crystals are sprinkled onto the die before fabricating the retainer pattern. Hence the crystals line the tissue surface of the wax pattern. The retainer patterns are first fabricated using resin. The resin is polymerized and the salt crystals are dissolved by washing and ultrasonic cleansing. The dissolved salts form voids on the tissue surface of the resin pattern. The resin patterns with the voids are invested, burned out and cast. The cast metal retainers will have the same voids, which act as centers for mechanical retention. This technique is followed in Virginia bridges (explained before).

Chemical Bonding of Resin

Chemical bonding between the resin and the metal retainer can be produced by chemical etching or tin-plating or using chemical adhesives.

Chemical etching

A gel consisting of Nitric and Hydrochloric acids is applied to the internal surface of the metal framework for approximately 25 minutes. As electrolytic etching is extremely technique sensitive, chemical etching may be more reliable as it is a single procedure.

Tin plating

Tin has the ability to form organic complexes with several specific adhesive resins resulting in significantly greater bond strengths. Precious alloys can be plated with tin and used as frameworks for resin retained fixed partial denture.

Bonding Agents (Cements)

Composite resins play an important role in the bonding of the metal framework to etched enamel. Other resin adhesives that are commonly used include, 4 META (4 methacryloxy ethyl trimellitic anhydride), MDP (10-methacryloyloxydecyl dihydrogen phosphate). These resins do not require acid etching as they bond chemically with the retainer. An opaque composite resin can be incorporated into the resin cement to minimize graying effect.

Clinical Procedure (Cementation)

- The prepared tooth surface should be isolated (using rubber dam), etched and cleaned using pumice and water.
- Currently 37 per cent Phosphoric acid is the most accepted concentration used to etch the enamel. It is applied for 30 to 60 seconds.
- Specially formulated composite resins are available for bonding resin bonded fixed partial dentures. E.g. Panavia'
- Next, the cement is placed on the internal surface of the prosthesis (retainer) and the restoration is slowly inserted. Firm pressure should be applied for complete seating.

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- Retraction of the gingival tissue, tongue, lips and cheek.

Gingival retraction permits completion of the preparation and cementation of the restoration and helps the operator to make a complete impression of the preparation.

Importance of Finish Line Exposure

- The gingival tissue must be healthy and free of inflammation before cast restorations are fabricated.
- The finish line must be reproduced in the impression. The marginal fit is very important in preventing recurrent caries and gingival inflammation *(Marginal Integrity).*
- Hence, the finish line must be temporarily exposed to reproduce the entire preparation.

Techniques for Gingival Retraction

The techniques used for gingival retraction can be broadly classified into mechanical, chemico-mechanical and surgical. Mechanical methods include the use of copper bands, retraction cords and rarely rubber dams. Chemico-mechanical methods include the use of gingival retraction cords. Surgical methods include rotary curettage and electrosurgery.

Mechanical Methods of Gingival Retraction

Commonly used mechanical methods for gingival retraction are:

- Copper band
- Retraction cord
- Rubber dam

Copper band It is used to carry the impression material as well as to displace the gingiva to expose the finish line. Impression compound or elastometric impression materials can be used along with this band.

Technique A copper band is welded to form a tube corresponding to the size of the prepared tooth. One end of the tube is trimmed to follow the profile (outline) of the gingival finish line (Fig. 31.4). After positioning and contouring the tube over the prepared tooth, it is filled with modelling compound.

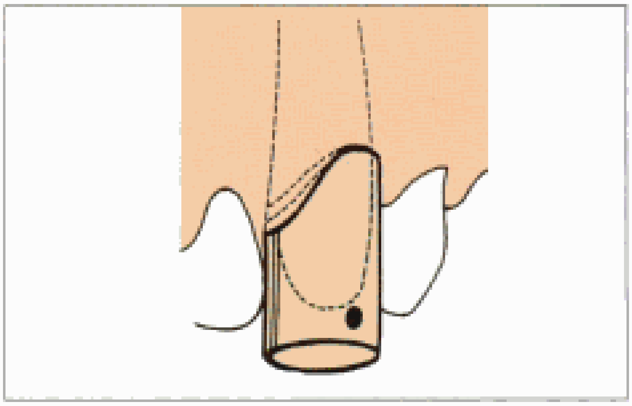

Fig. 31.4: The end of a copper band is trimmed to follow the finish line. Note the orientation hole made on the facial surface

The tube filled with the modelling compound is seated carefully in place along the path of insertion of the tooth preparation (Fig. 31.5) and the impression is made.

Fig. 31.5: Making an impression on using a copper band

Disadvantage: It can cause injury to the gingival tissues.

Retraction cords Pressure packing the retraction cord into the gingival sulcus provides sufficient gingival retraction. Retraction cords should be made of absorbent materials like cotton. They are inserted into the gingival sulcus with special instruments. The technique for placement of the retraction cord is elaborated in chemico-mechanical methods of gingival retraction.

Chemicomechanical Methods of Gingival Retraction (Retraction Cord)

It is a method of combining a chemical with pressure packing, which leads to enlargement of the gingival sulcus as well as control of fluids seeping from the sulcus.

We know that a gingival retraction cord soaked in a chemical (which promotes gingival contraction) will provide better gingival retraction compared to a plain retraction cord. This is the principle behind the chemicomechanical method of gingival retraction.

Chemicals Used

The following chemicals are generally local vasoconstrictors which produce transient gingival shrinkage.

- 8 per cent Racemic epinephrine
- Aluminium chloride
- Alum (Aluminium potassium sulphate)
- Aluminium sulphate
- Ferric sulphate.

Ideal Requirements for Chemicals Used with Gingival Retraction Cords

- It should produce effective gingival displacement and haemostasis
- It should not produce any irreversible damage to the gingiva
- It should not have any systemic side effects.

Contraindications for Epinephrine

Epinephrine is one of the most commonly used chemicals for retraction. Hence, we have enumerated its contraindications.

- CVS disease
- Hypertension
- Diabetes
- Hyperthyroidism
- Known hypersensitivity to epinephrine.

For patients with cardiovascular disease and where epinephrine is contraindicated, other agents can be used to soak the retraction cord.

Technique

- The operating area should be dry. Fluid control should be done with an evacuating device and the quadrant containing the prepared tooth is isolated with cotton rolls.
- Next, the retraction cord is drawn from the dispenser bottle with sterile cotton pliers and a piece of approximately 5 cm (2 inch) long is cut off (Fig. 31.6).

Fig. 31.6: Retracting the cord from dispensing bottle

- The cord is twisted to make it tight and small (Fig. 31.7).

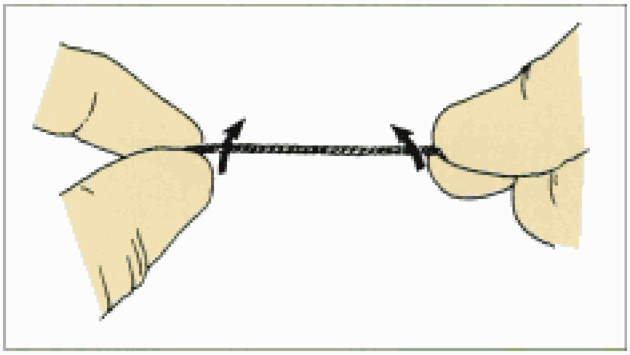

Fig. 31.7: The cord is twisted to make it as tight and as small as possible

- The retraction cord should be dipped in 25% $AlCl_3$ solution in a dapen dish.
- Haemorrhage can be controlled by using haemostatic agents like Hemodent liquid (aluminium chloride).
- The retraction cord is looped around the tooth and held tightly with the thumb and forefinger (Fig. 31.8).
- The cord is packed into the gingival sulcus starting from the mesial surface of the tooth. The cord should be stabilised near the distal end of the tooth.

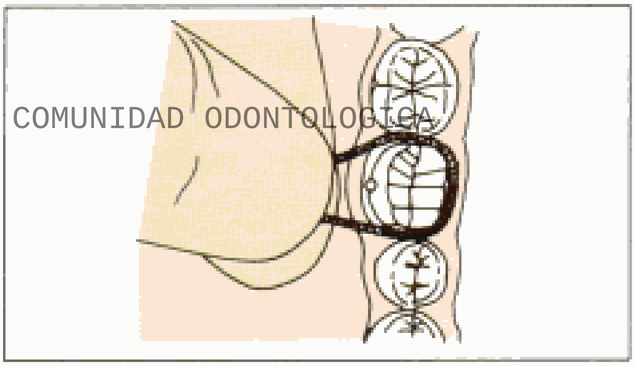

Fig. 31.8: A loop of retraction cord is formed around the tooth and held tightly

- The cord can be packed with special instruments like *Fischer Packing instrument* or a *DE plastic instrument IPPA*. (Fig. 31.9).
- Force should be applied in a mesial direction during cord placement so that the packed preceding segment does not get dislodged (Fig. 31.10).
- Occasionally it may be necessary to hold the cord with one instrument while packing with another (Fig. 31.11a). The instrument used for packing should be angled slightly towards the root to facilitate the sub-gingival placement of the cord (Fig. 31.11b).

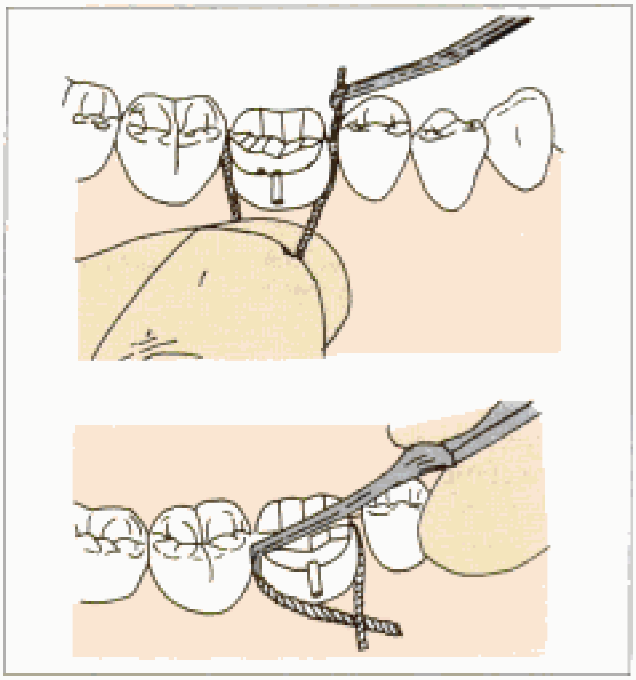

Fig. 31.9: The cord should be inserted starting from the mesial surface of the tooth till the distal surface

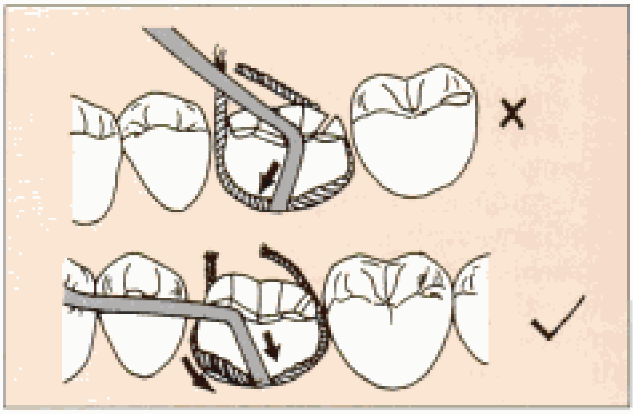

Fig. 31.10: The cord should be tucked into the sulcus progressively. The instrument should be held facing mesially in order to prevent dislodgement of the cord from the previously tacked areas

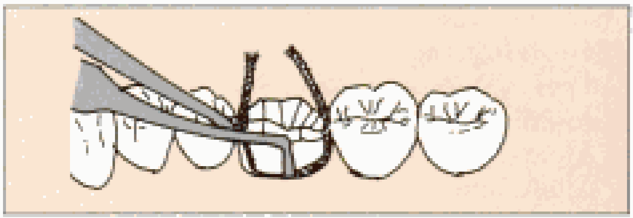

Fig. 31.11a: It may be necessary to hold the cord with one instrument while packing with the second

- The instrument is inclined at an angle towards the tooth surface. If it is held parallel to the long axis of the tooth, the retraction cord will be pushed against the wall of the gingival crevice, and will rebounce (Fig. 31.12).
- Excess cord is cut off near the inter-proximal area such that a slight overlap of the cord occurs in this region (Figs 31.13a and b). If the overlap occurs on the facial and lingual surfaces, the gingival finish line in that area may not be replicated properly in the impression.

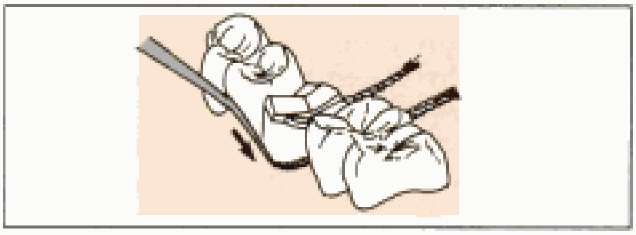

Fig. 31.11b: The instrument should be angled slightly toward the root to facilitate the subgingival placement of the cord

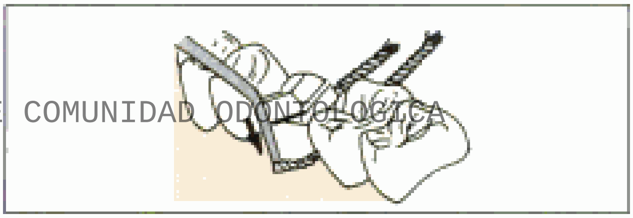

Fig. 31.12: The instrument should be held at an angle and not parallel to the tooth surface to prevent rebounce

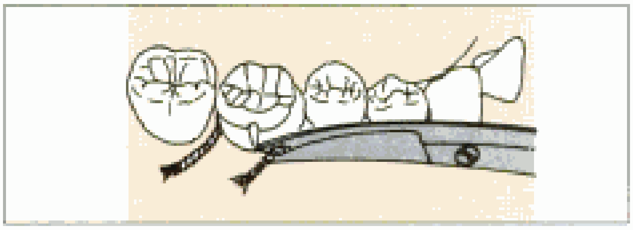

Fig. 31.13a: Excess cord is cut off near interproximal area of the mesial surface

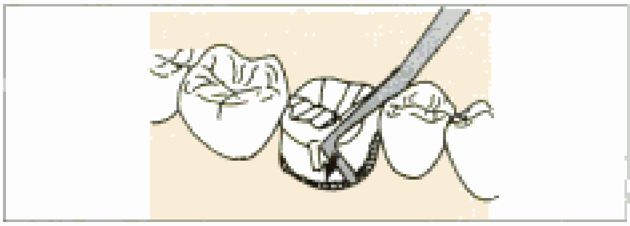

Fig. 31.13b: After cutting off the excess at the mesial end, the distal end of the cord is a tucked in until it overlaps the tucked mesial end

- Atleast 2-3 mm of cord is left protruding outside the sulcus so that it can be grasped for easy removal.
- After 10 minutes, the cord should be removed slowly in order to avoid bleeding.
- If active bleeding persists, a cord soaked in ferric sulphate should be placed in the sulcus and removed after 3 minutes.
- The impression should be made only after cessation of bleeding.
- The retraction cord must be slightly moist before removal. Removing dry cord from the crevice can injure the delicate epithelial lining of the gingiva.

Surgical Methods of Gingival Retraction

Surgical methods of gingival retraction include gingettage and electrosurgery. Now we shall read about each procedure in detail.

Rotary Curettage (Gingettage)

It is a troughing technique, wherein a portion of the epithelium within the sulcus is removed to expose the finish line. It should be done only on healthy gingival tissue.

The following criteria should be fulfilled for gingettage:

- Absence of bleeding upon probing from the gingiva
- The depth of the sulcus is less than 3 mm.
- Presence of adequate keratinized gingiva.

Technique

- It is usually done simultaneously along with finish line preparation.
- The torpedo diamond point (used to create a chamfer finish line) is carefully extended into the gingival sulcus (to half its depth) to remove a portion of the sulcular epithelium (Fig. 31.14).

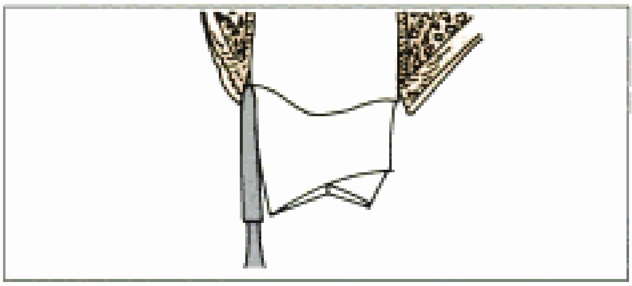

Fig. 31.14: A torpedo diamond can be used to do gingettage along with finish line preparation

- The hand piece should be run at slow speed to improve the tactile sensation.
- Abundant water should be sprayed during the procedure
- A retraction cord impregnated with $AlCl_3$ can be used to control bleeding (Fig. 31.15).

Disadvantages

- Technique sensitive as the instrument offers poor tactile sensation
- It can potentially damage the periodontium.

Electrosurgical Retraction

Electrosurgery denotes surgical reduction of sulcular epithelium using an electrode to produce

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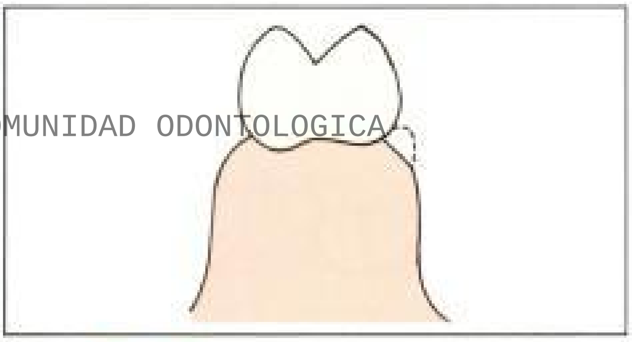

Fig. 31.26: Crown lengthening completed

adjacent to the edentulous spaces (Fig. 31.27). They can be removed either surgically or electrosurgically. Electrosurgical loop electrodes are best used for these procedures (Fig. 31.28).

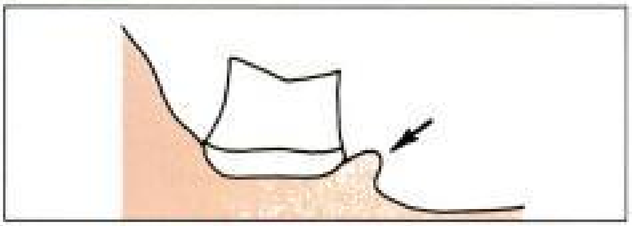

Fig. 31.27: Edentulous cuff

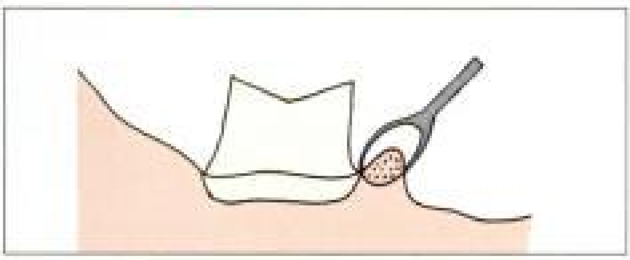

Fig. 31.28: Removing the edentulous cuff using a loop electrode

IMPRESSION MAKING FOR FIXED PARTIAL DENTURES

Impression making for fixed partial dentures is very important because only an accurate impression can produce a successful restoration.

Ideal Requirements of Impression Materials used for Fixed Partial Dentures

Impression materials used for fixed partial dentures should fulfil the following additional, critical requirements:

- *Dimensional stability and accuracy:* This is very important because accurate dies are essential for fabrication of the prosthesis. New generation elastomers are best suited.
- *Elasticity after cure:* Multiple dies can be poured only if the material is sufficiently elastic to allow removal of the cast without damaging the impression.
- *Flow:* They should have sufficient flow to record finer details especially the finish line.
- *Wettability:* They should be able to wet the oral tissues so that the material can flow easily into the gingival sulcus.
- *Versatality:* They should be compatible with model and die materials. It should also be possible to electroplate the impression.

Impression Techniques

In this section, we will discuss about the various impression techniques. The technique for impression making varies according to the type of impression material used and the type of tray selected. The techniques based on impression material used are generally described in detail in any material science book. Here, we have discussed about impression techniques based on the tray selected. Impression techniques can be classified based on the type of impression tray used as follows.

- Stock Tray / Putty-wash Impression
  - — Double mix
  - — Single mix
- Custom tray impression
  - — Single mix technique.
- Closed Bite Double Arch Method or triple tray technique.
- Copper tube impressions.
- Post space impressions.

Impression Making using a Stock Tray (Putty wash technique)

Here a primary impression is made with a stock tray and a final impression is made using the preliminary impression as the custom tray.

Indication

It is used for most clinical situations where a combination of medium to heavy bodied elastomer and light bodied elastomer is necessary.

Advantages

- Trays are readily available (no need to fabricate).
- Metal trays are rigid and do not distort.

Disadvantages

- Need to sterilize the trays.
- More impression material is required.

Technique

There are two methods to make a putty wash impression namely double mix putty wash technique and single mix putty wash technique.

Double mix Putty-wash technique

- A suitable stock tray is selected.
- Tray adhesive is applied uniformly into the tray (Fig. 31.29).

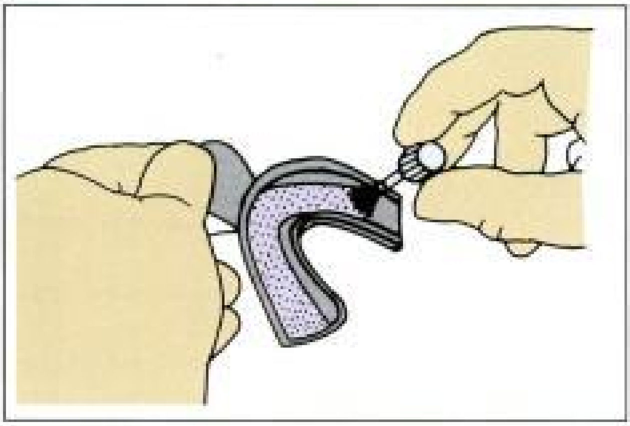

Fig. 31.29: The stock tray is painted with tray adhesive

- Putty impression material is mixed and made into a rope and loaded onto the tray (Fig. 31.30).
- A spacer for light body material, (usually a sheet of polythene) should be placed over the loaded putty material. (Fig. 31.31).
- The loaded tray alongwith the spacer is used to make a full mouth impression.

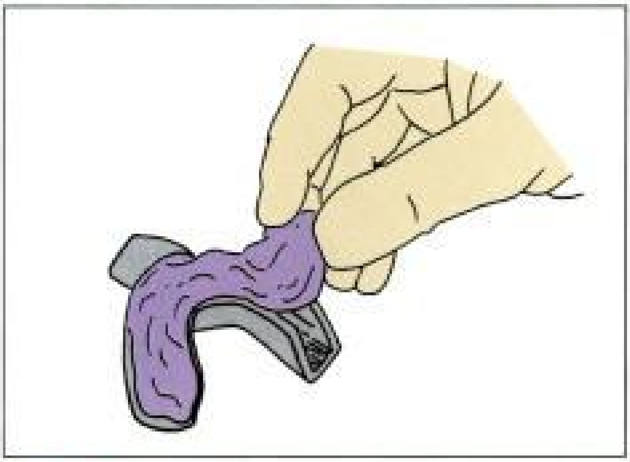

Fig. 31.30: Putty impression material is placed in the tray

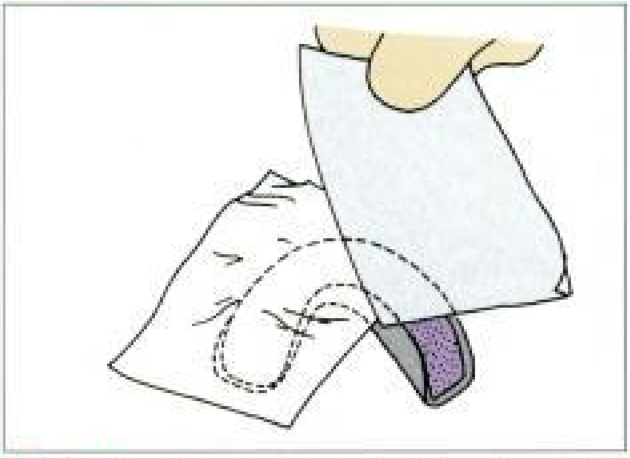

Fig. 31.31: A sheet of polythene is placed over the putty impression material to act as a spacer for light bodied impression material

- After making and removing the impression, the polythene spacer is carefully peeled away (Fig. 31.32).
- The impression is additionally relieved by scraping the areas, which recorded the tooth preparation.
- The light body material is then syringed over the putty impression and also over the tooth preparation (Fig. 31.33).
- The final impression will contain the accurate details recorded by the light body impression material. (Fig. 31.34).

Single mix putty wash technique In this procedure both the materials (light body and putty) are used simultaneously.

Fig. 31.32: The polythene spacer is removed

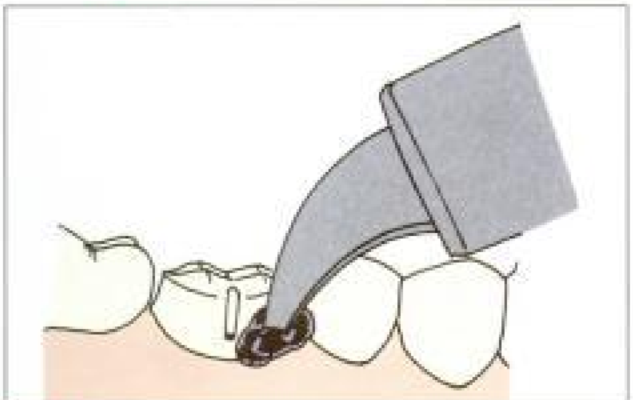

Fig. 31.33: Light bodied impression material is loaded on a syringe and injected into the sulcus area

Fig. 31.34: The final impression

- The putty material is loaded into the stock tray.
- The light body material is syringed around the tooth preparation.
- A full mouth impression is made using the loaded stock tray.

Impression Making Using a Custom Tray

This is an elaborate procedure wherein a custom tray is fabricated over the primary cast made using a primary impression.

Advantages

- Lesser amount of impression material is required
- More hygienic as it is used for a single patient
- Uniform thickness of impression material reduces the chances of distortion.

Disadvantages

- Increased time required for fabrication.
- Cannot be used in patients sensitive to acrylic

Technique

An acrylic special tray is constructed over the cast with two sheets of tinfoil spacer to provide space for the impression material as described in Chapter 6.The technique for making an impression using a special tray is called '*Single mix technique*'.

- *Step I:* Tray adhesive is applied over the acrylic special tray because the elastomers do not adhere to acrylic.
- *Step II:* Medium viscosity elastomer is loaded on the tray.
- *Step III:* The light body elastomer is syringed around the tooth preparation.
- The tray with the impression material is then seated over the tooth surface.
- The light body silicone records the details of the preparation with the medium or heavy viscosity elastomer.

Closed Bite Double Arch Method/Dual Quad tray/Double Arch/Triple tray/ Accu-bite/Closed Mouth Impression

Indications

- There should be sufficient inter-digitation between the natural teeth in order to provide a vertical stop and maintain vertical dimension.

- There should be sufficient space distal to the remaining teeth for adjustment.

Advantages

- Less impression material is required as only one part of the arch is recorded.
- Less time is taken as both the arches are recorded simultaneously.
- Maximum intercuspation position can be recorded more accurately as it is recorded during function.

Disadvantages

- Distortion is possible because the tray is not rigid
- Cannot be used for more than one casting per quadrant.
- Uneven distribution of impression material may occur.

A Few Words on Tray used for Triple Tray Technique

The tray consists of a plastic framework with a plastic sieve and a handle. The tray should be first tried on the patient so that he is able to approximate his teeth after placement of tray. The crossbar of the tray should be distal to the last tooth of the arch (Fig. 31.35).

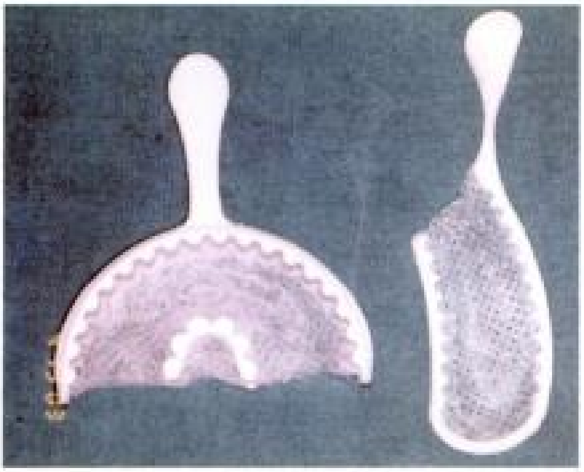

Fig. 31.35: Stock tray used to make a triple tray impression

Procedure

- The syringe material is injected into the area to be recorded.
- The high viscosity material is mixed and placed in excess on both the arches.
- The tray is placed in between the arches.
- Patient is asked to inter-digitate (bite) slowly.
- After making the impression, the patient is instructed to open his mouth slowly.
- As the patient opens his mouth, the tray will adhere to one arch.
- Bilateral pressure (right and left) should be applied to remove the tray as it helps to minimize distortion (Fig. 31.36).

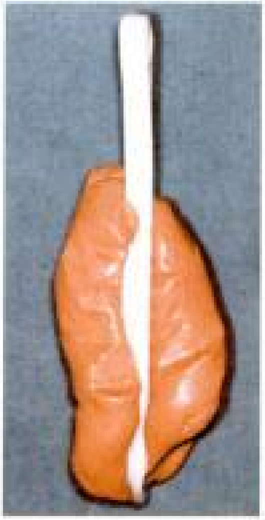

Fig. 31.36: An impression made using the triple tray technique

- Die stone is poured into the impression of the tooth preparation.
- The impressions are boxed and casts of both arches are poured.
- Articulation should be done on a hinge articulator with an incisal pin to maintain vertical dimension.

Copper Band Impression Technique

It is a single tooth impression wherein a copper band is positioned around the prepared tooth and the impression material is loaded into the band to record the impression.

Indications

- Single tooth preparation.

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Temporization or Provisional Restoration

INTRODUCTION

The word provisional means established for the time being, until a permanent arrangement can be made. After tooth preparation, a temporary protective/ functional restoration is fabricated over the prepared tooth to be used until the fabrication of the final prosthesis. Temporary restorations are usually fabricated and provided on the same day of tooth preparation. Before we go into the fabrication of a provisional restoration, let us review the ideal requisites of these restorations.

IDEAL REQUIREMENTS OF PROVISIONAL RESTORATIONS

Even though a definitive restoration can be placed as soon as two weeks after tooth preparation, the provisional restoration must satisfy important needs of the patient and dentist. The basic requirements of provisional restorations can be broadly classified into biological, mechanical and aesthetic requirements.

Biological Requirements

A temporary restoration should:

- Protect the pulp because a freshly prepared tooth will have increased sensitivity.
- Maintain periodontal health (good marginal fit).
- Good occlusal compatibility/harmony. Tooth position should establish contact with adjacent and opposing teeth. Inadequate contacts will lead to supra-eruption and horizontal movement of the opposing and adjacent teeth respectively.

Mechanical Requirements

Mechanical requirements include function, displacement and removal for reuse.

Function

The restoration should function like a beam in which substantial occlusal forces can be transmitted/distributed.

Greater strength is achieved by reducing the depth and sharpness of embrasures and by increasing the cross-sectional area of the connector.

Displacement

This can be prevented through proper tooth preparation and a provisional restoration with a closely adapted internal surface.

Removal for Reuse

The provisional restoration should not be damaged during removal. The luting agent should be sufficiently weak to allow removal.

Material Requirements

Usually provisional restorative materials are of fluid consistency (e.g. acrylic resin) during fabrication, which become rigid once the material is set. Hence, the setting/set material should have the following requirements:

- Convenient handling: Adequate working time, easy moldability, rapid setting time etc.
- Biocompatibility: Non-toxic, non-allergic, non-exothermic.
- Dimensionally stable during setting.
- Easy to contour and polish.
- Adequate strength and abrasion resistance.

- Good aesthetics: Translucency, colour, contourable, colour stable
- Good patient acceptance: the material should be non-irritant to the oral tissues.

- It should be easy to repair or to add more material.
- Chemical compatibility with provisional luting agents: It should not react adversely with the luting agents used to fix the restoration.

TYPES OF PROVISIONAL RESTORATIONS

Provisional restorations can be classified based on the following methods:

- Method of fabrication
- Type of material used
- Duration of use
- Technique for fabrication

Depending on the Method of Fabrication

Based on the method of fabrication, provisional restorations can be classified into custom made and preformed restorations.

Custom Made Provisional Restorations

Here, the restoration is fabricated to reproduce the original contours of the tooth. An impression of the prepared tooth is made and a cast is poured. The prepared tooth on the cast is waxed up and carved to reproduce the original contours.

Advantages

- Minimum interference
- A wide variety of materials can be used
- Helpful in evaluating the adequacy of tooth reduction. By measuring the thinness of the restoration, the tooth preparation can be altered.

Disadvantages

- Additional lab procedure involved.
- Time consuming.

Preformed Provisional Restorations

Preformed crowns are commercially available prefabricated crowns. These crowns are available in various sizes. The operator can choose the size and material that would best suit the patient and place it as a provisional restoration. Before cementation these crowns are slightly altered and modified to fit the tooth.

Advantages

- Less time consuming

Disadvantages

- Rarely satisfies the requirements of contour. It has to be customized with self-cure resin.
- Generally limited to single tooth restorations.

Materials Available in Preformed Crowns

Here I have discussed about the common materials and their salient features that are used in commercially available preformed crowns. Commonly available preformed crowns include polycarbonate, cellulose acetate, aluminium, and tin-silver.

Polycarbonate

- Has the most natural appearance
- Usually available in a single shade
- But can be altered by the shade of the luting agent
- Available for incisor, canine and premolar teeth.

Cellulose Acetate

- It is available as shells into which auto-polymerising resin can be filled and inserted over the prepared tooth. As the resin does not bond to the shell, it can be easily removed.
- It is a thin (0.2 to 0.3 mm), transparent material.
- It is available in all tooth types (incisors, molars, etc).
- The shade of this temporary crown depends entirely on the auto-polymerising resin. Shade matching can be done by adding colours to the resin.

Aluminium and Tin-silver

- These materials are suitable for posterior teeth.
- They have anatomically shaped occlusal and axial surfaces.

- Care must be taken during try-in verification to avoid fracture of their delicate margins.
- As it is highly ductile, it allows easy contouring.

- The crown may require cervical enlargement during insertion. This can be done using special instruments like *swaping or stretching blocks*.

Nickel-Chromium

- These are used for children with extensively damaged primary teeth.
- They cannot be altered with resin.
- These crowns can be easily recontoured using pliers.
- They should be cemented using high strength luting agents.
- Very strong
- Indicated for long-term temporaries.

Depending on the Type of Material Used

Based on the type of material used, provisional restorations can be classified into resin restorations and metal restoration.

Resin based Provisional Restorations

The various resin-based materials used to make provisional restorations are:
- Cellulose acetate
- Polycarbonate
- Poly-methyl methacrylate: Chemically activated resin.
- Poly-R methacrylate: R group could be ethyl or isobutyl forms of resin. These resins have greater strength than conventional resins.
- Microfilled composite: BisGMA (Bisphenol A glycidyl dimethacrylate).
- Urethane di-methylacrylate: Light cured resins. The amount of filler in these systems should have sufficient filler for optimal handling or manipulation.

Choice of resin material should be based on:
- Polymerization shrinkage.
- Strength.
- Colour stability.
- Toxicity

Direct composite provisional restoration: This is a new type of resin based provisional restoration. The composite used here is Bis-acryl composite. This material exibits less heat and curing shrinkage. Hence, it can be fabricated using direct technique intra-orally.

Metal Provisional Restorations

Metal provisional restorations are usually fabricated using:
- Aluminium
- Nickel-chromium
- Tin-Silver

Based on Duration of Use

Based on the duration for which the restoration is intended to be used, provisional restorations can be classified into:
- Short-term temporary: for use up to 2 weeks
- Long-term temporary: for use from 2 weeks to a few months.

Short-term Temporary Restorations

- These are used when the prosthesis is to be used for a maximum of two weeks.
- They are indicated after tooth preparation in fixed partial dentures.
- They are either custom-made resins or available as preformed crowns.
- Polycarbonates or aluminium crowns are the most commonly used short-term temporary restorations.

Long-term Temporary Restorations

They are usually made of cast metal. Though their strength is more than average, they have a history of frequent breakage.

Indications

- Long span posterior fixed partial dentures.
- Prolonged treatment time.
- If the patient is unable to avoid excessive forces on the prosthesis.

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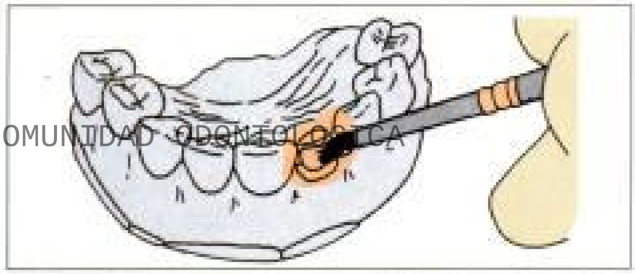

Fig. 32.7: The prepared area and adjacent portions of the plaster cast are painted with separating medium

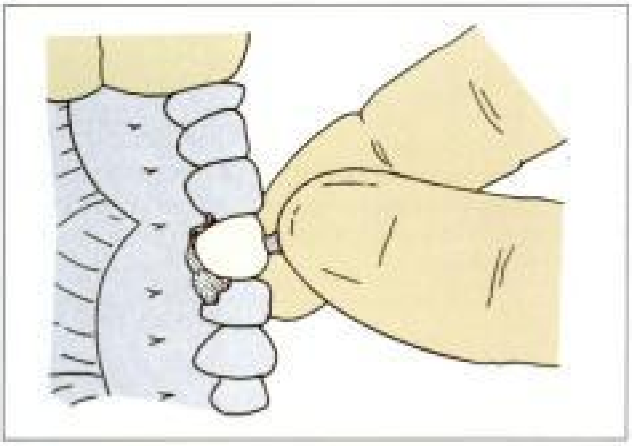

Fig. 32.8: The preformed crown shell filled with resin is placed onto the prepared tooth on the plaster cast

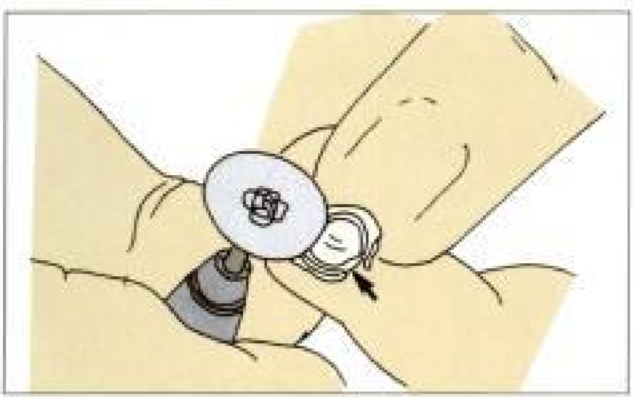

Fig. 32.9: Gingival excess created by the expressed acrylic is trimmed back with a garnet disc upto the level of the finish line (*arrow*)

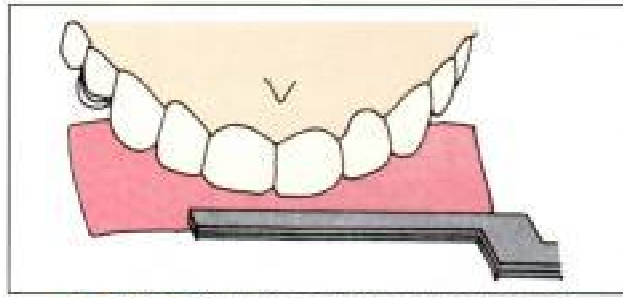

Fig. 32.10: Next, the occlusion is checked with articulating paper

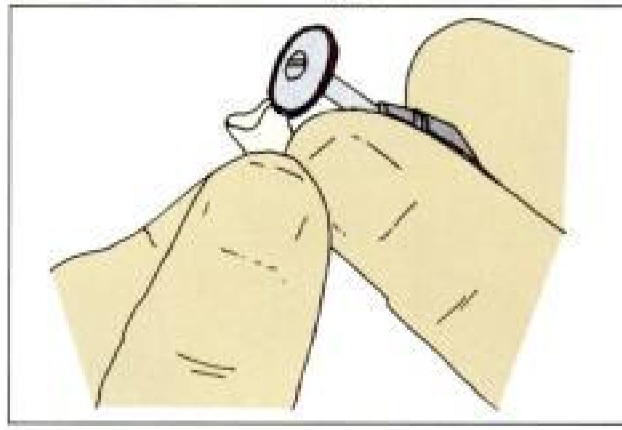

Fig. 32.11: Axial surfaces near the margins of the restorations are smoothed with a Burlew disc

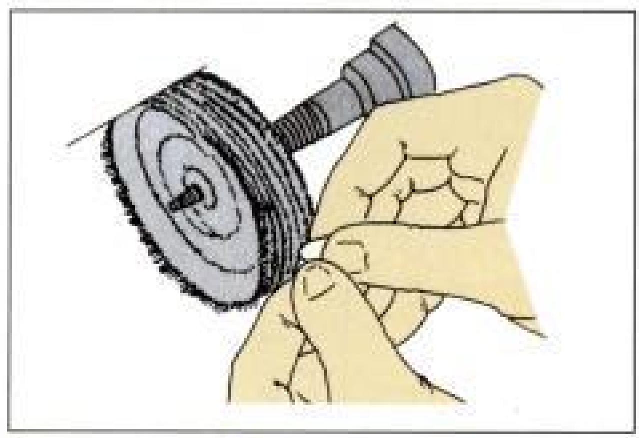

Fig. 32.12: Axial surfaces are polished using white polishing compound on a muslin rag wheel

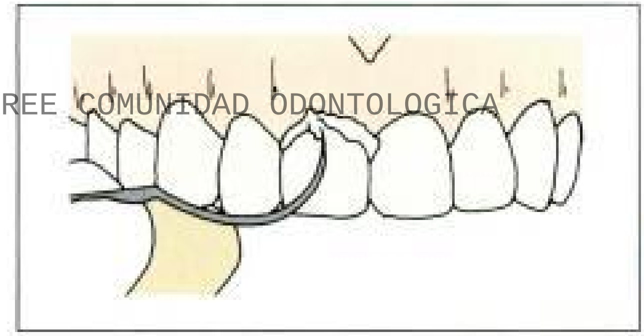

Fig. 32.13: During cementation, excess cement is removed from the gingival crevice with an explorer

DIRECT FABRICATION OF PREPARING A METAL PROVISIONAL RESTORATION ON A POSTERIOR TOOTH (FIGS 32.14 TO 32.24)

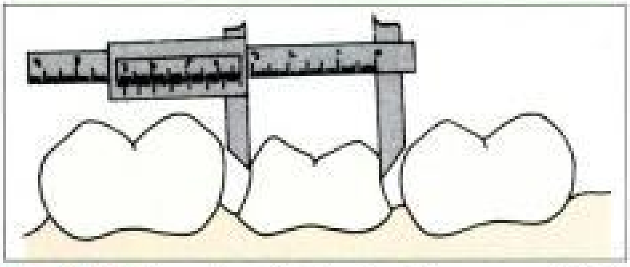

Fig. 32.14: The mesiodistal diameter of the prepared tooth is measured using a vernier caliper

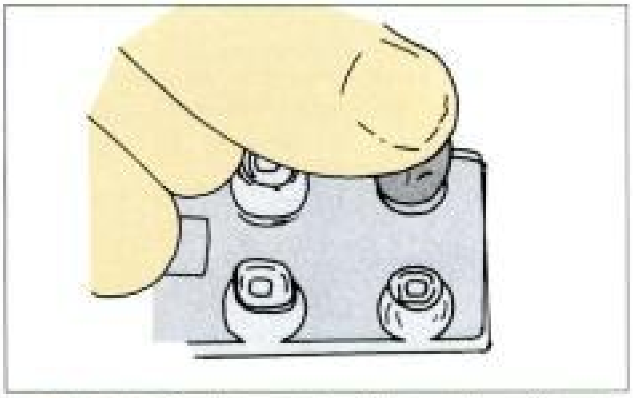

Fig. 32.15: Gingival margins of the metal provisional restoration can be flared slightly on the stretching block

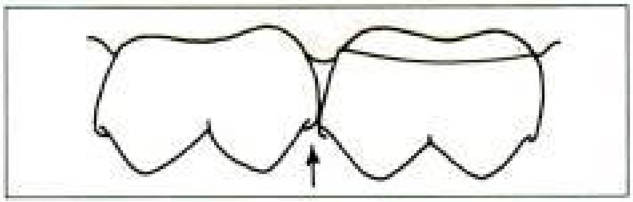

Fig. 32.16: Any discrepancy between the height of the marginal ridges of the crown and the adjacent teeth should be evaluated. If there is any discrepancy it indicates that the crown is too long and should be trimmed gingivally

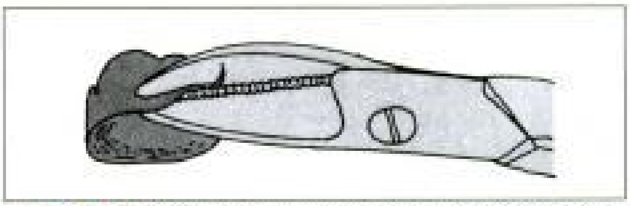

Fig. 32.17: Estimated excess height of the restoration is removed from the gingival margin

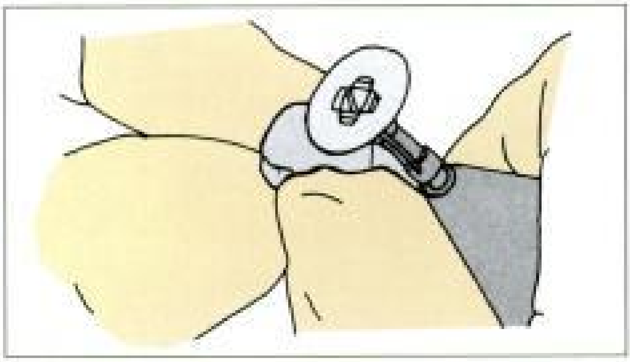

Fig. 32.18: Next, the gingival margin is smoothed

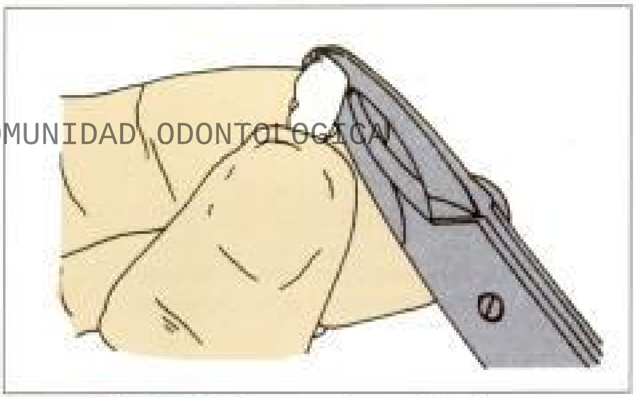

Fig. 32.19: Consequently axial surfaces are contoured with pliers

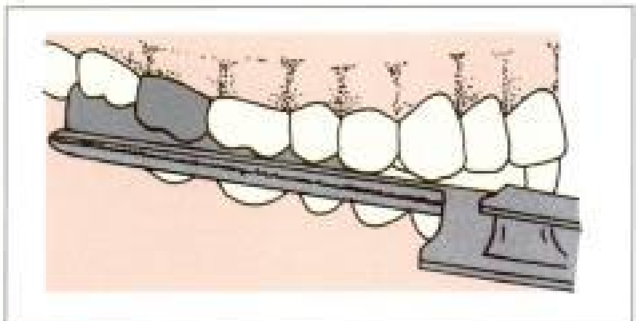

Fig. 32.20: Finally the prosthesis is inserted and the occlusion is checked with articulating paper

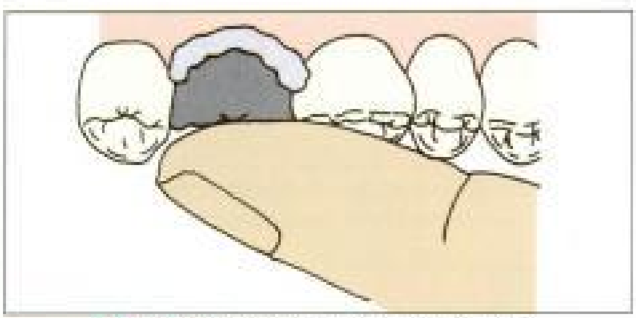

Fig. 32.21: The crown is cemented using zinc oxide-eugenol cement

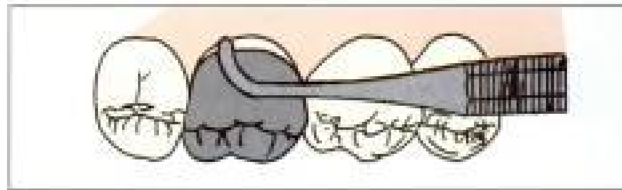

Fig. 32.22: The margins of the crowns are burnished

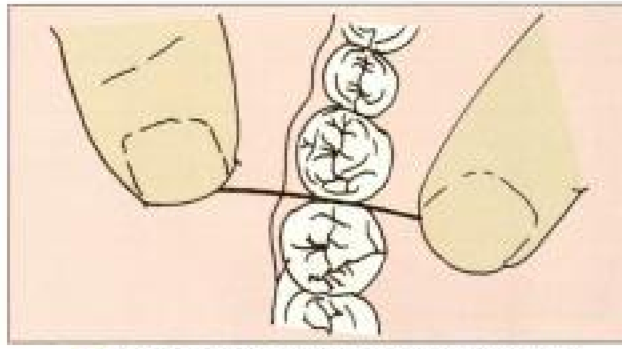

Fig. 32.23: Excess cement is removed from the interproximal region with dental floss

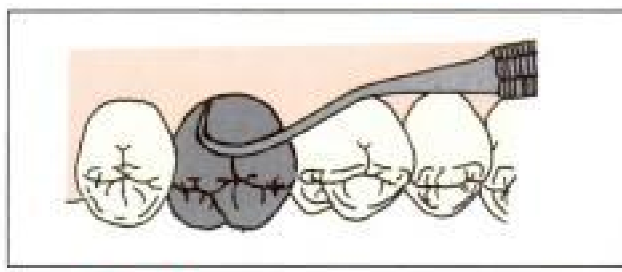

Fig. 32.24: All cement must be removed from the crevice with an explorer

FABRICATION OF AN ACRYLIC PROVISIONAL RESTORATION FOR A POSTERIOR TOOTH USING INDIRECT TECHNIQUE (FIGS 32.25 TO 32.47)

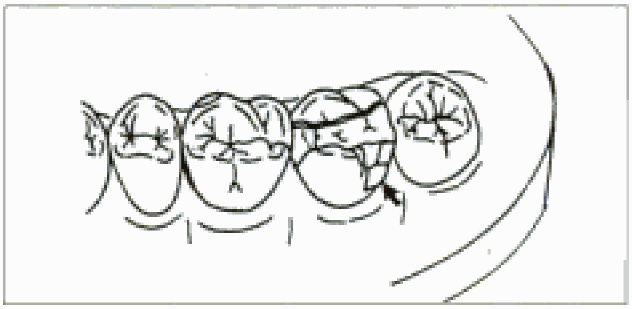

Fig. 32.25: Defects, such as a missing cusp *(arrow)*, should be filled in on the cast

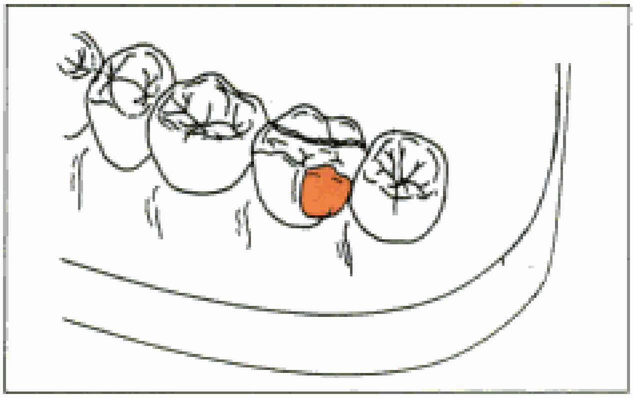

Fig. 32.26: Utility wax is placed to fill the defect

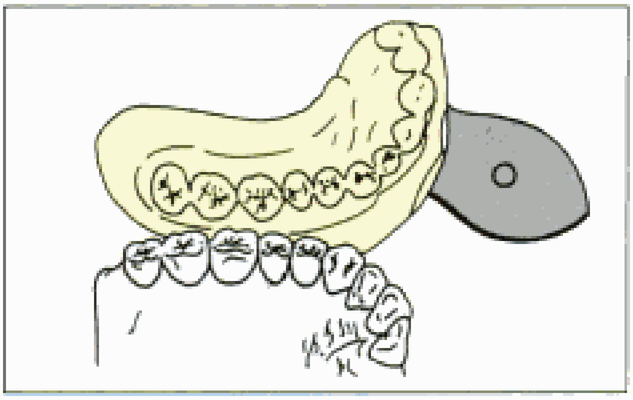

Fig. 32.27: An overimpression is made from the diagnostic cast

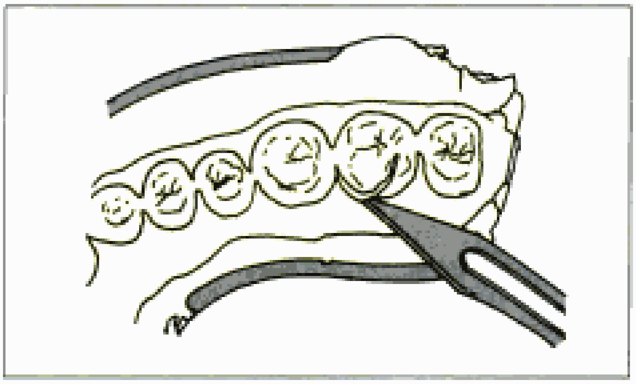

Fig. 32.28: Thin edges in the gingival areas of the overimpression are cut away

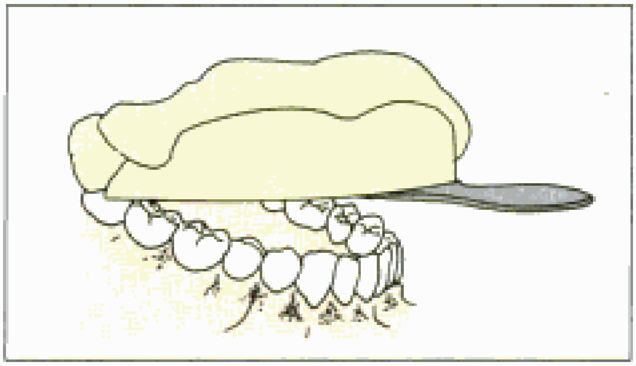

Fig. 32.29: After making the over-impression, the tooth preparation is carried out. After preparing the tooth, an alginate impression of the prepared tooth is made

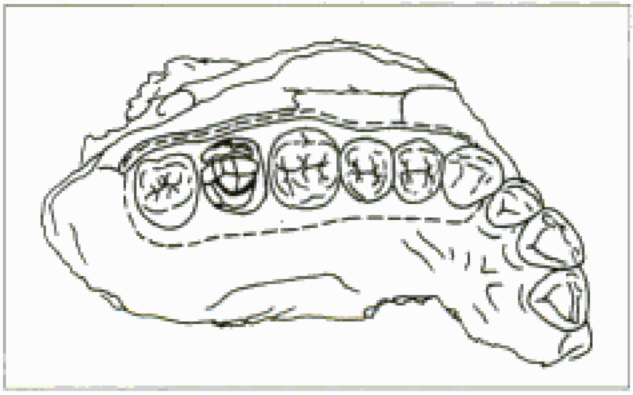

Fig. 32.30: Untrimmed quick-set plaster cast poured from the alginate impression

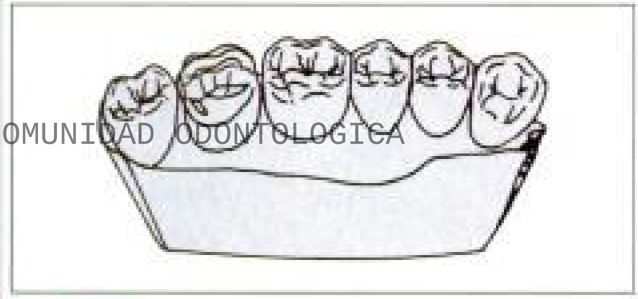

Fig. 32.31: The plaster cast of the prepared tooth is trimmed neatly before processing the temporary restoration

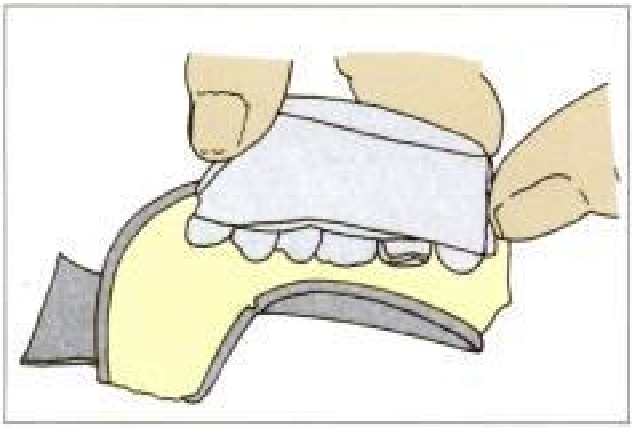

Fig. 32.32: The cast is tried in the over impression before proceeding

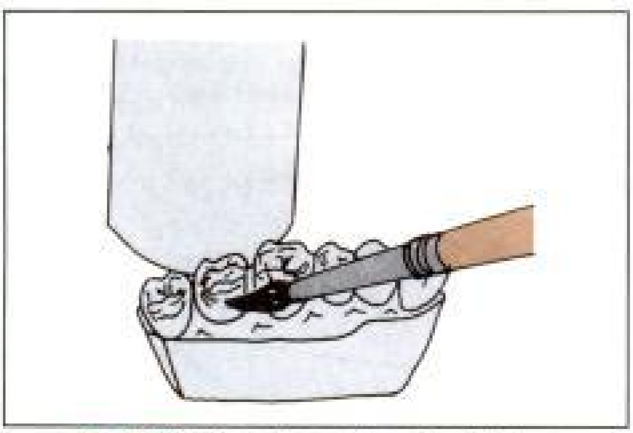

Fig. 32.33: Separating medium is painted on the plaster cast

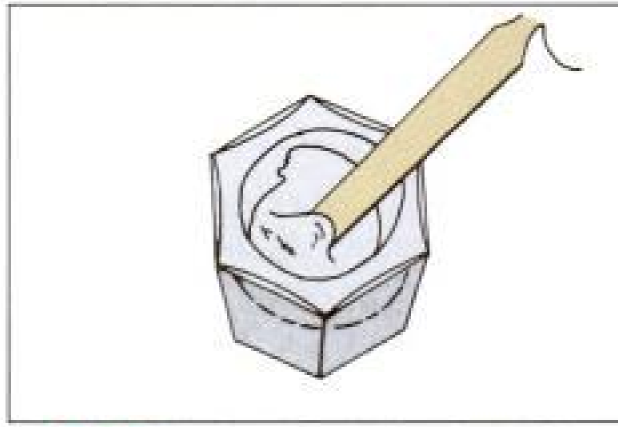

Fig. 32.34: Acrylic resin is mixed in a dappen dish

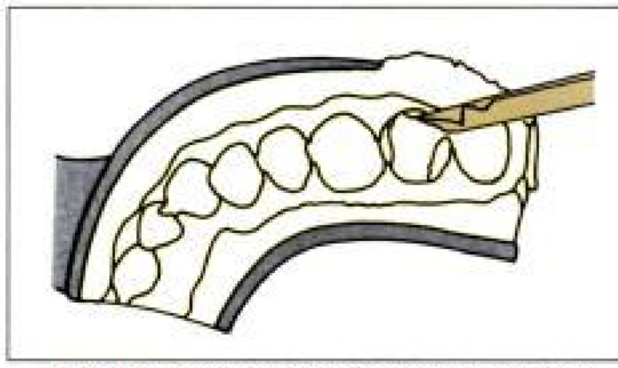

Fig. 32.35: Resin is placed into the overimpression

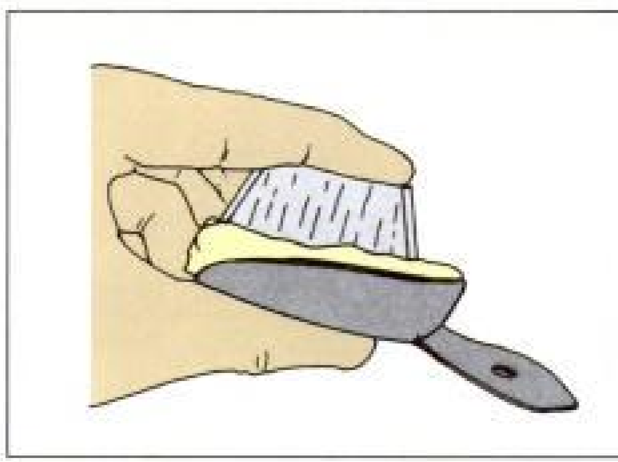

Fig. 32.36: The cast is seated firmly in the overimpression

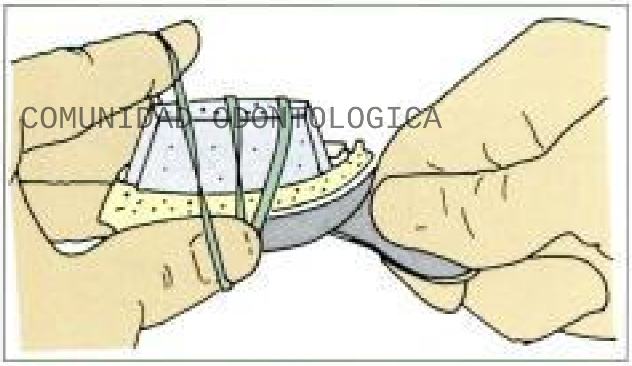

Fig. 32.37: The cast is held in place with a rubber band

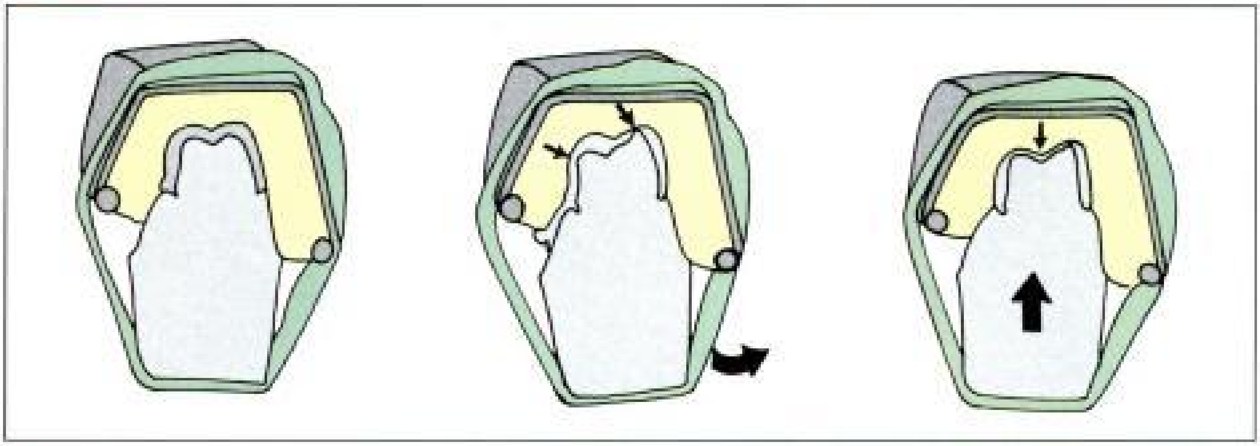

Fig. 32.38: Cross-sections of casts seated in overimpressions: correctly seated (a); if the cast is pushed to one side, the provisional restoration will be deficient (b); overseating of the cast will produce a provisional restoration with a thin occlusal surface (c)

Fig. 32.39: The cast can be broken to remove the provisional restoration

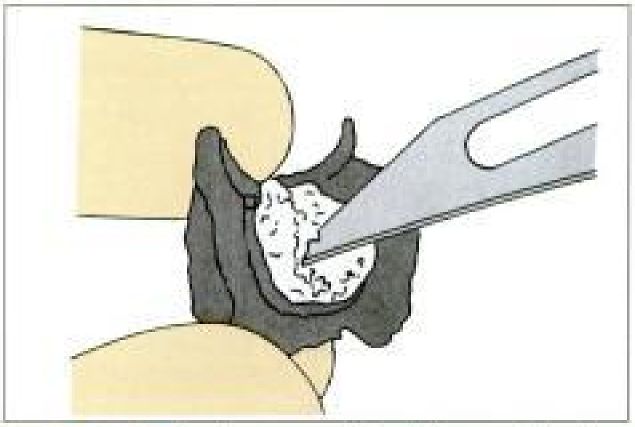

Fig. 32.40: Any plaster remaining in the provisional restoration is removed

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33

Lab Procedures Involved in the Fabrication of FPD

INTRODUCTION

Fabrication of a fixed partial denture involves the fabrication of the wax pattern, casting, soldering and finishing. Here we shall study in detail about these procedures.

DIES AND WORKING CASTS

A die is a positive replica of the individual prepared tooth on which the margins of the wax patterns are finished. These are individual tooth replicas prepared for easier handling during wax pattern fabrication and finishing of inaccessible areas of the cast.

Ideal Requirements of a Die System

- The die should be easy to remove and replace in its original position.
- The die must be stable when placed in the cast.
- It should be easy to mount in the articulator.

Types of Dies

Based on the design, die systems can be classified into:

- Working cast with separate die system
- Working cast with removable die system.

There are three commonly used removable die systems, they are:

- — Dowel pin system
  - – Straight
  - – Curved
- — Di-lok tray system
- — Pindex system
- Accutrac system

Working Cast and Separate Die System

Here, two casts are poured from a single impression and one cast is sectioned and used as a die and the other is not sectioned and is used as the working cast. The wax pattern is prepared on the die and later transferred to the working cast. The die is shaped and finished using an acrylic trimmer and the portion of the die below the cervical line is finished using a scalpel. Sharp undercuts in the base should be avoided.

Advantage
- Simplest and easiest method

Disadvantage
- The wax pattern may get distorted while transferring it from the die to the cast.
- Proximal margins tend to get overcontoured.

Working Cast with a Removable Die System

In this system a special type of working cast is prepared and the dies are carefully sectioned so that the individual dies can be removed and replaced in their original position in the cast. Dowel pin systems, di-lok tray systems and the pindex systems come under this category.

Dowel Pin Systems

Dowel pins may be straight or curved.

Straight dowel pin systems

They are prepared using two techniques, namely the pre-pour and post-pour techniques.

Pre-pour technique

- Here the die pins are positioned in their appropriate places within the impression using bobby pins and sticky wax (Fig. 33.1).

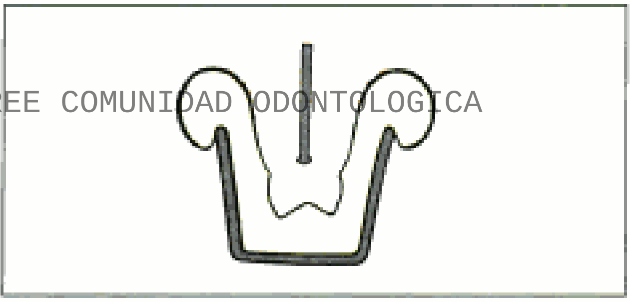

Fig. 33.1: The dowel pin is positioned within the impression using sticky wax

- After positioning the pins, the impression is poured up to the level of the alveolar process of the remaining teeth (Fig. 33.2).

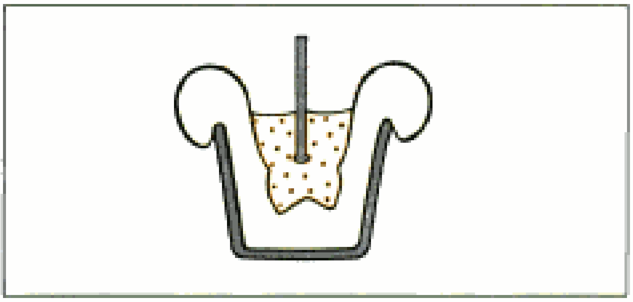

Fig. 33.2: First pour is poured upto the level of the alveolar process

- Separating medium is applied over the first pour and die pin and the remaining portion of the cast is poured (Fig. 33.3).

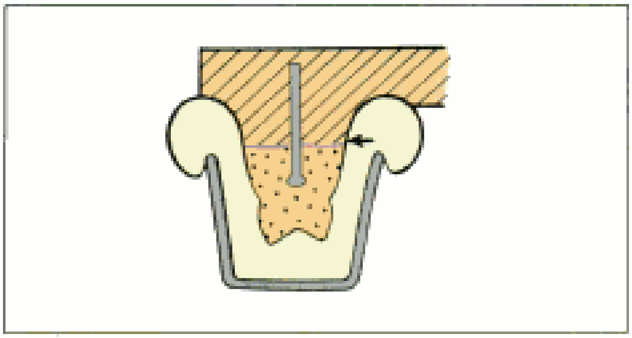

Fig. 33.3: Separating medium is applied and the base is poured

- After the cast is set, the dies are sectioned by placing vertical sections on the interproximal regions of the cast using a die sectioner or a manual saw. Vertical sections at the interproximal regions should be made without damaging the contour of the adjacent teeth (Fig. 33.4).

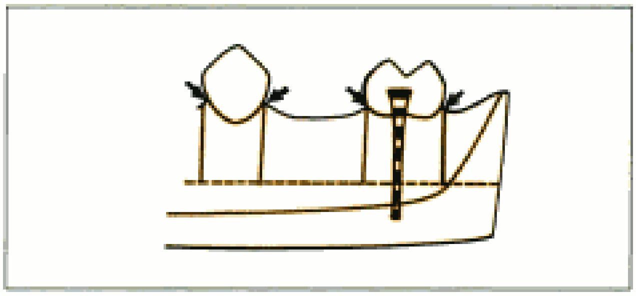

Fig. 33.4: Vertical sections at the interproximal regions are sufficient to separate the dies because the separating medium between the two pours will function as the horizontal section

- Since the separating medium was applied before pouring the second half of the cast, the dies can be easily separated with vertical sections alone.
- The die is carefully separated from the cast without chipping. After removing the die, a small hole will be visible in the cast. This indexing hole will guide the pin into position while replacing the die.

Post-pour Technique (cemented pin technique)

Here, the cast is poured upto the level of the crowns of the teeth in the impression. Subsequently, small holes are drilled within the first pour in the required places and the dowel pins are cemented into the holes (Fig. 33.5). The remaining part of the cast is poured and the dies are sectioned as described in the pre-pour technique.

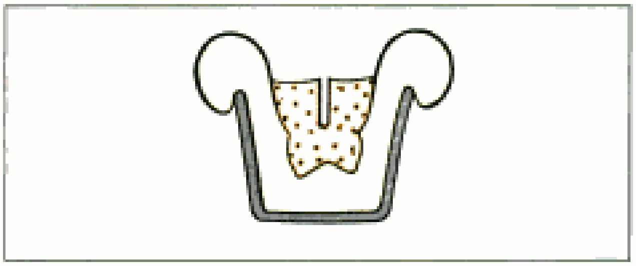

Fig. 33.5: In the post pour technique, holes are drilled into the set first pour to position the pins

Advantages

- Easy to prepare
- No special equipment is necessary

Disadvantages

- The pins may get displaced while pouring the cast.

Curved Dowel Pin System

This is similar to straight dowel pin technique except that curved pins are used. The curved pins will project from the sides of the base of the cast. When the projecting pins are pressed, the die unit attached to the respective pin will pop out from its place (Fig. 33.6).

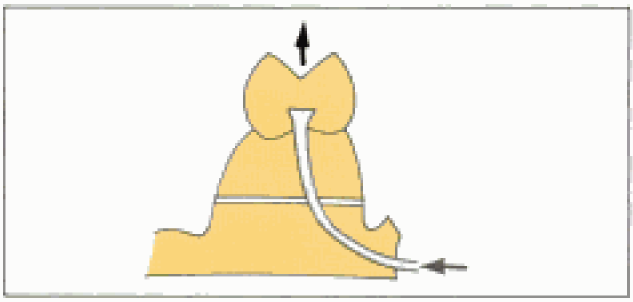

Fig. 33.6: Curved dowel pin system (pushing the pin from the side pops the die out).

Di-lok Tray System

This technique uses a special tray to pour the cast. This special tray has orientation grooves on the inner aspect. Actually the tray is made of multiple components, which can be assembled or dismantled as required (Fig. 33.7).

Impression is poured using a two-pour technique. The first pour is poured upto the level of the impression and the second or base pour is poured after positioning the rim of the di-lok tray over the impression. Before the second pour is set, the base of the di-lok tray is assembled and the cast is allowed to set. Later, the di-lok tray is dismantled and the grooves on the base of the cast formed by the di-lok tray is used as a guide to do die sectioning.

Advantages

- Simple and easy to prepare
- The cast can be mounted in an articulator

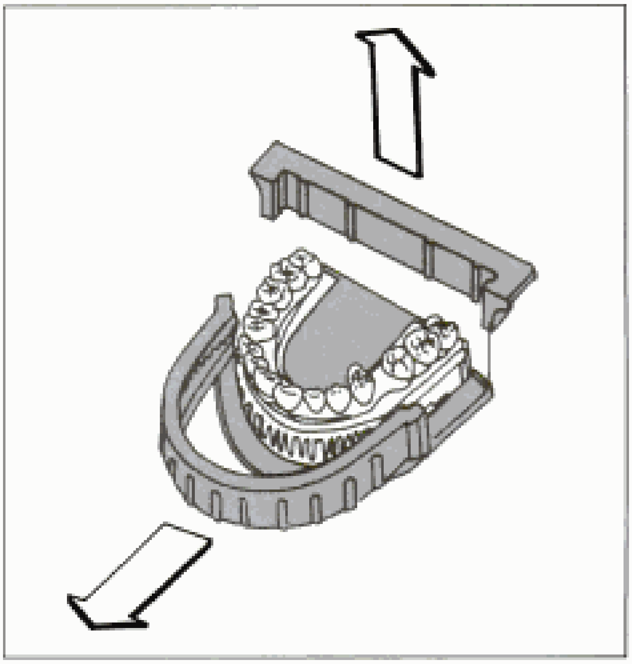

Fig. 33.7: Di-lok tray

Disadvantages

- Requires special equipments.

Pindex System

This system is similar to the post-pour dowel pin technique. Here a special drill press equipment is used to do die sectioning. The drill press has a platform with a slot like opening through which the drill pin will project during the procedure. The entire platform is spring mounted and when pressed down automatically starts the drill, which will project through the slot. The unit has a red pilot light lamp on top, which will shoot a point exactly on the drill. This red pilot pointer will act as a guide while drilling (Fig. 33.8).

Die sectioning procedure is simple wherein the cast of 15 mm base is placed on the drill press and drill holes are prepared in the under surface of the base of the cast using the pilot light as a guide. After making the drill holes to the required depth, sleeved die pins are placed and cemented using cyanoacrylate adhesive. Remember that the holes will not be very deep. Hence a portion of the pins wil be projecting from the base of the cast (Fig. 33.9).

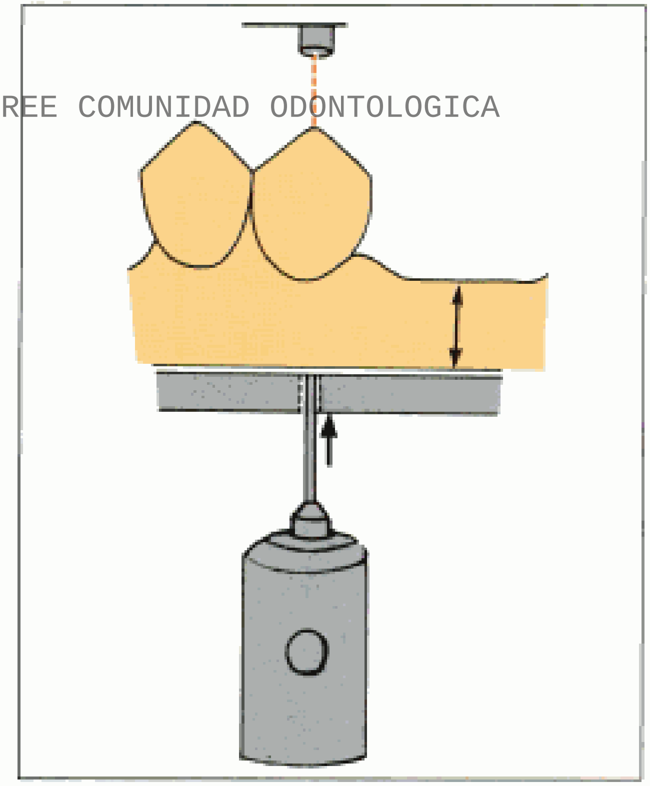

Fig. 33.8: The cast is placed on the pindex machine and the pilot light is used as a guide to drill holes in the base of the cast. The platform of the pindex machine is spring loaded. When the cast is pressed against the platform, the motor will get activated and drill a hole in the cast

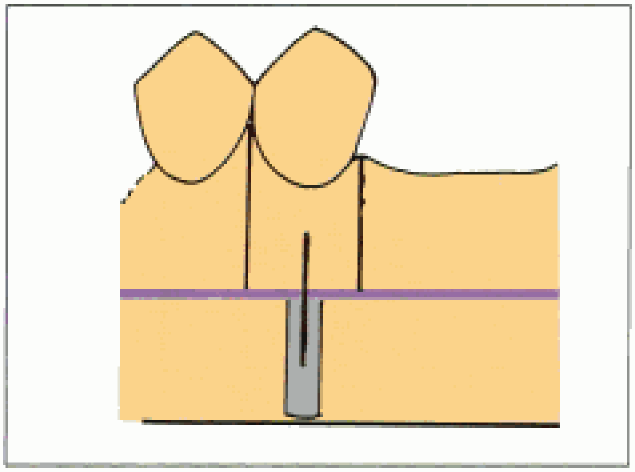

Fig. 33.9: After drilling the cast, sleeved pins are positioned and a separating medium is applied on the base and an additional base is prepared. After making the final base, the individual dies are sectioned, which can be removed and replaced into the sleeve

After cementing the pins, a base is poured over the base of drilled cast. Consecutively the dies are sectioned but not upto the base as described in the dowel pin system.

Advantages Allows accurate placement of the die pins.

Disadvantages Special equipment is required.

The Accutrac System

- These dies are exclusively used in the fabrication of laminate veneers.
- Basically this system involves the fabrication of two casts as described in the working cast with separate die system. One cast (master cast) is sectioned into dies and used to prepare the coping. After preparing the wax pattern, the sectioned dies are reassembled in the master cast.
- The master cast is blocked out with wax (filled with wax to seal the crevices).
- The second cast (refractory cast) is duplicated from the blocked out, sectioned, die master cast using addition silicone. The second cast is poured using specially formulated stone, whose expansion will compensate for the shrinkage of porcelain when fired in the furnace.

WAX PATTERN FABRICATION

Usually wax pattern fabrication denotes the wax pattern fabricated to cast metal or castable glass ceramics (DICOR). Wax pattern fabrication involves three major steps namely fabrication of the retainer, the pontic and connector.

Fabrication of the Retainer Wax Pattern

The method of fabrication of the retainer component will vary according to the material used and the design of the restoration. The principal steps to be followed during the fabrication of a wax pattern for most retainers are similar to a great extent. A retainer wax pattern can be fabricated by using the following techniques:

Direct Technique

Here the pattern is fabricated directly over the prepared tooth in the oral cavity. It is done with type I wax. The procedure is tedious and technique sensitive. Hence, it is not used for fixed partial denture patterns.

Indirect Technique

Here the pattern is fabricated over the prepared tooth in the die/cast. It is made using type II wax. *It is more preferred due to the following advantages:*

- The pattern can be done in the lab thereby reducing the chairside time.
- The lab work can be done by the technician thereby decreasing the work load of the dentist
- It allows better visualisation of the margins of the restoration especially from the gingival aspect.

Since it is the commonly used technique, we have discussed it in greater detail.

A note on waxes used for indirect technique:

The type II wax (inlay wax) should fulfil the following ideal requirements:

- It should have a contrasting colour so that the margins of the pattern can be distinguished from the cast.
- It should have a slightly lower melting point compared to type I wax.
- It should satisfy the ADA specification No: 4.
- It must flow readily when heated without losing its properties.
- It should be rigid at low temperatures.
- It should not flake or chip during carving.

Procedure

The indirect wax pattern is fabricated by preparing a wax coping followed by adding layers of wax to build up the axial and occlusal contours. Finally the margins of the patterns are finished before casting (Fig. 33.10).

Coping preparation, surface contouring and marginal finish are necessary for all metal or DICOR ceramic retainers whereas in case of metal ceramic retainers, the coping is alone prepared and cast using a metal ceramic alloy. The contours and margins are directly prepared using ceramic and fired. For metal ceramic restorations with ceramic facings, all areas where metal is to occupy are contoured to a greater detail. The area where the facing is to occupy is left to the level of the coping and a sharp cut back design should be provided in the wax pattern to mark the metal-ceramic junction.

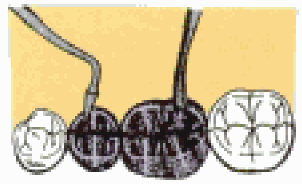

Fig. 33.10: Wax patterns prepared using indirect technique

Coping Preparation

- It can be done either using wax or heated sheet of resin. Usually wax is preferred.
- Wax can be coated on the tooth either using a wax spatula or by dipping the die into hot wax (Figs 33.11a and b).
- While adding new layers of wax, the previous layer should be melted in order to avoid the formation of voids or flow line on the inner surface of the restoration.
- The coping should be waxed in excess mesiodistally so that the proximal contacts are preserved, even after finishing and soldering (Fig. 33.12).

Preparing the Axial Contours

Axial contours include the contour of the buccal, lingual and proximal surfaces. They should be prepared based on the following principles:

- Establishing the proximal contact is the most important component of axial contouring. The proximal contacts determine the health of the gingiva (interdental papilla).
- Usually posterior proximal contacts occur at the occlusal third when viewed from the side. Exceptions include maxillary molars where it occurs in the middle third (Fig. 33.13).

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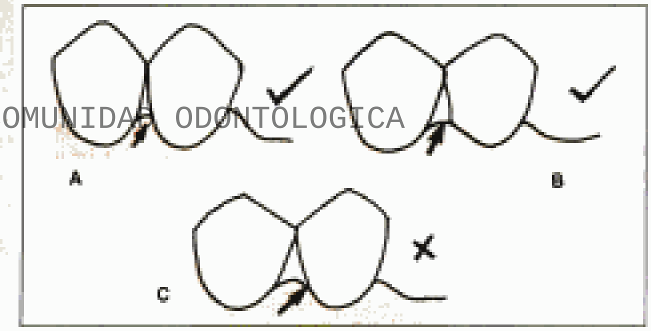

Figs 33.16a to c: (a) A flat proximal surface below the point of contact (preferred) (b) A concave proximal surface below the point of contact (preferred) (c) A convex proximal surface below the point of contact (not preferred)

- All the axial contours should be in harmony with the adjacent teeth.
- The heights of contour on the lingual surface of maxillary posteriors occur in the cervical third. The same in the mandibular posteriors occur in the middle third (Fig. 33.17).

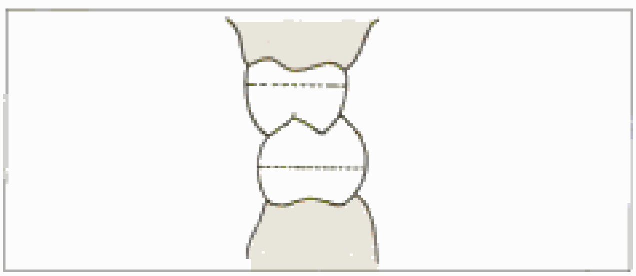

Fig. 33.17: The height of contour of the lingual surface of maxillary posterior is located in the cervical third but the same is located in the middle third for mandibular posteriors

- The lingual prominence is greater for mandibular posteriors compared to maxillary posteriors (Fig. 33.18).

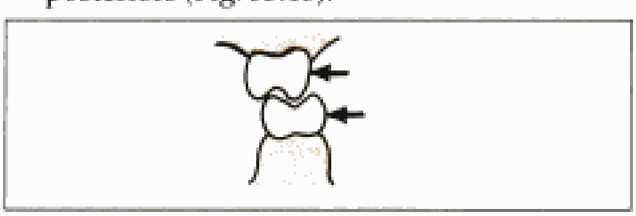

Fig. 33.18: Greater lingual prominence of the mandibular lingual surface relative to the maxillary lingual surface

- The subgingival axial surface should be flat to promote efficient cleaning. The part of the axial surface that extends sub-gingivally forms a part of the *emergence profile* (Fig. 33.19). *Stein*

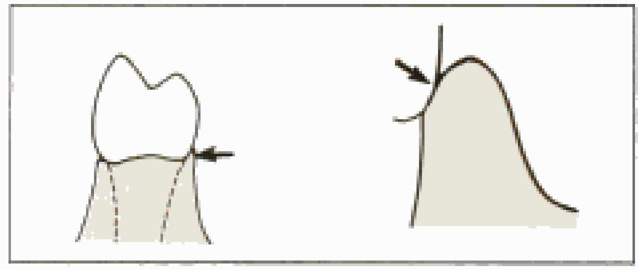

Fig. 33.19: Emergence profile

and Kuwata described emergence profile as the part of the axial contour that extends from the base of the gingival sulcus past the free margin of the gingiva. The emergence profile is a straight plane extending up to the height of contour.
- Overcontouring the axial surface can lead to food entrapment and gingival inflammation.
- Any depressions in the wax pattern should be removed by filling with wax. If the wax is removed by smoothening the pattern, the axial contours may get altered.
- Establishing a smooth surface is more important them achieving a highly polished surface.

Preparing the Occlusal Contours or Developing the Occlusal Morphology

The occlusal surface of the retainer should be built after completing the axial contours. The occlusal morphology of a retainer should be in harmony with the adjacent/opposite teeth and should follow all the concepts of occlusion described in Chapter 27. Special instruments like P.K. Thomas carvers are used to carve the occlusal surface of the restoration.

Procedure

- The tail end of the PKT carver should be used to build cones of wax over the areas where cusps are to be formed. E.g. while carving a mandibular molar, five cones of wax are built. The cones should be placed exactly on the cusp location (Fig. 33.20).
- After building the cones, the marginal ridges and the cusp ridges are built using the same instrument (Fig. 33.21).
- Additional wax is added near the peripheral ridges and contoured in harmony with the axial surface. The parabola of the axial surface

Fig. 33.20: Cones placed in relation to each cusp

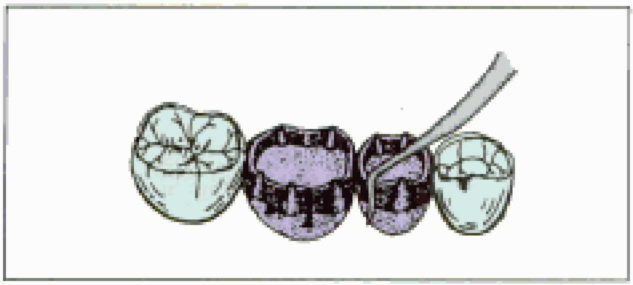

Fig. 33.21: Waxed up marginal ridges and cusp ridges

should continue upto the tip of the cusp (Fig. 33.22). All the external inclines of the cusp should be carved along with this step.

- Next, the partially waxed occlusal surface is

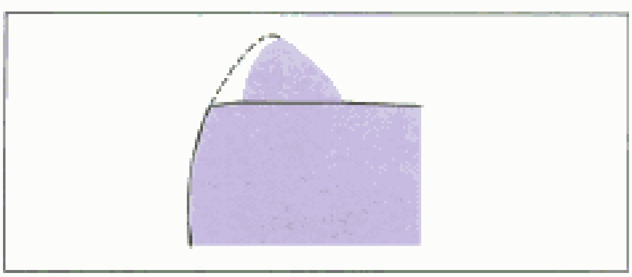

Fig. 33.22: The facial surface of the cusp should be contoured to follow the parabola of the axial surface

occluded against the opposing cast. *(In order to prevent wax from sticking onto the opposing pattern or cast, Zinc stearate powder should be applied over the wax pattern).* At this stage, the occlusal surface is said to resemble a 'fish's mouth' (Fig. 33.23).

- Next the internal inclines of the cusp are contoured (Fig. 33.24a). The ridges should be convex to obtain a single point of contact instead of an area of contact with the opposing cusp (Fig. 33.24b).

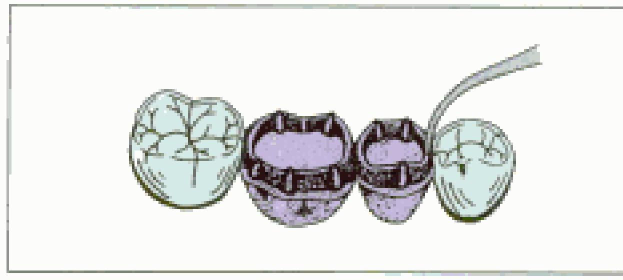

Fig. 33.23: The primitive occlusal wax build up resembles a fish mouth

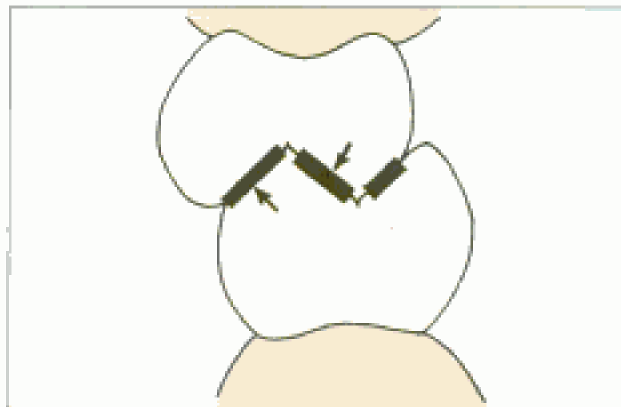

Fig. 33.24a: Straight cuspal inclines may lead to the formation of areas of contact (not preferred)

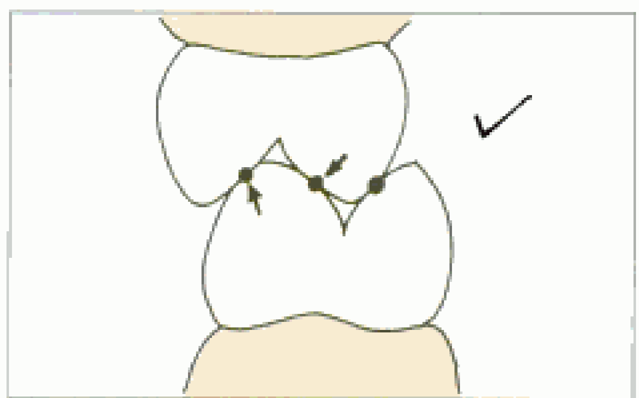

Fig. 33.24b: Convex cuspal inclines and ridges produce a point of contact (preferred)

- While carving the occlusal surface, frequent remount should be done to check for occlusion. The occlusal morphology should be modified according to the surrounding teeth in order to prevent stress concentration over the restoration. The restoration should never produce any form of interference during all mandibular movements.

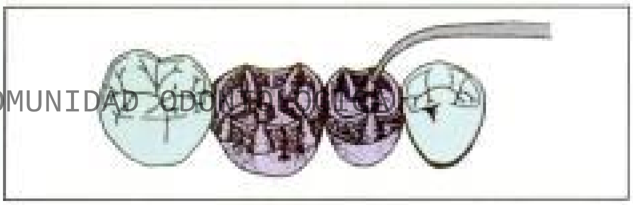

Fig. 33.24c: Illustration of a waxed up triangular ridge

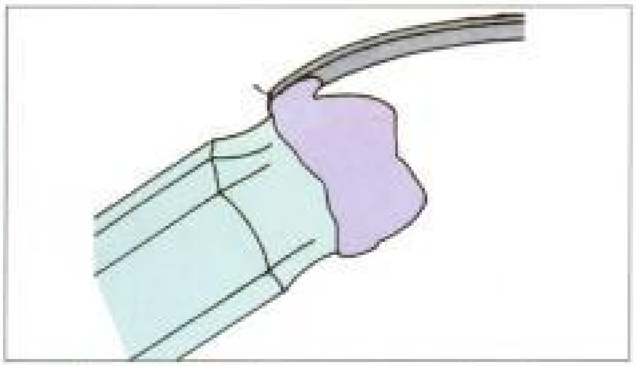

Fig. 33.25: Wax is added to the margin using a beavertail burnisher

Finishing the Margins of the Pattern

While a good margin cannot assure a good casting, a poorly finished margin will guarantee its failure.

- The wax pattern is transferred from the cast to the refractory die.
- Sharp instruments should not be used close to the die as it may damage the die leading to an improper fit. Hence, a beaver tail burnisher is preferred.
- The marginal regions of the patterns should be re-melted and additional wax should be added in this area to produce good marginal fit (Fig. 33.25).
- The margins are finished to a fine edge using the burnisher (Fig. 33.26).
- A cotton pellet soaked in die lubricant is held with a cotton plier. It is used to finish the occlusal grooves (Fig. 33.27).
- The axial surface is finished with a cotton roll. One end of the roll is dipped in die lubricant and the wet cotton is applied over the axial surface. The other end (dry end) of the roll is used to buff the wet wax until a smooth finish is obtained (Fig. 33.28).
- Remove the lubricant after finishing.

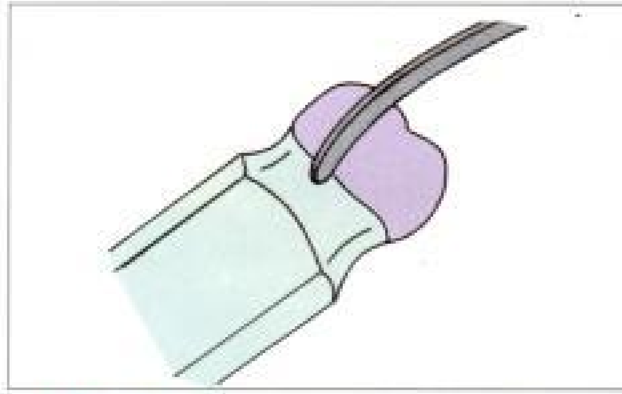

Fig. 33.26: Finally the margins are finished with a beavertail burnisher

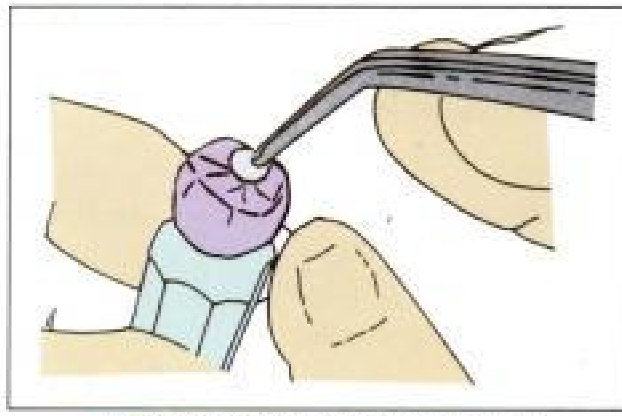

Fig. 33.27: The pattern is finished wiping with a cotton pellet

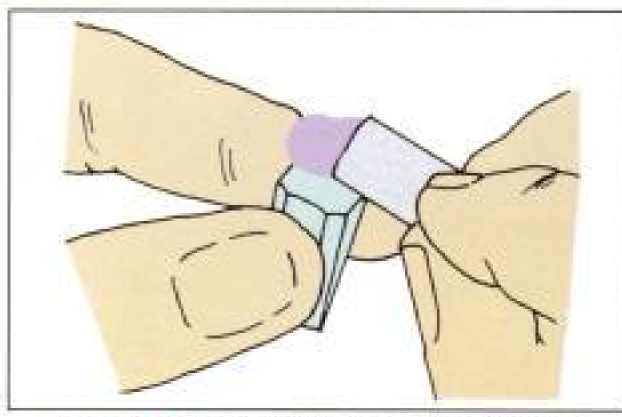

Fig. 33.28: Axial surfaces are smoothened with a cotton roll dipped in a die lubricant

Examination of Marginal Discrepancies (Fig. 33.29)

The margin should be examined for the following discrepancies.

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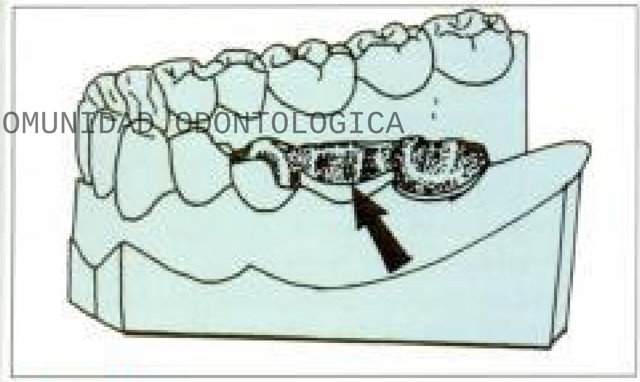

Fig. 33.31: The wax pattern is transferred from the die to the working cast and the fit is verified

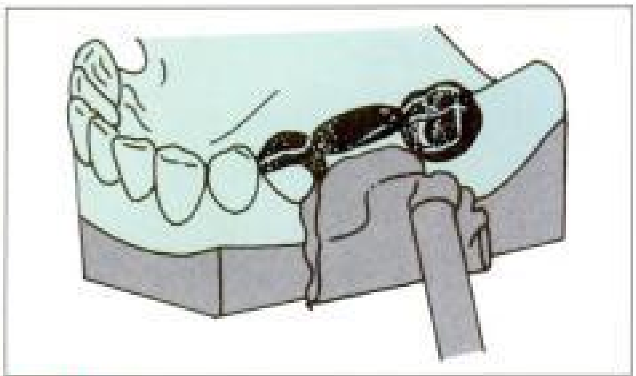

Fig. 33.32: Quick setting plaster is added to the gingival surface of the pontic. This is used as an index to prepare the pontic wax pattern

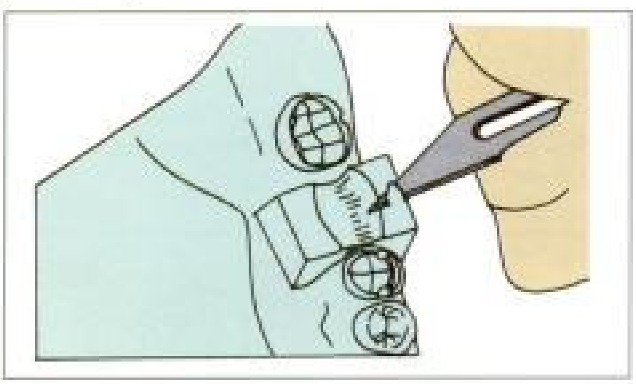

Fig. 33.33: When the plaster has set, the wax pattern is removed and the plaster matrix is trimmed so that the occlusal surface is free of plaster

are contoured according to the neighbouring teeth.

Cut Back

A cut back design is provided in the area where a ceramic facing is to be placed.

- A sharp explorer should be used to outline the area that will be veneered with porcelain (Fig 33.34).
- Deep cuts or orientation grooves should be made on the cut back area of the wax pattern.
- The wax between the orientation grooves should be reduced.

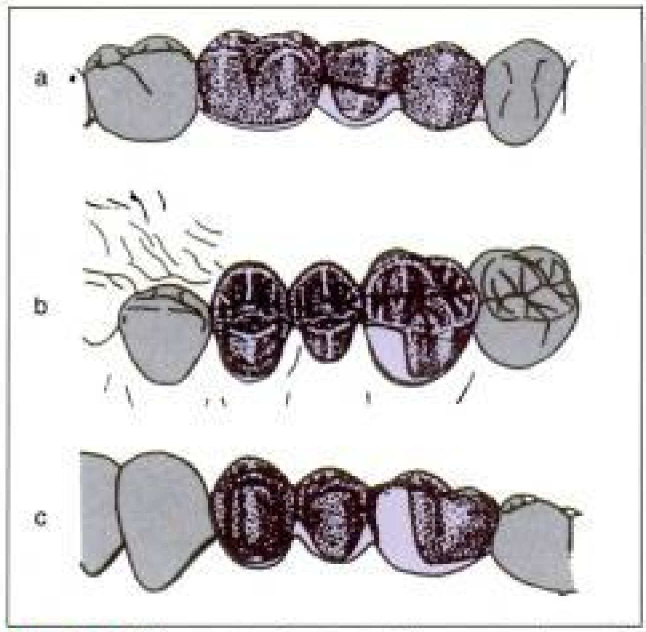

Fig. 33.34: Wax pattern for a maxillary posterior metal ceramic fixed partial denture from the facial (a), the occlusal (b), and the lignual, (c) aspects

Fabrication of Wax Patterns for All Metal Pontics

All metal pontics are fabricated as described for metal ceramic pontic except that a cut back design is not provided.

CASTING

The lost wax casting technique introduced by Taggart in 1907 is the most preferred casting technique used till date.

Steps in Casting Procedure

The various steps in a casting procedure are:

- Preparing the wax pattern for casting
- Spruing the wax pattern
- Attaching the sprue to the crucible former
- Investing the pattern in a casting ring
- Burnout of the wax pattern

- Casting
- Recovery
- Finishing and polishing

Preparing the Wax Pattern for Casting

After fabricating the wax pattern, the following procedures should be carried out prior to casting.

- The margins of the wax pattern should be readapted.
- The pattern is checked for smoothness, finish, and contour.
- The sprue should be attached to the thickest portion of the wax pattern.
- The wax patterns can be removed from the die using the sprue.
- A surfactant should be applied on the wax to obtain better wetting of the investment.
- The wax pattern is invested immediately to prevent distortion.

Spruing the Wax Pattern

The wax pattern should be sprued before investing. This sprue acts as a channel for metal flow during casting.

Sprue Formers and Sprues

A sprue is defined as, *"The channel or hole through which plastic or metal is poured or cast into a gate or reservoir and then into a mold". "The cast metal or plastic that connects a casting to the residual sprue button"* – GPT.

A sprue button is defined as, *"The material remaining in the reservoir of the mold after a dental casting"* – GPT.

A sprue former or sprue pin is defined as, *" A wax, plastic, or metal pattern used to form the channel or channels allowing molten metal to flow into a mold to make a casting"* - GPT.

Actually a sprue is the channel and a sprue former is the pattern used to make a sprue but colloquially the term sprue is used denote the sprue former hence, we have also used the same colloquial terms in the following sections.

Sprue Design

Sprue design will vary depending on the type of restoration being cast, the alloy used and the casting machine.

The three basic requirements of a sprue design are:

- The sprue must allow the molten wax to escape from the mold.
- It must enable the molten metal to flow into the mold with minimal turbulence.
- The metal within the sprue must remain molten slightly longer than the alloy that has filled the mold. This will act as a reservoir to compensate for the shrinkage that occurs during solidification of the casting.

Materials Used to Make Sprues

Wax

Wax sprues are preferred for most castings because they melt at the same rate as the pattern and allow easy escape of molten wax.

Plastic

- Solid plastic sprues soften at a higher temperature and may block the escape of wax producing more casting roughness.
- They are more rigid than wax hence they resist distortion.
- Hollow plastic sprues are available. They permit escape of wax during burnout.

Metal

- Non-rusting metal should be used to prevent wax contamination.
- Hollow metal sprues increase the contact surface (as little wax will actually flow into the hollow metal sprue and strengthens the attachment).
- They are usually removed before casting.
- Careful removal is essential to prevent small broken particles of the investment from falling back into the mold space.

Sprue Diameter

- It should be larger than the thickest portion of the pattern.

- Reservoir should be provided to prevent localised shrinkage porosity.

Recommended Sprue Diameters

- 2.5 mm (10 gauge) sprues for molar metal ceramic restorations.
- 2.0 mm (12 gauge) sprues are preferred for premolar partial veneer restoration.
- Narrow sprues are sufficient for casting to be done on centrifugal machines. Air pressure within such narrow sprues may prevent premature flow of molten metal (i.e. flow is prevented till the centrifugal spring is released).

Positioning the Sprues

- A sprue should be placed at 45° angulation near the bulk of the pattern. The axial walls should have an obtuse angle (135°) in relation to the sprue. This type of placement helps to prevent air entrapment during investing and the occurrence of suck back porosities after casting (Fig. 33.35).

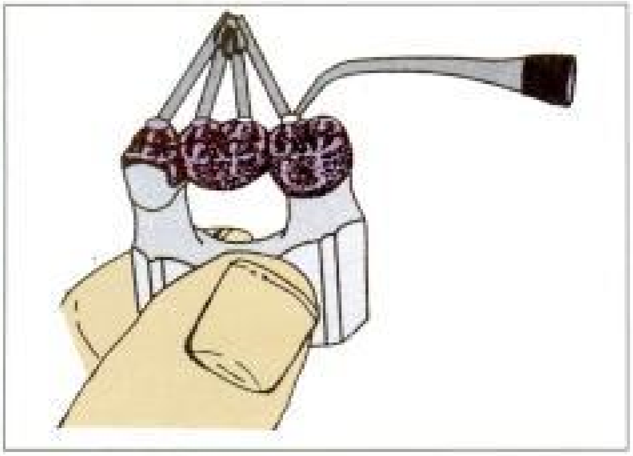

Fig. 33.35: One sprue is attached to each retainer and to each cusp of the pontic

- The point of attachment should be flared to prevent turbulence during metal flow (Fig. 33.36).
- Venting: small auxiliary sprues or vents should be placed in order to improve the casting as they form pathways for the gases to escape.

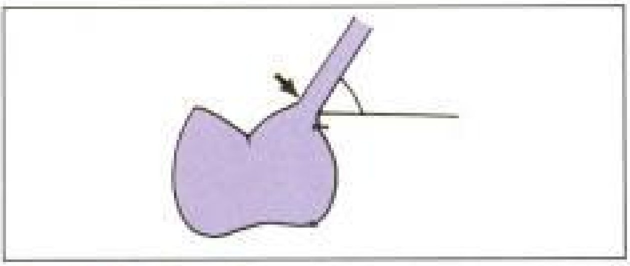

Fig. 33.36: The point of attachment of the sprue should be flared to prevent turbulence during metal flow

Attaching the Sprue to the crucible former

The sprue is attached to the crucible former made usually of rubber. The crucible former is a conical structure with a base placed at one end of the ring. A crucible former can be defined as, *"The base to which a sprue former is attached while the wax pattern is being invested in refractory investment; a convex rubber, plastic or metal base that forms a concave depression or crucible in the refractory investment"* – GPT.

The free end of the sprue should be attached to the tip of the crucible former. The crucible former is removed once the investment sets. The conical depression formed in the investment due to the crucible former, which aids in metal flow during casting is called *crucible*. The sprue should be adjusted such that the terminal end of the wax pattern is only about 6 mm away from the free end of the investment. This distance should be maintained because the air in the mould space should escape out through the pores in the investment during casting (Fig. 33.37).

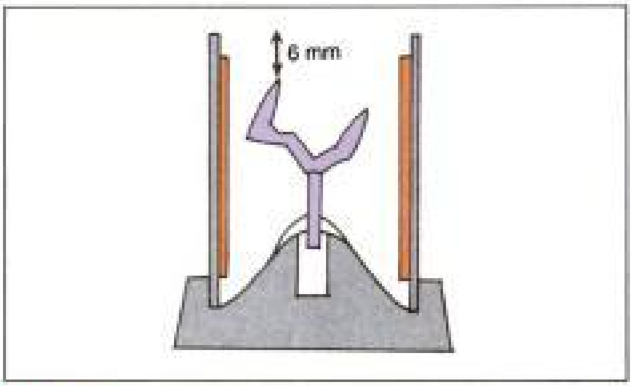

Fig. 33.37: The wax pattern should be positioned such that there is a maximum spaces of 6 mm between tip of the pattern and the free end of the casting ring

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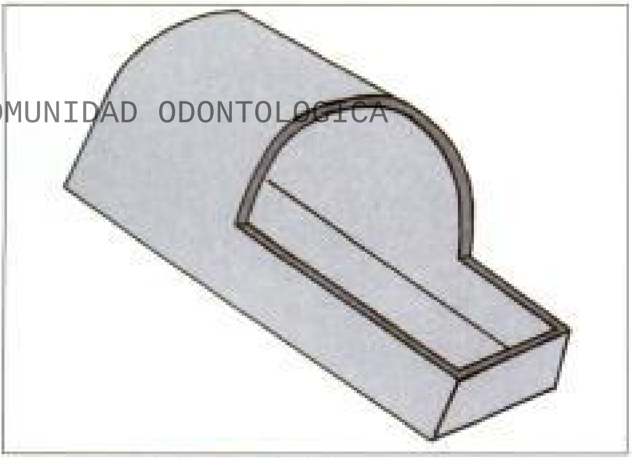

Fig. 33.39: Casting crucible

Weighing the Alloy

The following standard weighing measurements can be used to avoid excessive wastage of the alloy:

- 6 grams for premolar retainer castings
- 9 grams for molar retainer castings
- 12 grams for pontic castings.

Casting the Alloy

The alloy is placed in the crucible and heated using a open flame from a torch. The reducing part of the flame should be used in order to prevent oxidation of the alloy. A little flux should be added to metal ceramic alloys and heated further till they ball up (like mercury) and obtain a mirror like surface that appears to spin. In case of Nickel Chromium alloys, casting can be done once the sharp edges get rounded. Once the alloy is ready to be cast, the locking pin of the machine is released and casting is completed.

Recovery

Recovery of casting involves the removal of residual investment adherent to the cast surface. Gypsum-bonded investments quickly disintegrate when quenched in water. However, residual investment should be removed using a toothbrush or an ultrasonic cleanser. On the other hand, phosphate-bonded instruments do not disintegrate easily and should be removed using a blunt instrument or by sand blasting using aluminium oxide.

SOLDERING

Soldering is done to fabricate connectors in fixed partial dentures. When long patterns are cast, the occurrence of casting defects increase, hence, it is more advisable to cast multiple smaller units which can be soldered later. Soldering also aids to rectify minor casting discrepancies. It is usually done after casting the metal framework and before porcelain build-up (pre-ceramic solders). Sometimes soldering is done after porcelain firing, and these solders are called *post-ceramic solders*.

Definition

Soldering involves joining two components of metal with an intermediate metal whose melting temperature is lower than the parent metal.

Requirements of a Solder

A solder metal should have the following properties:

- It should fuse safely below the sag or creep temperature of the parent alloy.
- It should resist tarnish and corrosion
- It should be non-pitting
- It should be free flowing
- It should match the color of parent metal
- The joint should be strong.

Composition of Solders

Most commonly used solders in fixed partial dentures include gold and silver. Dental gold solders are designated by fineness to indicate the proportion pure gold contained in 1000 parts of the alloy.

Composition and flow temperature of commonly used dental solders

Fineness	*Au*	*Ag*	*Cu*	*Sn*	*Zn*	*Flow temp (°c)*
490	49	17.5	23	4.5	6	780
585	58.5	14	19	3.5	4.5	780
615	61.5	13	17.5	3.5	4.5	790
650	65.0	12	16.0	3.0	4.0	790
730	73.0	9.0	12.5	2.5	3.0	830

Soldering Flux

In Latin *flux* means *flow*. These are agents, which improve the flow of metal. Soldering flux is a chemical, which is used to improve the flow of a soldering metal. Chemicals that limit the flow of metals are called *antifluxes*.

Functions of a Flux

- *Protector:* It covers the metal surface and prevents oxide formation.
- *Reducer:* It helps to reduce the oxides present on the metal surface.
- *Solvent:* It dissolves any oxide present and removes it.

Composition of a Flux

- Borax glass $Na_2B_4O_7$ (55 parts)
- Boric acid (35 parts)
- Silica (10 parts)

Anti-flux

It is a chemical agent used to control the flow of the metal. Soldering anti-fluxes are used to control the flow of the solder metal. These materials are very essential to produce a parallel/even continuous connector. One of the most common anti-fluxes used is graphite. But pencil graphite vaporizes. Hence, better fluxes like Rouge (Iron oxide) in chloroform can be used.

Soldering Investment

These are silica-bonded investments that contain fused quartz. Fused quartz is used because it is the lowest thermally expanding form of silica.

Types of Soldering

Based on the technique, soldering can be classified into:

- Soldering for metal ceramic restoration.
- Oven soldering
- Torch soldering
- Infrared soldering
- Laser welding

Soldering for Metal Ceramic Restorations

It is usually done prior to ceramic application hence it is also known as pre-ceramic soldering. Post-ceramic soldering materials are also available. Pre-ceramic soldering is done at a temperature of 1075 to 1120°C whereas post-ceramic soldering should be done at a temperature of 920°C because ceramic may begin to sag at higher temperatures.

Post-ceramic soldering should be done after ceramic firing hence, the procedure should be more cautiously done to avoid staining of the ceramic. The ceramic portions should be finished only after soldering.

Advantages of Pre-ceramic Soldering

- The metal framework can be soldered and tried-in prior to ceramic build up.
- Minor casting errors can also be patched up during ceramic build-up.

Disadvantages of Pre-ceramic Soldering

- Difficult to build ceramic on already soldered units.

Advantages of Post-ceramic Soldering

- Porcelain can be properly built up due to better access.

Disadvantages of Post-ceramic Soldering

- The metal and porcelain may sag at high soldering temperatures.
- It is more technique sensitive.
- The solder joint should be re-glazed and re-fired.

Oven Soldering

Furnace or oven soldering is performed under vacuum or in air. A piece of solder is placed in the joint space and it is heated to a standard temperature in the furnace. The major advantage of these solders is that they produce superior joint strength.

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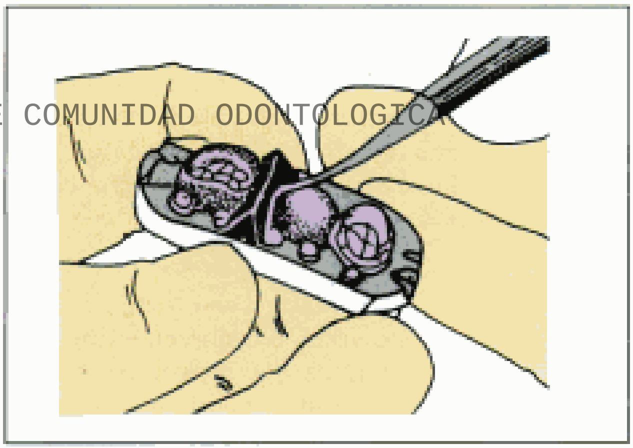

Fig. 33.43: A triangular-shaped piece of utility wax is placed in the solder joint area. This will act as a channel for the solder metal to flow

- The units are invested and the investment is allowed to bench set.
- The invested wax is eliminated using boiling water or chloroform.
- The area of the restoration surrounding the joint should be coated with anti-flux to limit the flow of the metal.
- After coating the flux and anti-flux, the assembly is preheated in a burnout furnace.
- The connectors are soldered using a torch or a furnace.

Disadvantages

- Not economical

CERAMIC/ACRYLIC VENEERING

The ceramic or acrylic veneers in metal resin or metal ceramic restorations are usually added after soldering. These veneers are added onto the cutback area provided in the cast framework.

Ceramic Veneering

Ceramic veneering is done in three steps namely preparation of the metal surface, porcelain application, and porcelain firing.

Metal Preparation

- Any minor casting defects in the cut back area should be corrected. The casting should be cleanly recovered from residual investment. Recovery includes sand-blasting and ultrasonic cleaning.
- The gingival surface of the pontic should be reduced. Care should be taken to prevent over reduction. Remember the gingival surface of the pontic should always be covered with porcelain.

Porcelain Application

- After preparing the metal, an opaque layer of porcelain should be applied over the metal surface (Fig. 33.44).

Fig. 33.44: A thin "wash layer" of opaque porcelain is applied with a brush

- Next the gingival surface of porcelain is coated with cervical porcelain (Fig. 33.45).

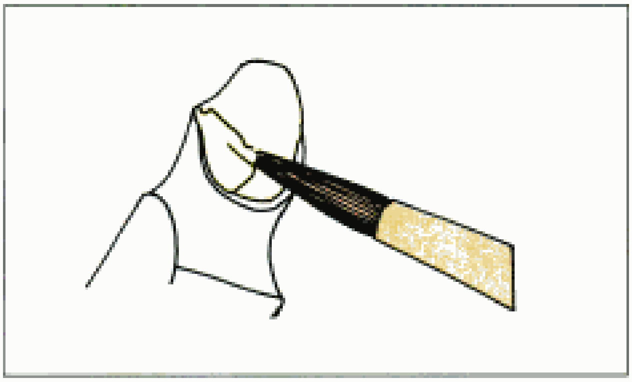

Fig. 33.45a: Coating the gingival surface with cervical porcelain

- Layers of cervical, body and incisal porcelains should be used to build up the facial surface (Fig. 33.46).
- When two or more adjacent units are built up together, the porcelain in the interdental area should be sectioned to demarcate junction of the two units.
- A separating liquid is applied over the edentulous ridge prior to building up the gingival surface of the pontic.

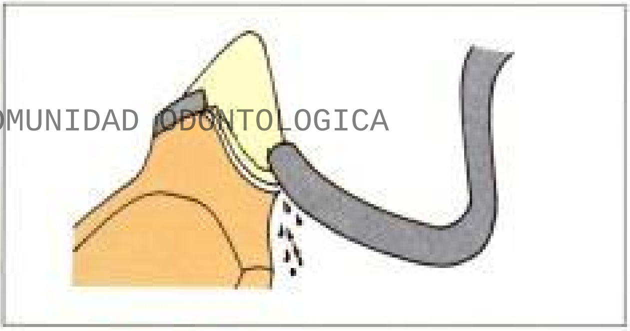

Fig. 33.45b: Excess porcelain should be separated out carefully

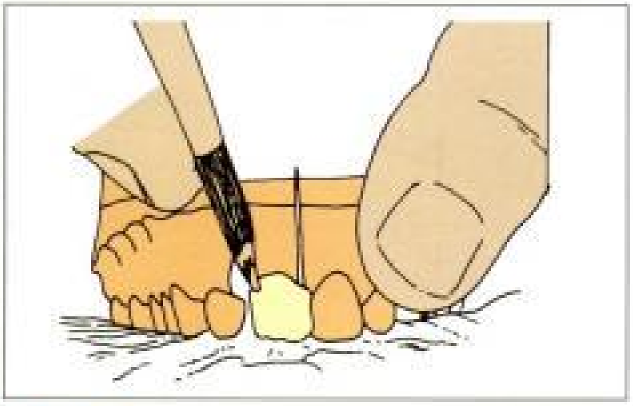

Fig. 33.46: The labial surface is built with body porcelain

- Next the porcelain is fired as per the manufacture's instructions.
- After firing the core porcelain, glaze porcelain is added and fired as usual.

Acrylic Veneers

The procedure is similar to ceramic veneering except for a few differences. One of the major differences is that only mechanical bonding exists between the metal and resin. Hence, the bond strength is considerably less.

Procedure

The steps to be followed for resin veneering are:

- Mechanical undercuts (for retention) should be made over the entire metal surface to be veneered. *Mechanical undercuts can be created by sprinkling plastic retentive pearls over the wax pattern before casting.*
- The surface of the cast metal can be roughened using Al_2O_3 air abrasive unit.
- A small quantity opaque resin is added onto the metal surface. Body shade resin is added over the opaque resin and contoured using a modelling instrument.
- The resin should be polymerised under pressure in a warm water bath. Light cure resins are also available.
- The resin core should be carved to remove excess material. Space should be provided to accommodate incisal shade resin.
- Finally incisal shade resin is added and contoured using a modelling instrument.
- After polymerization of the incisal resin, the restoration is finished and polished.

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Cementation of Fixed Partial Dentures

FINISHING AND POLISHING

After ceramic firing, the restoration should be finished and polished prior to insertion. The following procedures should be carried out during this phase.

- Surface defects can be removed using grinding stone or rubber wheel.
- Subsequently finer abrasive should be used to obtain a more effective polish.
- Only light pressure should be applied while using an abrasive.
- The polished surface will contain a microcrystalline layer known as *Beilby layer*.
- Superior polish can be obtained using heavy pressure against a wheel or brush coated with jeweller's rouge at high rotational speed.

LUTING AGENTS

In this section, we have discussed about the composition, manipulation, advantages, disadvantages and uses of commonly used luting agents in the cementation of fixed partial dentures. Before we go into the details let us read about the basic requirements for a luting agent

Ideal Requirements of Luting Agents

A luting agent should:

- Have a long working time
- Adhere well to both tooth structure and cast alloys
- Provide a good seal
- Be non-toxic to the pulp
- Have adequate strength properties
- Be compressible into thin layers
- Have low viscosity and low solubility
- Have good working and setting characteristics

Luting Agents commonly used for fixed Partial dentures include

- Zinc phosphate cements
- Zinc oxide eugenol cements
- Zinc silicophosphate cements
- Zinc polycarboxylate cements
- Glass ionomer cements
- Resin cements

Zinc Phosphate Cement

It is advocated in most clinical situations. It is preferred in cementation of permanent and long-term temporary restorations.

Advantages

- Adequate compressive strength
- Good mechanical properties
- Limited solubility.

Disadvantages

- Produces pulpal irritation due to low initial pH.
- Slow setting time.

Composition

It is available as powder and liquid systems. The powder contains heavy metal oxides (Zinc oxide, Magnesium oxide) and the liquid contains phosphoric acid and Water (28 to 38%). Traces of Aluminium phosphate are also present.

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TRY-IN

We know that the cast restoration is tried in before ceramic build-up. Similarly the finished restoration should be tried in before cementation. Try-in procedures depend on the type of the restoration. Hence, in this section we have discussed the try-in procedure for cast metal and ceramic restorations separately.

Try-in Procedures for Cast Metal Restorations

During try-in, the following features are checked in the cast restoration:

- Proximal contact
- Marginal integrity
- Stability
- Occlusion

Checking for Proximal Contacts

- The proximal contact between the crown and a natural tooth should allow the passage of floss (Fig. 34.1).
- The operator should compare the contacts of other teeth in the dentition.
- Ideally the contacts should be stable and easy to maintain.
- Subjective symptoms (patients response) are sufficient to confirm a tight contact.
- The most common problem seen in relation to a proximal contact is excessive tightness. This can be corrected by:
  - — Adjusting with a rubber wheel (all metal restoration)
  - — Adjusting with a cylindrical mounted stone (porcelain restoration)
- Deficient proximal contacts in a gold casting can be corrected by soldering.

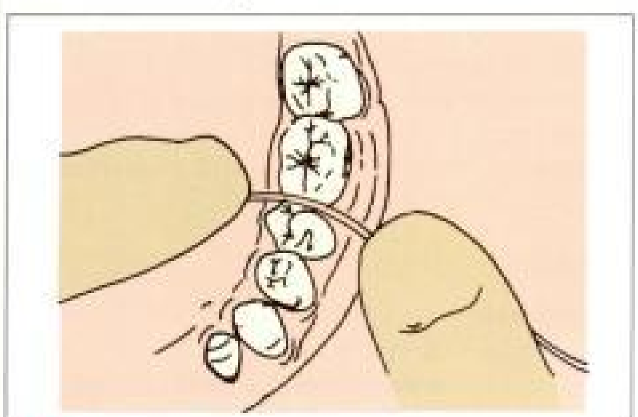

Fig. 34.1: Proximal contacts are tested with dental floss

Checking for Marginal Integrity

- Margin adaptation with a gap around 30 μm is clinically acceptable.
- Testing whether the casting binds to the tooth surface, is helpful to determine the marginal integrity. This can be done using the following materials:
  - — Disclosing waxes
  - — Suspension of rouge in chloroform or ether (Pressure indicating paste)
  - — Air abrasion to form a matte finish
  - — Powdered sprays
  - — Water soluble marking agents
  - — Elastomeric detection paste (by far the most reliable)
- Marginal integrity can be assessed by moving a sharp explorer from the restoration to the tooth and from the tooth to the restoration.

Checking for Stability

- The restoration should not rock or rotate when a force is applied.
- Instability produced by a small positive nodule on the fitting surface can be corrected by trimming.
- If the instability is due to a distorted wax pattern, the casting procedure should be repeated.

Checking for Occlusion

Occlusal discrepancies are one of the most common errors that occur during the fabrication of a fixed partial denture. Hence, occlusal adjustment during eccentric movements (clinical correction) is necessary.

Occlusal discrepancies can be corrected by the following techniques:

- *Technique 1:* Colored ribbons, placed inter-occlusally are used to determine the occlusal contacts (red ribbon is used to record centric contacts and green ribbon is used to record eccentric contacts) (Fig. 34.2).

Fig. 34.2: Coloured ribbons can be used to record centric and eccentric contacts

- *Technique 2:* A matte finish is given on the occlusal surface of the metal restoration and the patient is asked to occlude in centric and eccentric relations (areas of contact appear shiny). But this technique has the following disadvantages:
  — It is not possible to differentiate between centric and eccentric contacts.
  — Time consuming
  — Can be used only for cast metal restorations.

Correcting Occlusal Discrepancies

Occlusal discrepancies can be checked either in the clinic or in the lab. Laboratory analysis requires a remount procedure (a new inter-occlusal record is made and the casts are articulated in a semi-adjustable articulator—described in Chapter 27). The premature contacts are corrected in the lab using a rubber wheel. After refining the occlusion, it is rechecked in the mouth.

Try-in Procedure for Ceramic Restoration

During the try-in of a porcelain restoration, the following factors should be examined.

Checking for Proximal Contact and Marginal Fit in Ceramic Restoration

- They are examined as explained in cast metal restorations.
- When metal ceramic restorations are to be reduced, the metal and ceramic surfaces should be ground simultaneously in order to prevent ceramic from being stained by the metal particles.
- Grinding at the metal ceramic junction should be done in a direction parallel to the junction.

Checking for Occlusal Discrepancies in Ceramic Restorations

Occlusal discrepancies can be checked using technique 1 explained in cast metal restoration. They should be corrected only after glazing because unglazed ceramic shows increased pyroplastic flow (flow at high temperatures). The reduced area should be reglazed.

Evaluation of Aesthetics in Ceramic Restorations

This is unique to ceramic restorations, as metals are not used to replace missing anterior teeth. The contour of the gingival embrasure space and the placement of the incisal edge are important factors to be considered during anterior try-in.

Checking for Embrasure Contour

Proper contour of the gingival embrasures is essential to minimize the dark spaces formed between the prosthetic components. This is more important in anterior teeth as these dark spaces produce a very unaesthetic appearance. These spaces should be evaluated clinically and should be corrected by adding porcelain and recontouring the restoration.

Checking for the location of the incisal edge:

It can be checked by asking the patient to pronounce the letter 'F' so that the incisal edge touches the vermillion border.

Aesthetic Characterizations

Some mild discrepancies can be incorporated into the restoration to produce a natural appearance. A staining kit can be used to replicate the following characterizations on the restorative surface.

- Enamel cracks
- Stained crack lines

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2.	Mechanical breakdown		
a.	Flexion, fracture of metal	– Inadequate thickness – Improper casting technique – Improper occlusion	– Remake bridge
b.	Solder joint failure	– Insufficient width and depth of the joint – Insufficient bulk of joint metal – Improper soldering technique	– Remake bridge
c.	Pontic failure	– Inadequate strength – Faulty occlusion in lateral excursions	– Remake bridge
d.	Failure of bonded porcelain	– Faulty design – Incorrect occlusal preparation on the teeth – Inadequate strength at inter-proximal metal	– Correct tooth preparation and remake
3.	Gingival irritation Gingival recession	– Plaque retention – Improper design – Faulty retainer margin – Incorrect occlusal anatomy – Over contoured retainer – Inadequate embrasure	– Give correct instructions on home care – Remake bridge
4.	Periodontal breakdown – General – Local	– Poor bridge design – Incorrect assessment of abutment strength – Insufficient abutment selected – Traumatic occlusion	– Remake – Remake
5.	Caries – Directly on the margins – Indirectly starting elsewhere in mouth – following cementation failure	–	– Conventional filling materials
6.	Pulpal necrosis	– Improper tooth preparation technique – Increased occlusal load due to improper occlusion	– Remove and recement/remake For anterior: Apicectomy and retrograde filling For posterior: Endodontic therapy

Removing a Failed Fixed Partial Denture

If a permanent prosthesis fails, it can be removed by the following methods:

1. Using a crown remover (Back action or spring activated).
2. Using a straight chisel.
3. Using a brass ligature wire
4. Using a screw thread
5. Using a Richwil crown remover
6. Using a haemostat
7. Using an ultrasonic scaler tip
8. By cutting the retainer with a bur.

Section Four

Maxillofacial Prosthetics (MFP)

- Introduction to Maxillofacial Prosthodontics
- Types of Maxillofacial Defects
- Types of Maxillofacial Prosthesis
- Materials Used in Maxillofacial Prosthetics

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- Complete dentures
- Implants

- Acquired
  - Complete dentures
  - Partial dentures
  - Flange prosthesis
  - Mandibular exercisers
  - Implants
- Extraoral
  - Auricular prosthesis
  - Ocular prosthesis
  - Orbital prosthesis
  - Nasal prosthesis
  - Composite prosthesis
  - Lip and cheek prosthesis

Treatment supplements:

- Radiotherapy supplements
  - Stents
  - Splints
  - Shields
  - Carriers
  - Positioners
  - Radiation appliances
- Surgical supplements
  - Prosthetic dressings
  - Surgical splints
  - Surgical obturators
- Chemotherapeutic supplements.

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Types of Maxillofacial Defects

MAXILLARY DEFECTS

In the following section we shall discuss about the types of maxillary defects, prosthetic implications of their surgical management and the restoration of these defects with modified partial or complete dentures.

Patients with maxillary defects will have difficulties in mastication, speech and deglutition. The aim of a maxillofacial prosthesis should be to restore the normal physiological function in these patients. The fabrication of various prosthesis used in the management of these defects are described in the next chapter.

Types of Maxillary Defects

Maxillary defects can be broadly classified as follows:

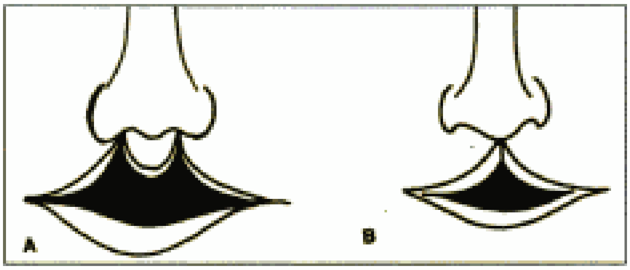
- Congenital
  - Cleft lip
  - Cleft palate
- Acquired
  - Total maxillectomy
  - Partial maxillectomy

In the following section, we shall discuss about the clinical considerations of common maxillary defects in detail.

Congenital Maxillary Defects

The most common congenital maxillary defects include cleft lip and cleft palate. Other defects like sub-mucous cleft palate, Pierre Robin syndrome, hemifacial microsomia are treated using the same basic principles followed in the management of cleft lip/palate cases.

Cleft lip and cleft palate Cleft lip occurs due to improper fusion between the fronto-nasal and maxillary process. If this occurs on one side it leads to a unilateral cleft. If it occurs on both sides, it leads to a bilateral cleft. In Mohr's syndrome, a median (midline) cleft lip is seen (Fig. 36.1).



Figs 36.1a and b: (a) Bilateral cleft lip (b) Single median cleft lip

Aetiology includes infections, drugs (phenytoin, ethanol and barbiturates), poor diet, and hormonal imbalance in the first trimester and genetic factors (13 trisomy Ptau's syndrome).

Cleft lip with or without cleft plate occurs in a ratio of 1:1000. It is twice as common in males when compared to females. It can either be unilateral or bilateral. Unilateral cleft lip is more common on the left side.

Classification of Clefts

Classification based on the extent of the defect: Clefts can be classified into three types under this category.

- Class I : Cleft lip with cleft alveolus (primary palate) (Fig. 36.2).
- Class II : Cleft of hard and soft palate (secondary palate) (Fig. 36.3).
- Class III: Combination of I and II (Fig. 36.4).

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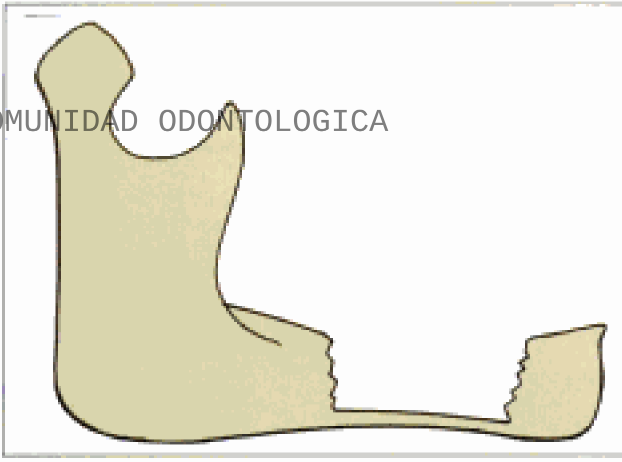

Fig. 36.17a: Class I marginal resection

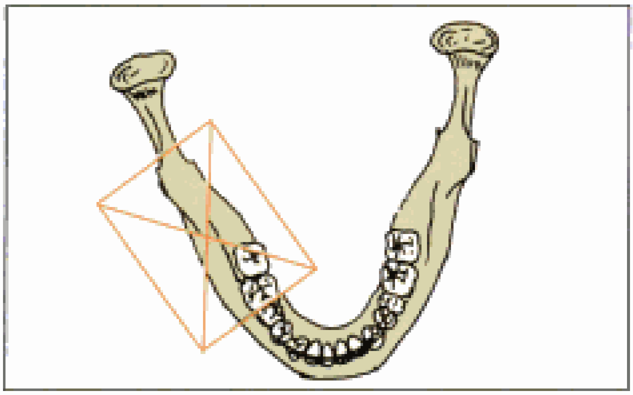

Fig. 36.17b: Class II

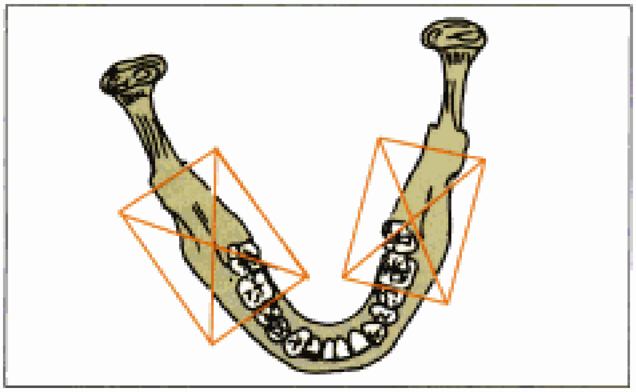

Fig. 36.17c: Class II modification a

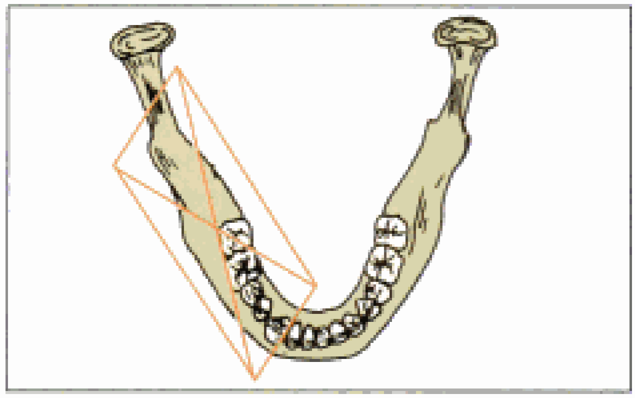

Fig. 36.17d: Class II modification b

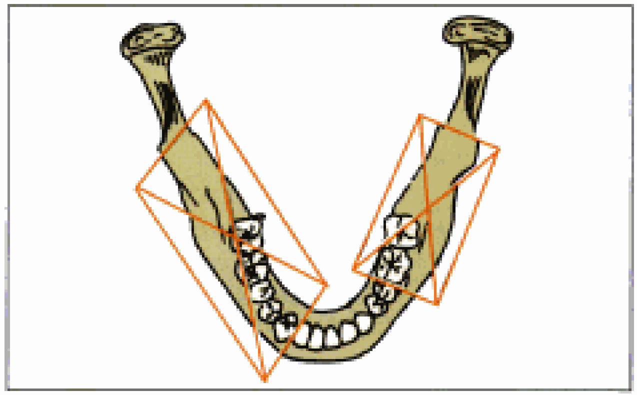

Fig. 36.17e: Class II modification c

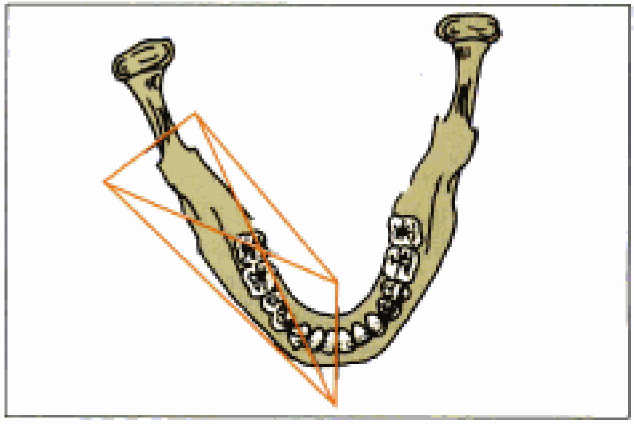

Fig. 36.17f: Class III

on the other (Fig. 36.17e).

Class III: Segmental free end resection upto or crosses the midline (Fig. 36.17f).

Class IV: Class III + resection of the temporo-mandibular joint (Fig. 36.17g).

Class V: Anterior bounded resection (Fig. 36.17h).

VELO-PHARYNGEAL DEFECTS

They are basically defects of the palate, which affects the closure of the naso-pharyngeal and

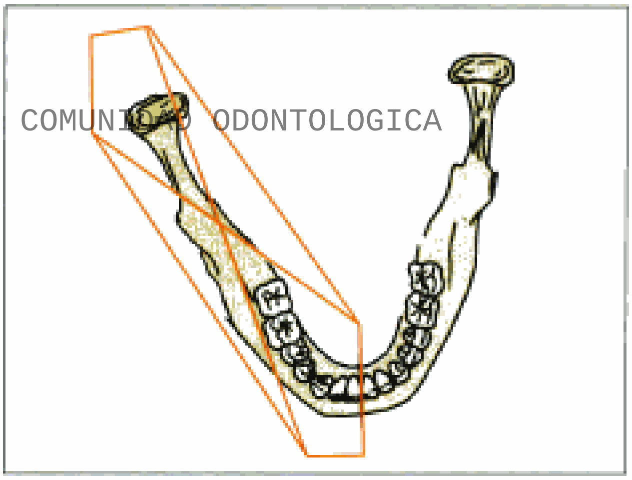

Fig. 36.17g: Class IV

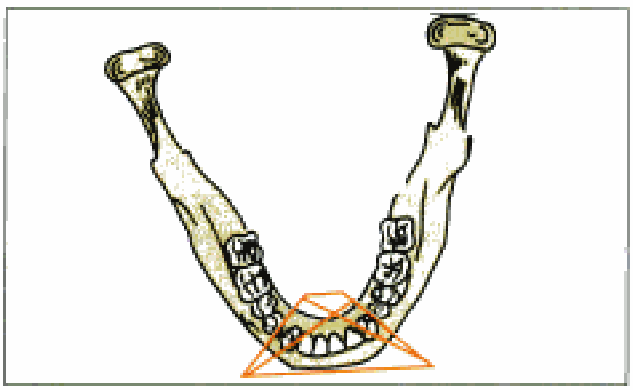

Fig. 36.17h: Class V

oro-pharyngeal isthmus. This lack of closure will affect speech. Since speech is a learned function, it tends to be easily disturbed by ablative surgery or congenital malformations.

Causes for Velo-pharyngeal Defects

These defects may result from

- Congenital malformations (cleft palate)
- Developmental aberrations (short hard or soft palate)
- Acquired neurological defects
- Surgical resection of neoplasms leading to hyper-nasality and decrease in intelligibility of speech.

Types of Velo-pharyngeal Defects

They can be classified into congenital and acquired defects.

Congenital Velo-pharyngeal Defects

They are classified based on the physiological and/or structural integrity of the tissues.

Physiological velo-pharyngeal defects (palatal incompetence) The velo-pharyngeal structures are normal but the mechanism of closure is absent. Examples include patients with neurological diseases like myasthenia gravis, cerebrovascular accidents like closed head injuries (Fig. 36.18).

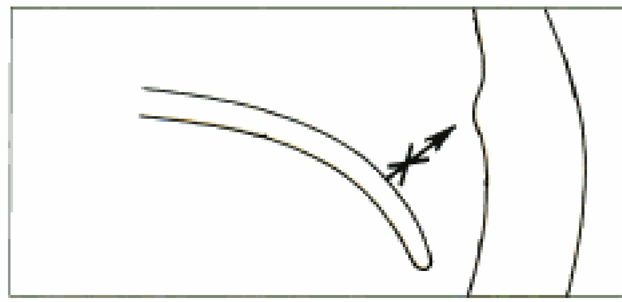

Fig. 36.18: Physiological velo-pharyngeal defect

Velo-pharyngeal defects due to poor structural integrity (palatal insufficiency) The movements of the velo-pharyngeal structures are normal but the length of the soft palate is inadequate to ensure complete velo-pharyngeal closure. Examples are cleft palate and soft palate defects (Fig. 36.19).

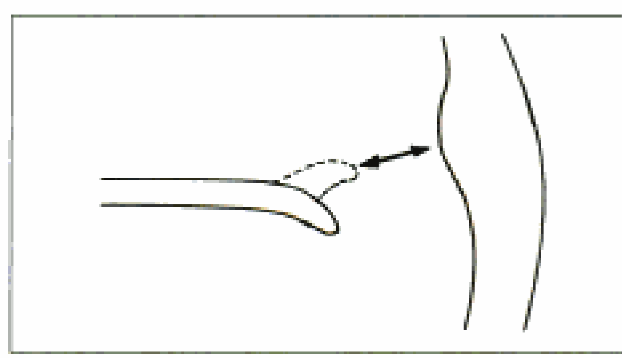

Fig. 36.19: Anatomical velo-pharyngeal defect

Acquired Velo-pharyngeal Defects

They are broadly classified into defects due to surgical resection of neoplasms and defects due to trauma and neurological deficiencies.

Treatment of Velo-pharyngeal Defects

- Congenital velo-pharyngeal defects due to palatal insufficiency can be restored by surgical reconstruction followed with the insertion of an obturator to correct the residual palatal insufficiencies.

- Congenital velo-pharyngeal defects due to poor structural integrity can be treated with palatal surgery.
- Acquired velo-pharyngeal defects due to surgical resection can be treated by surgical reconstruction and prosthodontic rehabilitation (E.g. obturator).
- Acquired velo-pharyngeal defects due to trauma and neurological deficiencies can be treated by prosthodontic rehabilitation using a palatal lift prosthesis.

EXTRAORAL DEFECTS

Extraoral defects occur due to trauma, neoplasm or congenital malformation. Extraoral defects that occur due to trauma are dealt separately under traumatic defects.

The common neoplasia of the head and neck include:

- Epithelial tumours: epithelial facial tumours may have a melanocytic, keratinocytic or adrenal origin.
- Connective tissue tumours: adenomas, fibromas, leiomyomas and lymphomas.

After surgical resection, the patients are referred for prosthodontic rehabilitation. The types of prosthesis required vary according to the size, extent and location of the tumours.

Extraoral congenital malformations that require maxillofacial prostheses include:

- Auricular defects:
  - — *Microtia* (small ear) associated with atresia of the external auditory meatus.
  - — *Anotia* (complete absence of the auricle).
  - — Smaller ear defects.
- *Nasal defects:* The defects arising due to surgery are known as Rhinotomy defects.
- *Ocular defects:* It involves the defects in the eyeball with intact eyelids (lacrymal apparatus. An orbital defect involves both the eyeball and the eyelids. Most of the ocular defects are acquired (by surgical procedures like evisceration–removal of the eyeball preserving the sclera, enucleation and excentration).
- *Lip and cheek defects* like double lip, hemifacial microsomia etc.
- *Combination* of the above mentioned defects.

Aesthetics is the major principle behind the placement of these prosthetic appliances. Hence, most of these prostheses are non-functional. Commonly used extraoral maxillofacial prostheses are described in the next chapter.

TRAUMATIC DEFECTS

Common causes of trauma include physical trauma and trauma due to heat and electrical agents. Trauma can be classified under International classification of diseases as intentional and unintentional. Suicide, an intentional injury is the second most common cause for death. The common causes for unintentional injuries are listed below according to their order of incidence:

- Moving vehicle accidents or Road traffic accidents
- Falls
- Fires and burns
- Drowning
- Poisoning
- Aspiration of objects
- Fire arms
- Air plane crashes
- Water transport
- Electric current

Traumatic defects differ from neoplastic defects in the following ways:

- They do not occur in predictable locations
- The patient usually does not have any associated systemic problems (the patients with neoplastic defects are often accompanied with systemic complications). Hence, these patients respond favourably to reconstruction than neoplastic defects.
- Patients with traumatic defects are more critical about their aesthetics than those with neoplastic defects.

Types of Maxillofacial Injuries

Maxillofacial trauma can be grossly grouped as follows:

- Fracture of the hard tissues include cranial fractures, orbital fractures, nasal fractures, jaw fractures.
- Soft tissue injuries involving the temporomandibular joint and other soft tissues adjacent to the trauma site.

As mentioned before, the extent of damage and rehabilitation required for a trauma case is unpredictable. A comprehensive knowledge about maxillofacial trauma and its management is essential for a prosthodontist to restore these defects.

The significance of these injuries becomes prominent especially when they occur for partially or completely edentulous patients. In these patients, the prosthetic appliance may have to be used as splints to approximate the fractured segments.

Treatment Goals for a Trauma Patient

There are six main treatment goals for rehabilitation of a trauma patient.

1. *Oral intake:* It is the primary goal of rehabilitation. It is important for the patient to masticate a normal diet apart from fluid intake.
2. *Closure of palate:* It should be achieved by surgery or by an interim prosthesis.
3. *Sensation and mobility of the tongue*: It is essential for functioning of the tongue during mastication and speech. Scar bands which limit the movement of the tongue should be removed
4. *Circumoral competence:* The lip should be mobile and competent in order to control the saliva and the bolus. This is also essential for obtaining access during maintenance.
5. *Maxillary and mandibular realignment:* Skeletal and dental realignment is essential to obtain proper occlusion (masticatory function).
6. *Appearance:* Last but not the least, appearance is the ultimate goal of rehabilitation.

Traumatic patients are usually managed in four phases. The first phase is the initial stabilization of the patient, which lasts for 2 weeks. At this stage, the physician determines the prognosis and the treatment plan.

The next phase is the *early management phase*, which extends for 2 to 8 weeks. Treatments like inter-maxillary fixation, splinting, root canal treatment etc are done here.

The third phase is the *phase of intermediate management* that extends for 3 to 8 months. In this phase a treatment prosthesis is provided and other defects are rectified to bring the tissues to normal contour.

The fourth phase is the *phase of definitive management*, which extends from 6 months to three years. A permanent prosthesis like complete denture, fixed partial denture, implant, etc. is fabricated in this phase.

Chapter 37
Types of Maxillofacial Prosthesis

- Complete Dentures in Maxillofacial Prosthetics
- Removable Partial Dentures in Maxillofacial Prosthetics
- Fixed Partial Dentures in Maxillofacial Prosthetics
- Implants
- Obturators and Velo-pharyngeal Prosthesis
- Extra-oral Prosthesis
- Treatment Prosthesis

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- The tooth adjacent to the labial scar usually (lateral incisor) should be set above the occlusal plane with a slight lingual rotation. This helps to make the scar less conspicuous (Fig. 37.2).

Fig. 37.2: The lateral incisor near the cleft scar should be lingually rotated and arranged above the occlusal plane for aesthetic reasons

- The labial flange of the denture should be reduced for aesthetic reasons.
- After processing the denture, small acrylic projections and irregularities should be trimmed away prior to insertion.
- Over extension in the labial vestibule should be corrected only after trying the prosthesis using disclosing wax.
- An obturator bulb may be necessary to seal a posterior palatal cleft. The bulb can be fabricated over the denture few weeks after denture insertion.
- In case of single compete dentures, extensive occlusal discrepancies can be over come using modified Meyer's technique. A bilateral posterior cross bite is common for these patients.
- Over dentures can be prepared over healthy remaining teeth or implants or a combination of both. Maxillary partial dentures with crowns on posterior teeth can also be prepared.

Complete dentures for total maxillectomy defects

- In these patients, a huge defect will be present in the upper jaw. One half of the residual ridge will be missing.
- Retention will be very poor because of air leakage, poor support and stability, reduced tissue bearing surface area and lack of a proper peripheral seal.
- The contour of the defect and the remaining portion of the hard palate should be used/engaged to maximise the retention of the prosthesis.
- Similarly the height and contour of the remaining residual alveolar ridge will determine the stability of the denture.
- The portion of the complete denture that extends into the defect is denoted as the *obturator* of the denture (Fig. 37.3). This obturator may show rotation within the defect based on three factors:

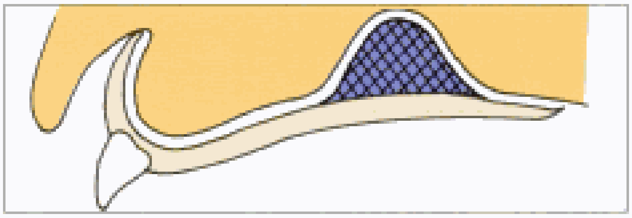

Fig. 37.3: Complete denture with obturator extending into the defect

  — The amount and contour of the remaining hard palate
  — The size, contour and the lining mucosa of the defect
  — Availability of undercuts and support areas within and peripheral to the area of defect.
- The denture may also rotate around the medial wall of the defect as the prosthesis moves during mastication.
- Patients with square or ovoid arch have better retention and stability than those with tapered arches. This is due to the increase in surface area.
- The junction between the skin graft lining placed on the defect and the oral mucosa will form a *scar band* (Fig. 37.4). This scar band is flexible enough to allow the insertion of the prosthesis and taut enough to prevent sudden

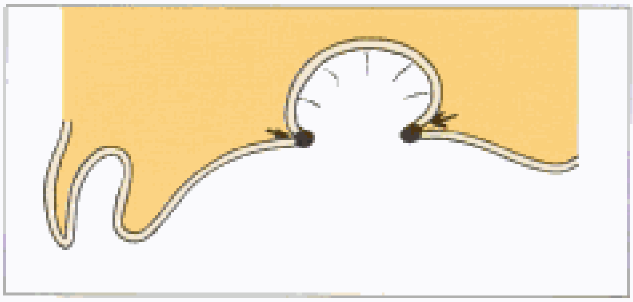

Fig. 37.4: Retentive scar band formed near the defect

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- Reduced salivary output and presence of thick mucinous saliva will impair retention.
- Abnormal pathway of mandibular closure will induce lateral dislodging forces on the denture. Mandibular deviation with abnormal profile and jaw relation will affect the normal arrangement of artificial teeth.

- The factors that determine the prognosis of these dentures are:
  — The extent of bone and soft tissue resection (smaller resection has better prognosis).
  — The involvement of tongue, floor of the mouth and buccal mucosa during resection.
  — The motor and sensory control of the tongue.
  — The mobility and bulk of the tongue.
  — Position of the tongue (if the base of the tongue was resected it will have a retruded position).
  — Mandibular deviation
  — The nature of mandibular movements
  — Postsurgical lip closure and control (usually the lower lip on the resected side will be retracted posteriorly leading to lip and cheek biting).
  — Post-radiation effects
- While border moulding, the non-resected side should be traced to its full depth.
- The lingual flange of the resected and non-resected side should be recorded accurately to improve both the placement and retention of the denture.
- The support of the prosthesis can be obtained from the buccal shelf, crest of the ridge, retromolar pad and the soft tissue pad posterior to the bony resection.
- The lip and cheek on the resected side will be heavily scarred and can dislodge the prosthesis. The denture flange should be designed such that it repositions the lower lip on the resected side. This labial flange is referred to as the *Lip plumper* (Fig. 37.6).
- While recording the jaw relation, the labial fullness of the maxillary occlusal rim should be reduced in order to make the jaw discrepancy less conspicuous.

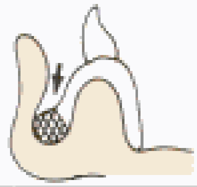

Fig. 37.6: Mandibular denture with lip plumper

- The vertical dimension of occlusion should be reduced for patients with limited tongue movement in order to facilitate speech.
- The posterior teeth on the non-resected side should be positioned more buccally in order to transmit more forces along the supporting areas.
- The posterior teeth on the resected side should be placed lingual to the crest so that the occlusion is improved. The scars in the buccal mucosa may be unyielding and displace the denture. This is prevented by the lingual placement of the teeth.
- *Occlusal ramps* should be developed on the opposing maxillary denture according to the severity in the occlusal discrepancy. The occlusal ramp should be placed buccally in the resected side and palataly on the non-resected side.
- The mandibular teeth should be able to contact the ramp without any guidance. Tracing wax is added over the ramps and the mandibular movements should be carried out to check for positive contact.
- Other steps in the fabrication of the prosthesis are carried out as usual.
- The patient should be instructed to avoid using the denture for mastication for atleast a week after insertion.
- The ramps should be adjusted during recall visits to improve occlusion.
- Lip plumpers may be added with auto-polymerising resin in order to reduce lip biting.

REMOVABLE PARTIAL DENTURES IN MAXILLOFACIAL PROSTHETICS

In this section, we shall read about the modifications required for removable partial dentures to restore various maxillary and mandibular defects.

Removable Partial Dentures for a Cleft Lip and Cleft Palate Patient

- Fabrication is similar to that for a normal patient.
- Removable partial dentures with a palatal lift prosthesis with/without an obturator should be provided for patients with cleft lip associated with soft palate defect (velopharyngeal deficiency).
- Tortuous fistula like openings may be present in patients where a bone graft was not provided to fill the cleft. In order to prevent the impression material from entangling into these defects, gauze dipped in petroleum jelly should be placed over the site during impression making.
- There will be severe scarring in the healed soft tissue. These tissue scars will appear as tortuous folds of firm mucosa. In such cases, the removable partial denture should be designed such that its margins follow the scars and do not cross the scars.
- The thickness of the beading along the margins of the major connector should be reduced for these patients.

Removable Partial Dentures for Total Maxillectomy Defects

- The prognosis is dependent on the number of remaining teeth. The remaining natural teeth enhance the comfort, aesthetics and the functioning of the prosthesis.
- The size of the defect influences the stability of the prosthesis. Bigger defects provide minimal support and the prosthesis will be heavy and bulky. The prosthesis will have maximal rotation on the defective side and the gravitational forces (downward pull) may aggravate the problem.
- The displacement of the prosthesis is dependent on the quality of the edentulous ridge and the palate. The prosthesis should be designed to distribute masticatory forces to the edentulous ridge and the remaining teeth in a balanced manner. The mucosal and bony support will be compromised due to surgical resection.
- The edentulous area (defect) may extend from the midline anteriorly to the soft palate posteriorly. Hence, these patients will require a Kennedy's class II partial denture with a long lever arm.
- Square or ovoid arch forms have a better prognosis than tapered arch forms. Tapered arch forms have reduced surface area. This can lead to rotation and movement of the prosthesis into the defect during mastication.
- Preservation of remaining teeth is a primary concern of treatment. The prosthesis should be designed such that the abutment teeth are protected from excessive forces. The occlusion on the defective side will determine the occlusal forces acting on the abutment teeth.
- The location of the defect influences the outcome of the treatment. Maximum retention, stability and support can be obtained by utilising the defect. The defect must be engaged by the prosthesis to avoid the lateral torquing forces on the abutment teeth.
- The basic principles of partial denture design should be followed.
- The diagnostic casts should be surveyed to determine the favourable undercuts, location and contour of the guiding planes and the path of insertion.
- A compound path of insertion may be needed to utilise the favourable undercuts in the defect. For example, if the posterior and lateral defects are engaged, the prosthesis should be first inserted into the defect and then rotated into position.
- Multiple rests can be used to improve the stability. The rest seats should be rounded and polished such that the rest of the prosthesis can rotate without torquing the abutment teeth.
- Complete or Full veneer crowns may be given to establish ideal contours for retention, guiding planes and occlusal rests.
- When anterior abutment teeth are labially placed and with high survey lines, swing-lock type of dentures can be used. The vestibule should have adequate depth for the placement of the labial gate. The length of the gate should be minimal to reduce the stress on the teeth.

- The tooth adjacent to the anterior margin of the defect should have a rest and a retainer to avoid the rotation of the prosthesis.

- The abutment teeth are subjected to greater vertical and lateral forces as the defect will usually provide minimal support and the long lever arms will amplify the forces acting on them. Hence, the rest seats should be well prepared to avoid displacement of the prosthesis.
- Compromised abutment teeth may be treated endodontically and the crown can be amputated. The remaining root can be used as an overdenture abutment.
- The fulcrum line of the prosthesis is influenced by the following factors:
  - Position of the occlusal and cingulum rests.
  - Size and configuration of the defect.
  - Location and magnitude of the masticatory forces on part of the prosthesis that restores the defect.
- The prosthesis for these patients can have multiple fulcrum lines. The amount of rotation around these fulcrum lines is influenced by the configuration of the arch and the size of the defect. Preservation of natural teeth in the premaxillary segment shifts the fulcrum line in a posterior direction and increases the efficiency of the indirect retainers.
- The patients may exhibit varying degrees of trismus. If the depth of the palate and the height of the artificial teeth or components of the partial denture is greater than the maximum opening distance between the incisor teeth, the prosthesis cannot be inserted or removed.
- Multiple, well prepared and spaced rest seats on the posterior teeth will enhance the support.
- Use of multiple circumferential retainers, minor connectors and long, wide guiding planes can improve the stability.
- Sometimes lingual retentive clasps with buccal reciprocating arms can be used. The lingual retentive arms disengage from the abutment teeth during the superior movement of the prosthesis. But this design exhibits greater motion and reduced retention than the conventional design.
- Buccal and lingual retentive arms can be used to enhance retention for patients with tapering arch forms.
- The patient usually tends to bite on the anterior teeth. The masticatory forces on the artificial anterior teeth can displace the denture. Hence, the patient should be instructed to masticate primarily on the non-defective side.
- The medial palatal undercut in the defect should be blocked out with gauze lubricated with petrolatum. The bony undercuts in this region can distort the palatal impression.
- The lateral portion of the defect should be recorded, as these contours should be involved in the special tray fabrication.
- The framework fabrication is similar to the conventional method. The framework is used as a special tray for the master impression.
- The finish lines of the cast metal framework should be on the palatal mucosa and 2 mm short of the palatal shelf (Fig. 37.7).

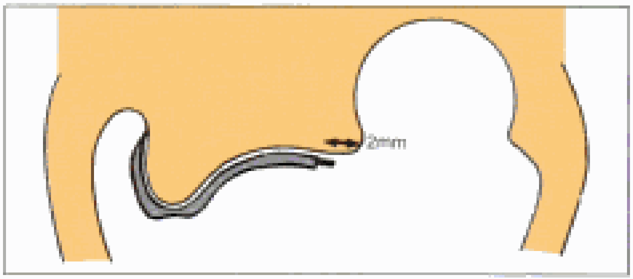

Fig. 37.7: The finish line of the partial denture framework should be placed 2 mm away from the defect

- The retention loops of the obturator should extend across the palate and should be 2 mm superior to the palatal contour (Fig. 37.8).
- The framework is physiologically adjusted using a disclosing medium.
- The obturator part of the prosthesis is fabricated in acrylic resin so that it can be adjusted and relined. Auto-polymerising resin is moulded onto the framework and the defect and verified for extensions and tissue adaptation. The framework with the moulded

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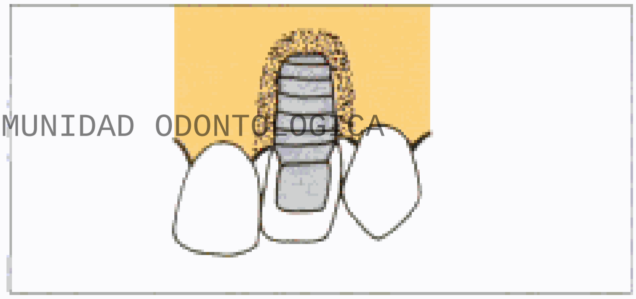

Fig. 37.10: Implant supported single tooth replacement anchored on a bone graft

Usually these patients have hyperplastic gingiva but decreased attached gingiva. Hence, periodontal consideration should be given more importance.

IMPLANTS

In maxillofacial prosthetics, implants are employed as primary retentive structures. Their use may vary from single tooth replacements to extra-oral implants that are used to retain extra-oral prosthesis. The principles and placement are universal and are discussed in Chapter 39.

OBTURATORS ANDVELO-PHARYNGEAL PROSTHESIS

Obturators

An obturator can be defined as, "*A prosthesis used to close a congenital or acquired tissue opening, primarily of the hard palate and/or contiguous alveolar structures. Prosthetic restoration of the defect often includes use of a surgical obturator, interim obturator, and definitive obturator*" – GPT

Rehabilitation of maxillary resection is done in three phases. During the first phase, a surgical obturator is placed. An interim obturator is placed in the second phase and a definitive obturator is placed during the third or final phase.

Types of Obturators

Obturators can be classified:
- Based on the phase of treatment
- Based on the material used
- Based on the area of restoration

Based on the Phase of Treatment

- *Surgical obturators:*
  It is defined as, "*A temporary prosthesis used to restore the continuity of the hard palate immediately after surgery or traumatic loss of a portion or all of the hard palate and/or contiguous alveolar structures (i.e., gingival tissue, teeth)*" – GPT.

It is of two types namely,
  - Immediate surgical obturator: It is inserted at the time of surgery
  - Delayed surgical obturator: It is inserted 7 – 10 days after surgery.
- *Interim obturators:*
  It is defined as, "*A prosthesis that is made several weeks or months following the surgical resection of a portion of one or both maxillae. It frequently includes replacement of teeth in the defect area. This prosthesis, when used, replaces the surgical obturator that is placed immediately following the resection and may be subsequently replaced with a definitive obturator*" – GPT.
- *Definitive obturators:*
  It is defined as, "*A prosthesis that artificially replaces part or all of the maxilla and the associated teeth lost due to surgery or trauma*" – GPT.

Based on the Material Used

Based on the material used, obturators can be classified into:
- Metal obturators
- Resin obturators
- Silicone obturators

Based on the Area of Restoration

- Palatal obturator
- Meatal obturator

Fabrication of a Palatal Obturator

- *Diagnosis and treatment planning:* The type of the defect will determine the size, location and extent of the obturator. We learnt about various defects and their treatment of choice in the previous chapter.

- *Preliminary impression using alginate:* Care should be taken to record the undercuts. The junction of the graft and the mucosa should be properly recorded, as it is an important retentive feature.
- *Fabrication of custom tray:* A custom tray is fabricated using any of the methods described in Chapter 6. Additional care should be given to orient the tray into the defect.
- *Border moulding:* The velo-pharyngeal extension can be recorded by asking the patient to swallow. Additional exercises like turning the head from side to side, placing the chin down onto the chest may also be required. Acrylic special trays are preferred for these patients.
- *Final impression with elastic impression material*: It can be made using alginate or elastomeric impression materials. The tray should be positioned properly and the scar band area must be accurately reproduced. The elastic recoil (*purse string action*) seen in the scar band tissues is responsible for the retention of the obturator. If the scar band is not effective, implants can be placed into the defect to improve retention.
- *Jaw relation:* It is very challenging to record the jaw relation for these patients. Acrylic denture bases are preferred because it is difficult to position other denture bases.
- *Teeth arrangement* should be done such that balanced occlusion is obtained.
- *Insertion and post-insertional management* is carried out as usual.

Clinical Considerations

- Surgical obturator is inserted on the day of the surgery.
- A preliminary cast is obtained before surgery on which a mock surgery is performed.
- A clear acrylic plate is fabricated and inserted after surgery.
- If the patient is dentulous, retention is obtained with simple clasps.
- If the patient is edentulous, the obturator is wired into the alveolar ridge and the zygomatic arch.
- The immediate surgical obturator is retained for 7 to 10 days after surgery.
- A delayed surgical obturator is inserted 7 to 10 days after surgery.
- This may be converted into an interim obturator by the addition of a lining material.
- This obturator is retained for 3 to 4 months post surgically. It is replaced with an interim or definitive obturator after complete healing of the surgical wound.

Uses

- Provides a stable matrix for surgical packing
- Reduces oral contamination
- Speech will be effective post-operatively
- Permits deglutition
- Reduces the psychological impact of the surgery
- May reduce the period of hospitalisation.

Meatal Obturator

- It is a special type of obturator that extends upto the nasal meatus.
- It establishes closure with the nasal structures at a level posterior and superior to the posterior border of hard palate. The closure is established against the conchae and the roof of the nasal cavity.
- It separates the oral and the nasal cavities.
- It is indicated in patients with extensive soft palate defects.

Disadvantages

- Nasal air emission cannot be controlled because it is in an area where there is no muscle function.
- Nasal resonance will be altered.

Palatal Lift Prosthesis (Fig. 37.11)

- It is a special type of obturator, which is a definitive prosthesis with a posterior extension.
- It is helpful in restoring palato-pharyngeal incompetence where the soft palate musculature is compromised. E.g. myasthenia gravis, bulbar poliomyelitis, cerebral palsy.
- It can be clubbed with an obturator if needed.

- The prosthesis is flasked in a three part mould and the material (acrylic or silicone) is processed as usual.

- The retention of the prosthesis is through ear-glass frames or tissue adhesives or extension of prosthesis into ear canal. Nowadays osseo-integrated implant retained prosthesis are given.

Nasal Prosthesis

- It is fabricated for rhinectomy patients
- There are two types of nasal prosthesis namely temporary and permanent.
- The temporary prosthesis is placed 3 to 4 weeks after surgery. It is usually made of heat cure acrylic as it can be relined. Most of the temporary prosthesis are retained with adhesives. It can be used for a maximum of 3 to 4 months.
- The permanent prosthesis is fabricated as described for auricular prosthesis.
- During impression making, care should be taken to block the nasal passages and prevent the entry of impression material.
- A facial moulage is made first and a special tray is fabricated over the defect area.
- Before making the master impression, syringe material is injected over the skin creases and undercuts to obtain a perfect record.
- Sculpting is done as usual.
- Processing is done with a two-piece mould. The technique is similar to the one described for auricular prosthesis.

Ocular Prosthesis

- It is used to replace enucleated eyes. One should remember that the lacrimal apparatus (eyelids and associated glands) is intact in these patients. Hence, the prosthesis only replaces the eyeball.
- The impression is made with irreversible hydrocolloids.
- A special tray is fabricated.
- The secondary impression is made with irreversible hydrocolloids.
- Casts are poured in two sections with two key-ways in the first pour and separating medium.
- Sclera is fabricated with wax.
- It is tried in the eye socket and evaluated for lid contours.
- Following which, it is flasked and de-waxed.
- Special scleral white acrylic resin is available for such procedures.
- Scleral resin is packed, processed, trimmed and polished as usual.
- Next the ocular ball prosthesis is tried in the patient's defect.
- The position of the iris is determined during the trial procedure. The patient is made to relax. The dentist should mark the location of the iris by comparing it with the unaffected eye on the other side.
- The iris is placed and fused to the scleral prosthesis. A cut back is created in the sclera to seat the iris button.
- Characteristic pigmentations on the iris can be applied according to the shade of the other eye. This procedure is known as *Iris painting*. It is done in five parts or phases namely, the pupil, base colour, detail, collaratte and limbus. The paints used include oil paint on acetate discs, oil paint and linseed oil, acrylic paints and watercolour.
- It should be remembered that this prosthesis could not give a life-like appearance. Hence, the patient is advised to wear glasses.

Patient's Instructions

- The patient is asked to remove the prosthesis atleast once a day for cleaning.
- The prosthesis should never be exposed to alcohol as it may discolour the prosthesis and the painting.

TREATMENT PROSTHESIS

A treatment prosthesis can be defined as, "*A prosthetic appliance used for the purpose of treating or conditioning the tissues that are called on to support and retain it*"

Commonly used treatment appliances include surgical obturators, mandibular training flanges and radiation appliances. Surgical obturators have been discussed under obturators. In this section, we shall discuss about the remaining appliances in detail.

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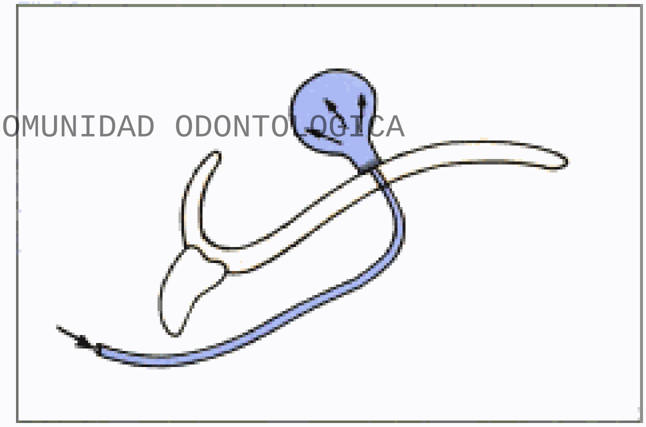

Fig. 37.16: Radiation carrier

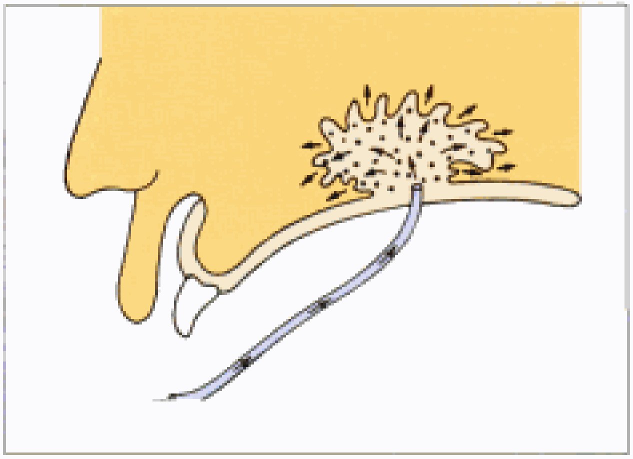

Fig. 37.17: Tissue bolus device

carrier to spare surrounding the tissues from unnecessary radiation exposure.

- Radioactive sources (radium or cesium) may be either preloaded or afterloaded into the carrier. When preloading, the radioactive source is positioned within the prosthesis just prior to the carrier being inserted.
- With after-loading techniques, the radiation carrier is designed with hollow catheters in pre-designed locations. Once the radiation carrier is in position, radioactive isotopes are threaded into the hollow tubing.

Fabrication

Impression of the tumor site is made and a cast is generated as usual. The radiation oncologist should determine the location of the radioactive source. The prosthodontist should design and fabricate the carrier in acrylic resin or silicone.

Tissue Bolus Devices (Fig. 37.17)

They are used when the tissues that are to be irradiated are irregularly contoured. Due to this irregularity some areas within the field may be untreated while other areas may develop isolated "hot spots".

Bolus is a tissue–equivalent material placed directly onto or into irregular tissue contours to produce a more homogeneous dose distribution. Most commonly used materials for a bolus in the head and neck region are saline, wax and acrylic resin.

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polymer chain. Polydimethyl siloxane commonly referred to as silicone is made from these fluid polymers. Commercially available rubber form polymers have fillers for additional strength.

Anti-oxidants and vulcanizing agents are added to transform the raw mass into a rubbery resin during processing. The process of cross-linking the silicone is known as *vulcanizing*. Vulcanizing can occur with or without heat. Accordingly silicones are available in two forms, namely HTV-Silicones (that require heat for vulcanization) and RTV-Silicones (that vulcanize at room temperature).

Types of Silicones

Based on their use, silicones can be classified into four types,

- *Implant grade*: They are placed within the tissues (breast implants). They must meet or exceed FDA requirements.
- *Medical grade:* They are approved for external use only. It is the most commonly used variety for fabricating maxillofacial prosthesis.
- *Clean grade:* Industrial use
- *Industrial grade:* Industrial use.

Classification Based on the Vulcanization Temperature

- *HTV-Silicone:* It requires heat for vulcanization. It is a highly viscous, white, opaque materials available as one or two-component putty. The catalyst or the vulcanizing agent used is Dichlorobenzoic acid (for condensation polymerisation) or platinum salts (for addition polymerisation). It requires advanced equipment for processing. They have better physical properties.
- *RTV-Silicones:* They are room temperature polymerising silicones. They mostly set by condensation polymerisation. Stannous octoate is used as a catalyst and ortho-alkyl silicate is used as a cross-linking agent. They are easier to process and allow intrinsic colouration.

Foaming silicones: It is a variety of RTV-silicone used specially in maxillo-facial prosthetics. The basic silicone has an additive, which releases gas when the catalyst (stannous octoate) is introduced. After processing, the gas is released giving it a foamy consistency.

POLYPHOSPHAZINES

It is a newer material under research. Modifications are required in the commercially available products to be used in maxillofacial prosthetics.

ADHESIVES

Adhesive systems used to retain a maxillofacial prosthesis are classified based on their mode of application. Example: Double sided tapes (most commonly used), pastes, liquid emulsions and spray-ons.

A single component RTV silicone is available for attaching silicone prosthesis. It has low molecular weight polymers with hydroxy blocked ends. The cross-linking agent (Methyl triacetoxy siloxane) gets hydrolysed by the moisture in the atmosphere and polymerises the material.

METAL

Metal implants are used to obtain bone anchorage for a prosthesis. Implant metals used are mostly titanium alloys. Metal may also be used to make denture bases. Base metal alloys are used for denture base fabrication.

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Section Five

Implant Dentistry (ID)

- Dental Implantology

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Chapter 39
Dental Implantology

- Introduction
- Classification of Implants
- Mechanism of Integration of Endosteal Implants (Osseo-Integration)
- Diagnosis and Treatment Planning for Implants
- Surgical Placement of Implants
- Failures in Implants
- Materials Used in Dental Implants

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- Depending on the materials used
- Depending on their reaction with bone
- Depending on the classification of edentulous spaces
- Depending on the treatment options

Depending on the placement within the tissues:

Depending on their placement within the tissues, implants can be classified into epiosteal. endosteal and transosteal implants.

Epiosteal Implants

It is a dental implant that receives its primary bone support by resting on it. E.g. Sub-periosteal implants (Fig. 39.1).

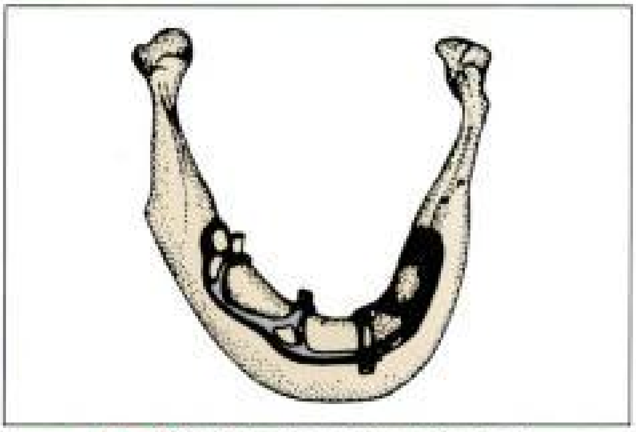

Fig. 39.1: Subperiosteal dental implants

Transosteal Implants

It is a dental implant that penetrates both cortical plates and passes through the entire thickness of the alveolar bone (Fig. 39.2a).

Endosteal Implants

It is a dental implant that extends into the basal bone for support. It transects only one cortical plate. It can be further classified into root form and plate form implants (Fig. 39.2b).

Root form Implants

They are used over a vertical column of bone. They are available in four forms namely, Cylinder or Press fit form, Screw root form and combination root form (Fig. 39.3a).

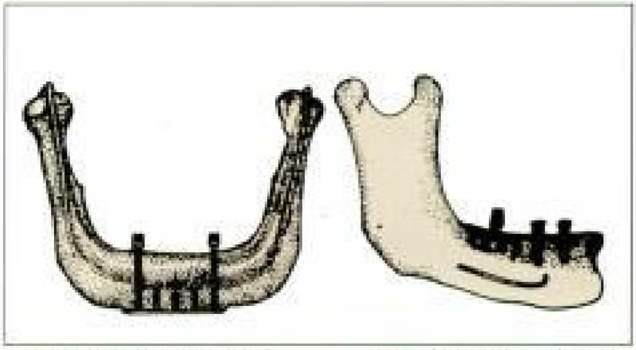

Fig. 39.2a: Transosteal implants

Fig. 39.2b: Endosteal implants

a b

Figs 39.3a and b: (a) Root form implants (b) Plate form implants

The cylinder root form depends on microscopic retention and is tapped or pushed into the prepared bone site during placement. Screw root forms are threaded and hence have macroscopic retention, which provides superior initial bone fixation. As the name suggests, they are screwed into the prepared site during insertion. Combination root forms share the features of both forms.

Plate form Implants

They are used for a horizontal column of bone, which is flat and narrow in the facio-lingual direction (Fig. 39.3b).

Depending on the Materials Used

Based on the materials used, the implants can be classified into Metallic implants (Titanium, Titanium alloy, Cobalt Chromium Molybdenum

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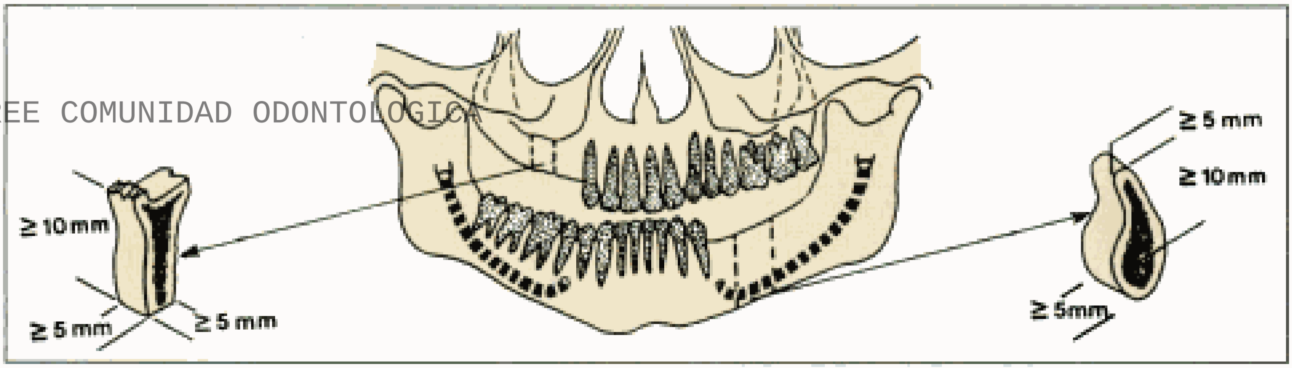

Fig. 39.4e$_1$: Kennedy's class II condition with division A bone in the upper arch and division B bone in the lower arch

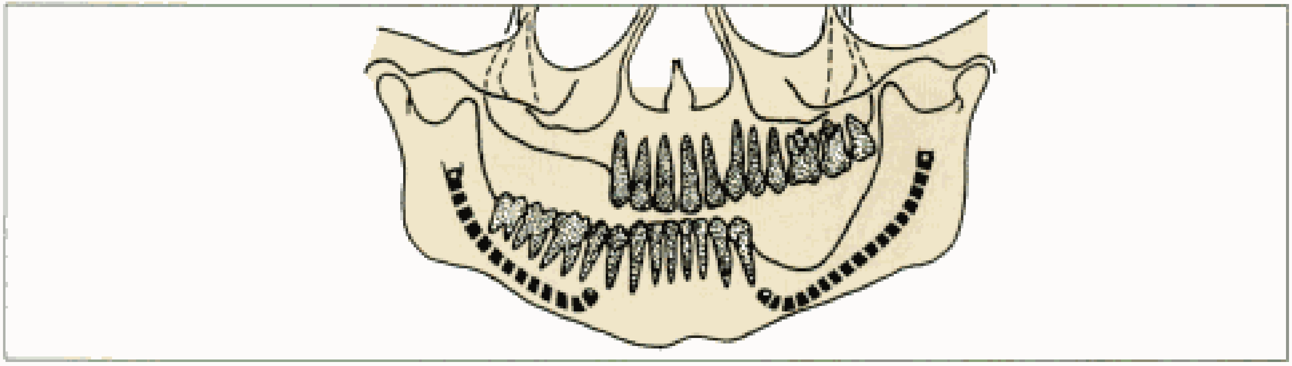

Fig. 39.4e$_2$: Kennedy's class II condition with division C bone in the upper arch and division D bone in the lower arch

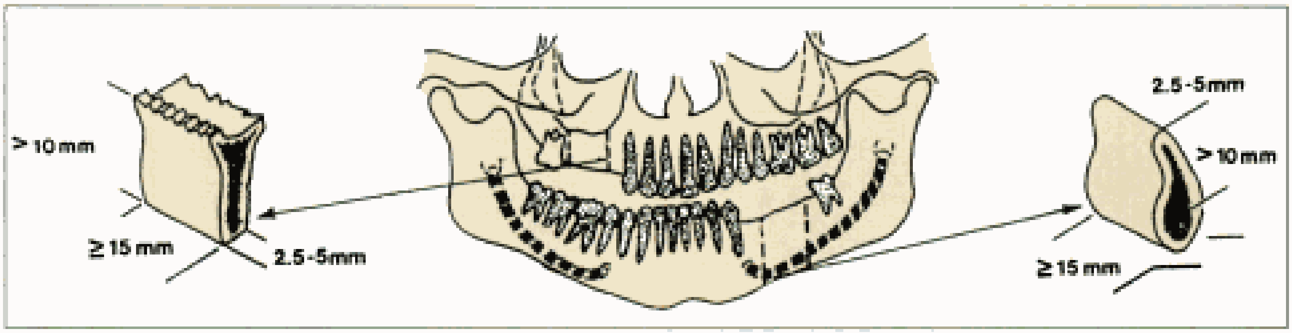

Fig. 39.4f$_1$: Kennedy's class III condition with division A bone in the upper arch and division B bone in the lower arch

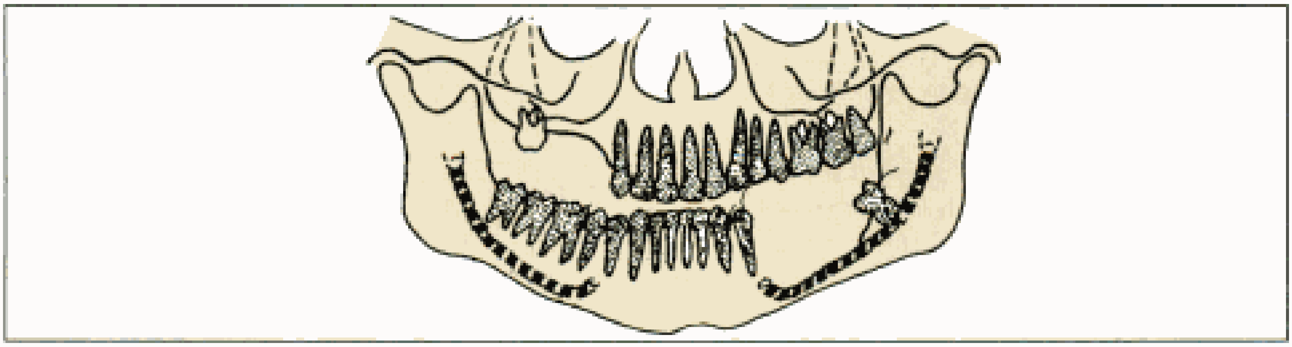

Fig. 39.4f$_2$: Kennedy's class III condition with division C bone in the upper arch and division D bone in the lower arch

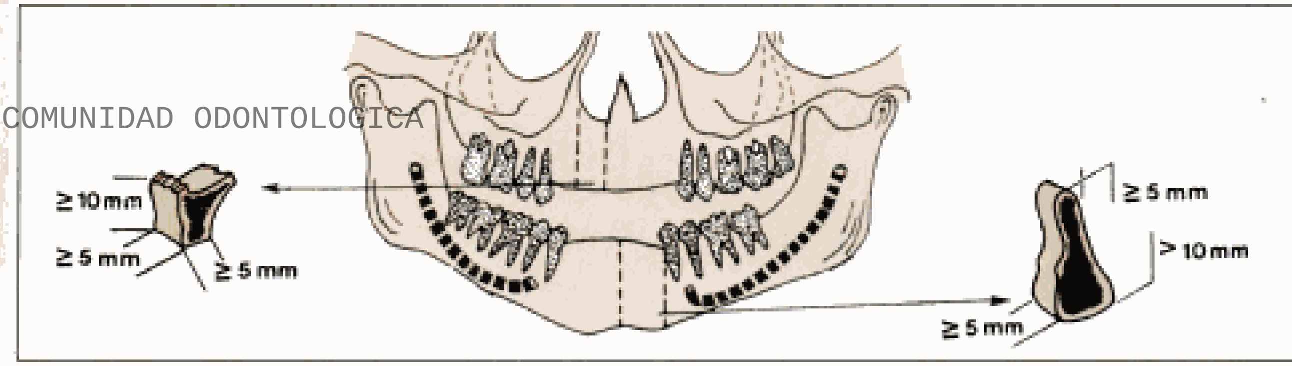

Fig. 39.4g$_1$: Kennedy's class IV condition with division A bone in the upper arch and division B bone in the lower arch

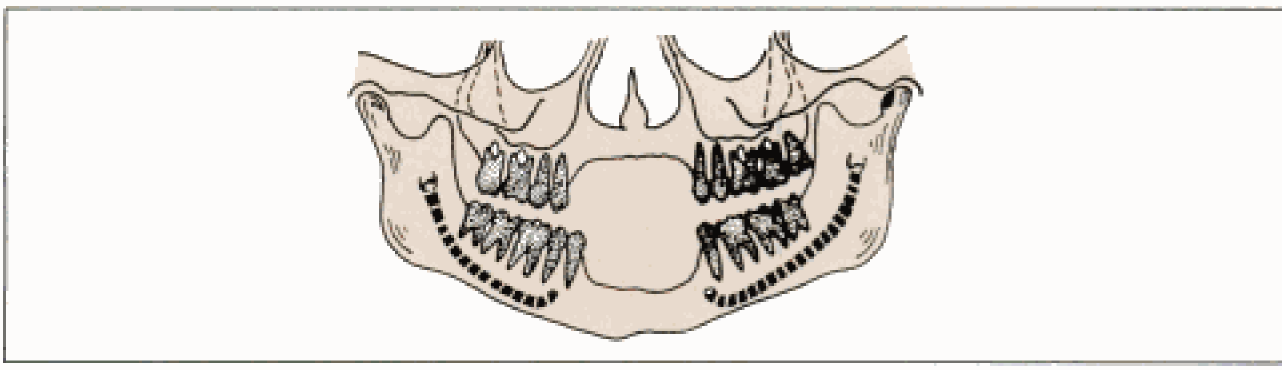

Fig. 39.4g$_2$: Kennedy's class IV condition with division C bone in the upper arch and division D bone in the lower arch

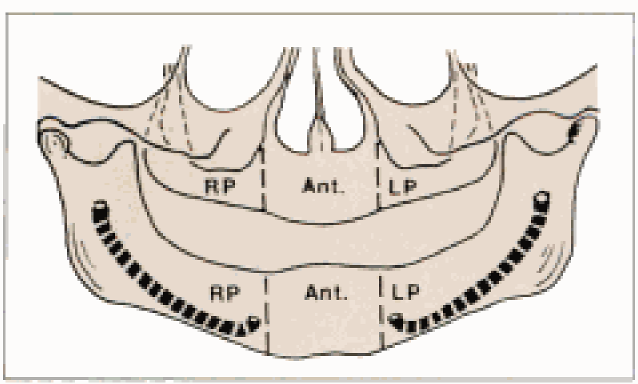

Fig. 39.4h: Completely edentulous jaw is divided into three segments for convenience . Anterior component (Ant) is between the mental foramina. Right (RP) and left (LP) posterior segments correspond to patient's right and left sides

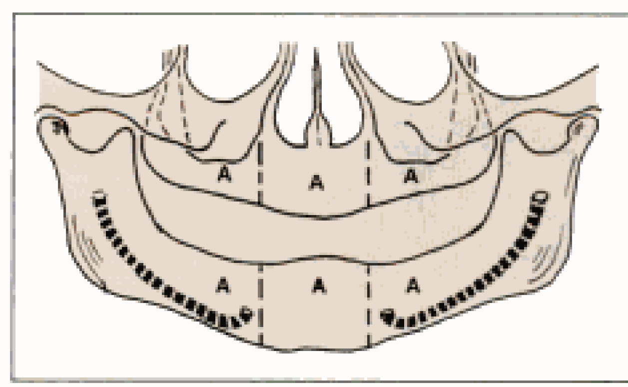

Fig. 39.4i: Type 1 division A arch

In case of completely edentulous patients, Misch segmented each arch into three segments namely anterior (Ant), right posterior (RP) and left posterior (LP) components. The clinical conditions are classified based on the density of bone (Refer treatment planning—discussed later) in each segment. According to the bone density present in the different components, the clinical conditions are grouped as Type I, Type II and Type III.

Depending on the Treatment Options

Misch in 1989 reported five prosthetic options of implants. Of the five, the first three are fixed prosthesis (FP) that may be partial or complete replacements, which in turn may be cemented or screw-retained. The fixed prostheses are classified

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surgery is carried out 3-6 months later when osseointegration is complete.

Biocompatibility Materials available at present are cp Ti (commercially pure Titanium), Ti-6Al-4V (Titanium—6 Aluminium—4 Vanadium), cp Niobium and Hydrooxyapatite (HA). cp Ti is the most biocompatible material.

Implant design Most conducive design for osseointegration is cylindrical. They can be either threaded, HA coated or not.

Implant surface A smooth surfaced implant is less prone for osseointegration as compared to an implant with mild surface roughness.

Surgical site A healthy site is required for good osseointegration. Previously irradiated area is contra indicated. Smoking is contra indicated for implant placement as it affects vascular supply to the surgical site.

Surgical technique The surgical site should be subjected to the minimum possible trauma. Surgical drilling is performed intermittently at a low rotatory rate using sharp instruments.

Infection control Infection especially from the periodontium should be avoided. All surgical protocols to avoid infection should be followed.

Weiss Theory of Fibro-osseous Integration

Weiss theory states that there is a fibro-osseous ligament formed between the implant and the bone and this ligament can be considered as the equivalent of the periodontal ligament found in the gomphosis (Fig. 39.6).

He defends the presence of collagen fibres at the bone-implant interface. He interpreted it as the peri-implantal ligament with an osteogenic effect. He advocates the early loading of the implant.

Osseointegration Vs Biointegration

In 1985, Putter proposed two ways of implant anchorage or retention as mechanical and bioactive.

Mechanical retention can be achieved in cases where the implant material is a metal. E.g.

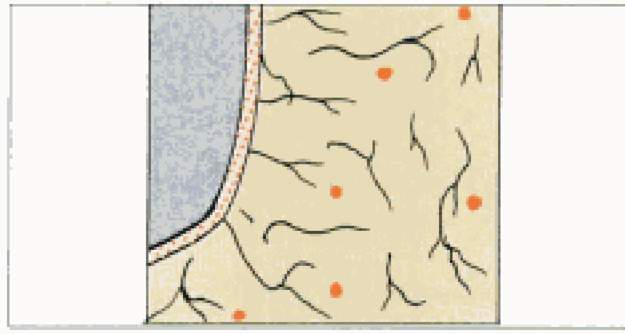

Fig. 39.6: Fibro-osseous integration

Commercially pure titanium and titanium alloys. In these cases, features like vents, slots, dimples, threads (screws) etc, aid in retention of the implant. There is no chemical bonding and the retention depends on the surface area. Greater the surface area, greater is the contact.

Bioactive retention can be achieved in cases where the implant is coated with bioactive materials like hydroxyapatite. These bioactive materials stimulate bone formation leading to a physico-chemical bond. The implant is ankylosed with the bone.

PARTS OF AN IMPLANT (Fig. 39.7)

Implant Body or Fixture

- The implant body is the component that is placed within the bone during first stage of surgery. It could be threaded or non-threaded.
- Threaded implant bodies are available in commercially pure (cp) Titanium or as Titanium alloys. The Ti or Ti alloys may be with or without a hydroxyapatite coating.

Healing Screw

During the healing phase, this screw is normally placed in the superior surface of the body. The functions of this component are:

- Facilitates the suturing of soft tissue.
- Prevents the growth of the tissue over the edge of the implant.

Healing Caps

Healing caps are dome-shaped screws placed over the sealing screw after the second stage of surgery and before insertion of the prosthesis.

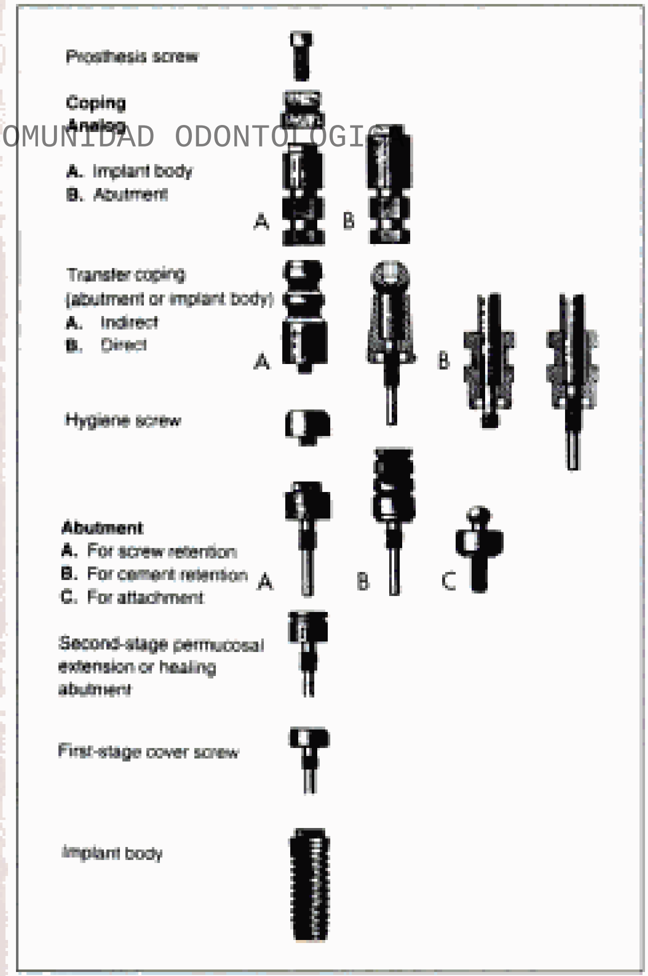

Fig. 39.7: Schematic representation of standard implant components

They may range in length from 2 to 10 mm. They project through the soft tissue into the oral cavity. They function to prevent overgrowth of tissues around the implants during the healing phase.

Abutments

Abutment is the part of the implant, which resembles a prepared tooth, and is designed to be screwed into the implant body. It is the primary component, which provides retention to the prosthesis (fixed partial denture).

Impression Posts

It is a small stem that facilitates the transfer of the intra oral location (of the implant or abutment) to a similar position on the cast. They are placed over the implant body during impression making.

Laboratory Analogues

These are machined structures, which represent the body of the implant. They are placed on the laboratory cast in order to fabricate an implant-supported prosthesis.

During surgery, after the implant body is inserted into the prepared bone cavity, the impression post is placed over it. Consecutively, the analogue is fixed over the impression post.

An impression is made and the analogue-impression post complex gets attached to the impression and comes away with it. When the impression is poured, the impression post analogue complex will get embedded to the cast.

Waxing Sleeves

Waxing sleeves are designed to be attached to the body of the implant. It is actually fixed to the laboratory analogue during the fabrication of the super structure. They will later form a part of the super structure of the implant (Fig. 39.8).

Prosthesis Retaining Screws

Prosthesis retaining screw penetrates the fixed restoration and secures it to the abutment.

Types of Implant Super-structures

A super structure is the prosthetic component fabricated over the implant after it's placement. At this stage, the implant that supports the prosthesis is considered as an abutment. Commonly used super structures include overdentures, fixed

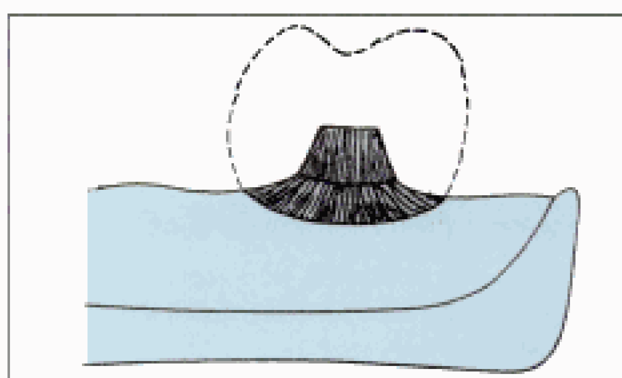

Fig. 39.8: Waxing sleeve

bridges, fixed detachable bridges and single crowns. Most super structures are connected to the implant via an attachment.

Implant Supported Overdentures

They can be either a complete or a partial over denture. The implants are placed on suitable sites on the edentulous ridge. The implant abutments may either be present individually or be connected to one another with a bar. Various specialised attachments are available to suit the interface between the implant abutment and the overdenture (Fig. 39.9).

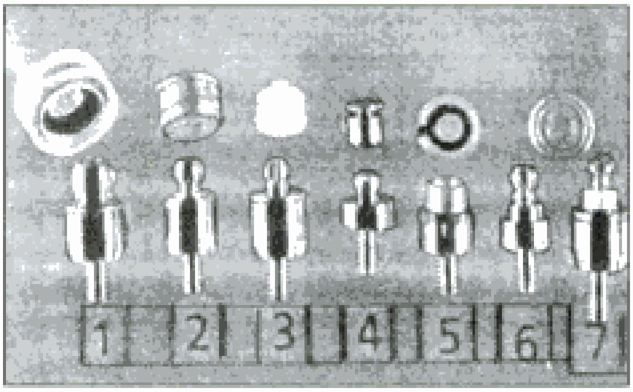

Fig. 39.9: O-ring attachments

The configuration of the abutment are not universally standardised and they vary according to the manufacturers. Hence, we have not discussed them in detail.

Based on the support derived, the implant supported overdentures can be of three types namely,

- *Soft tissue borne and implant borne:* Support is derived from the soft tissues and the implant
- *Tooth borne and implant borne:* Support is received from the remaining teeth and the implant.
- *Implant borne:* Support is received only from the implants.

All the above-mentioned can either be removable or cemented.

Implant Supported Fixed Partial Dentures

- These may be either pure implant supported or a combination of implant and tooth supported fixed bridges.
- The super structure is usually cemented over the implant.

Implant Supported Fixed Detachable Bridges

- This super structure is designed to be removed by the dentist and not by the patient.
- They are mostly implant borne and difficult to fabricate.
- The bridge is attached to the implants with screws or weak cements.

Implant Supported Single Tooth Replacements

They are of two types namely,

- Replacement of a single tooth without obtaining support from adjacent teeth. It should be designed with anti-rotational features.
- Replacement of a single tooth with support from the adjacent tooth. The practitioner should be aware that the supporting natural teeth might undergo intrusion.

DIAGNOSIS ANDTREATMENT PLANNING FOR IMPLANTS

Diagnosis and treatment planning includes all the clinical procedures enlisted in chapter 2. In this section I have discussed the salient features in relation to dental implants.

Evaluations of the Patient for ImplantTherapy

This includes medical, dental and diagnostic evaluation.

Medical Evaluation

Since the placement of an implant is basically a surgical procedure, the patient should be evaluated if he/she is fit to undergo surgery. Medically compromised patients who are unfit for surgical therapy are contraindicated for implant therapy as well. E.g. endocrine disorders, cardiovascular disorders, etc. All essential surgical precautions should be followed.

Dental Evaluation

First the bone at the preferred implant site should be evaluated. The bone can be classified into four types based on its density as (Fig. 39.10):

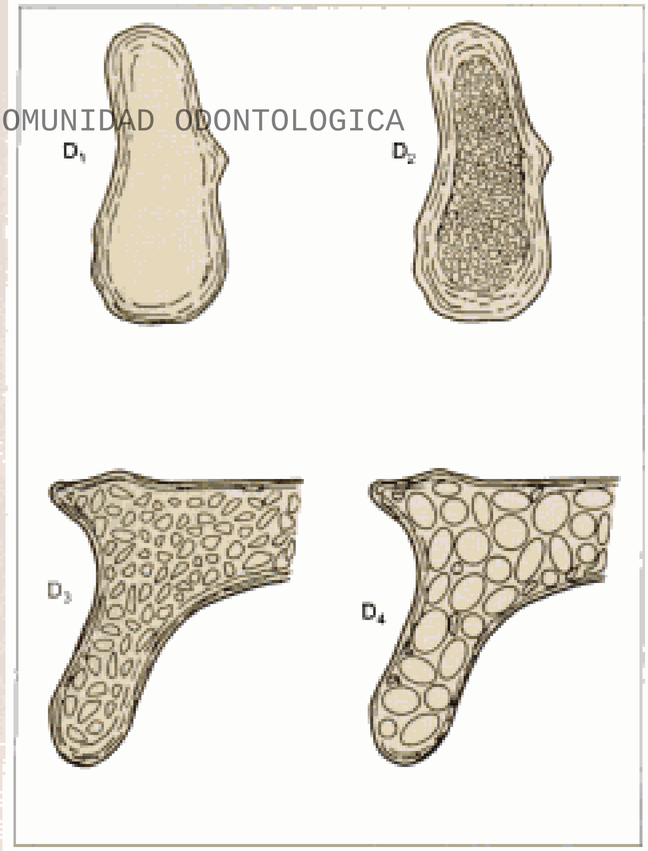

Fig. 39.10: Macroscopic description of the four bone densities

- Dense compact bone (D_1 bone)
- Porous compact bone (D_2 bone)
- Coarse trabecular bone (D_3 bone)
- Fine trabecular bone (D_4 bone)

D_1 bone
- It consists of very dense compact bone
- It is found in anterior regions of the mandible and in the lateral aspect of the symphysis of the mandible.
- It provides excellent stability to titanium implants and most of the other implant systems.
- Final prosthesis should be fabricated after bone healing.

D_2 bone—Dense to Thick porous Compact and Coarse trabecular bone:
- It has dense to porous compact bone on the outside and coarse trabecular bone on the inside.
- It is most commonly found in the anterior portion of the mandible followed by the posterior mandible.
- It provides excellent ridge healing.
- Threaded titanium implants and titanium plasma coated press-fit cylinder implants are preferred for such bone. The press-fit type is proved to be more effective.
- Hollow cylinder implants are not indicated, as adequate bone stability cannot be obtained in these cases.

D_3 bone – Porous Compact and Fine trabecular bone
- It has thinner porous compact bone and fine trabecular bone.
- It is found in anterior or posterior maxilla and posterior regions of the mandible.
- This type of bone is very easy to cut during the surgical procedures.
- Implants coated with Hydroxyapatite are indicated to increase the bone contact.
- Gradual loading of implant is indicated.
- Additional implants are indicated for greater support.

D_4 bone—Fine trabecular bone
- It has very less density and little or no cortical crestal bone.
- It is found in posterior maxilla in a long-term edentulous patient.
- It is the most difficult bone to obtain rigid fixation.
- Access is difficult.
- Limited area of contact with the implant. Hence a larger implant should be used to increase the contact area.
- It may be augmented with bone grafts.

After evaluating the bone density, the patient should be evaluated for the presence of parafunctional movement, as this is one of the major causes for implant failure. This is because in such cases, the implants face excessive stress.

Third, the area of the arch opposing the implant site should be evaluated. If the implant site opposes a dentulous area, more implants have to be placed in order to distribute the high masticatory load. Edentulous areas opposing a prosthesis require lesser number of implants due to decreased masticatory load.

Fourth, the location of the implant within the arch is analysed. Implants placed in the posterior quadrants should be designed to accept higher load.

Fifth, the forces that may act on the implant should be analysed. All forces should be transmitted along the long axis of the implant. Torquing and levering forces should be avoided as they produce increased bone loss.

Lastly, the crown implant ratio should be determined. Crown is the height of the super structure and the implant is the height of the implant submerged into the bone. Greater the crown root ratio, greater is the moment of force that is formed under lateral loads.

Diagnostic Evaluation

It involves the radiographic evaluation of bone.

- *Periapical radiographs*: It gives a detail picture about the amount and the quality of bone remaining.
- *Occlusal radiographs:* They provide information about the facio-lingual width of the bone.
- *Lateral cephalometric radiograph:* It is used to determine and evaluate the loss of vertical dimension, skeletal inter-arch relationships and the crown-implant ratio.
- *Panoramic radiograph:* It is the most frequently used radiograph. Vertical height of the bone can be evaluated. It also gives an idea about the location and extent of limiting anatomical structures.
- *Computed tomography*: It gives a detailed view of the cross-sectional anatomy of the alveolar ridges. The advantage is that superimpositions of structures do not occur and the disadvantage is its cost. It is the primary indication to determine pre-implantation procedure evaluation.

  It can also help to create three-dimensional representations of edentulous arch segments destined to receive implants. These 3D images can be used to develop a 3D model of the operative site using a computer guided milling machine or Stereo lithography (developing 3D images using two laser beams).
- *Measurement of mucosal thickness:* It is usually done by piercing the mucosa with a needle on an anaesthetised region. It is mainly indicated for maxillary edentulous spaces. The depth of penetration is marked on the needle and this is used to mark the amount of bone present in the cross-section of the model (bone mapping). The mucosal thickness can also be measured with special compasses and gauges.

Treatment Planning for Implant Therapy

In this section we shall read in detail about the characteristics of commonly available implant systems.

Root form Endosteal Implants

- Availability of adequate amount of bone is the primary requisite for these implants. A minimum of 8 mm vertical, 5.25 mm medio-lateral and 6.5 mm bucco-lingual bone is the minimal requirement.
- It is available in press-fit and self-tapping forms. Press-fit is smooth surfaced and usually coated with hydroxyapatite or titanium plasma spray. Self-tapping forms are usually threaded implants (Fig. 39.3a).

Indications

- Fixed bridges
- Fixed detachable prosthesis
- Over dentures
- Single tooth replacement

Blade form Endosteal Implants

- It may be either pre-fabricated or custom made (Fig. 39.3b).
- It is indicated when the width of the bone is not adequate for placement of a root form implant. It requires a minimum of 8 mm vertical bone height and 3mm bone width.

Indications

- When the implant has to support a fixed prosthesis along with natural teeth
- Full arch edentulous reconstruction

Ramus Blade or Ramus Frame Implants

These implants are used when insufficient bone (less than 6 mm bone height and 3 mm bone width) is present in the body of the mandible to support an endosteal implant. These are one-piece blade implants, which take support from the bone in the ramus region.

They are indicated for atrophied completely edentulous mandibular ridges.

SURGICAL PLACEMENT OF IMPLANTS

Implant placement procedure includes three steps namely, preparation of study models, preparation of surgical stents and surgical placement of the implants.

Preparation of the Study Models

It is the first step in implant placement wherein diagnostic casts prepared from diagnostic impressions are analysed. The diagnostic casts should be mounted on semi-adjustable articulators so that the condylar movements can be reproduced and other inter-arch factors can be analysed.

Preparation of the Surgical Stents

A surgical or a guiding stent is a prosthetic appliance, which helps to orient and position the implants. The term stent was coined after an English dentist Charles R. Stent.

A stent can be defined as, "*Eponym for a device used in conjunction with a surgical procedure to keep a skin graft in place; often modified with acrylic resin or dental modelling impression compound that was previously termed Stent's mass; also refers to any device or mold used to hold a skin graft in place or provide support for anastomosed structures.*" – GPT.

A surgical stent is, "*An appliance named for the dentist who first described its use, Charles R. Stent, a stent is used to apply pressure to soft tissues to facilitate healing and prevent cicatrisation or collapse*" – GPT.

(*Synonyms include COLLUMELLAR STENT, PERIODONTAL STENT, SKIN GRAFT STENT*).

Ideal Requirements

A surgical stent should fulfil the following requirements:

- It should obtain sufficient stability and retention from the remaining teeth
- It should provide an adequate overview of the surgical site
- It should provide enough space for the reflected mucoperiosteal flap

Fabrication

The stent is fabricated using the compression moulding technique. A pattern of the stent is prepared (it resembles a denture base). The stent should extend into the gingival embrasures like the collars of a denture base. Posteriorly, it is limited to the posterior palatal seal area (Fig. 39.11).

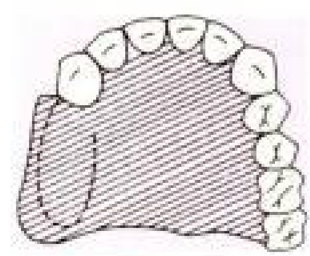

Fig. 39.11: Surgical stent

After acrylizing the stent, it should be checked on the master cast. The area where the placement of an implant is planned should be marked on the stent and drilled. Hence, the stent will contain holes at the sites where implants are to be placed (Figs 39.12 and 39.13).

Fig. 39.12: Acrylized surgical stent

In case of edentulous arches opposing dentulous ones, the stents are fabricated on the opposing arch and a small wire is incorporated onto the stent along the long axis of the existing teeth. When placed in the patient's mouth, the

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Group	Clinical conditions	Management
I (Optimum health)	No pain or tenderness on palpation, percussion, or function Rigid fixation; no horizontal or vertical mobility under 500 g load (IM 0) < 1.5 mm crestal bone loss from Stage II < 1.0 mm bone loss in preceding 3 years. After 1st year, stable probing (sulcus) depth < 4 mm. No exudate history No radiolucency. 0 to 1 bleeding index	Normal maintenance
II (Satisfactory) health	No pain or tenderness on palpation, percussion, or function. Rigid fixation; no horizontal or vertical mobility under 500 g load (IM 0) 1.5 to 3 mm crestal bone loss < 1.0 mm bone loss in preceding 3 years periods. Mayby > 4 mm probing depth from the original tissue thickness or 1st year bone loss, but stable in last 3-year periods. Past transient exudate history (+) or (—). No radiolucency. 0 to 1 bleeding index (may have a transient BOP 2 condition)	Reduce stresses Shorter intervals between hygiene appointments Gingivoplasty Yearly radiographs
III (Compromised health)	No pain or plapation, percussion, or function +/- Slight tenderness Initial rigid fixation; 0 to 0.5 mm horizontal (IM 0 to 2 mobility after prosthesis delivery; no vertical mobility > 3 mm bone loss the 1st year > 1 mm crestal bone loss in preceding 3 years, but less than ½ total bone loss (implantitis). > 5 mm probing depth and increasing in preceding 3 years. +/- History depth and increasing in preceding 3 years. +/- Slight radiolucency around crestal portion of implant 1 to 3 bleeding index	Reduce stresses. Drug therapy, antibiotics chlorhexidine Surgical reentry, revision surgery Change in prosthesis and/or implants
IV (Clinical failure —any of the following conditions	Pain or palpation, percussion, or function > 0.5 mm mobility horizontally; any vertical mobility (IM 3 to 4) Uncontrolled progressive bone loss More than ½ loss of bone supporting the implant Uncontrolled exudate Generalized radiolucency "Sleepers"	Removal of implant
V (Absolute failure)	Implants surgically removed. Implants exfoliated	Bone graft

Fig. 39.15: Implant quality scale

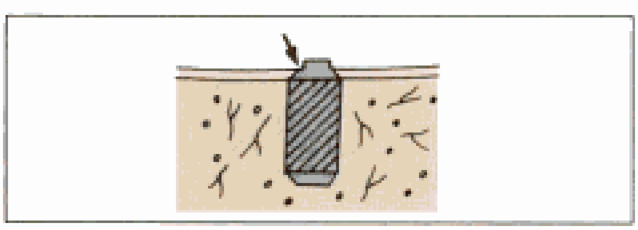

Fig. 39.16: Single stage implant

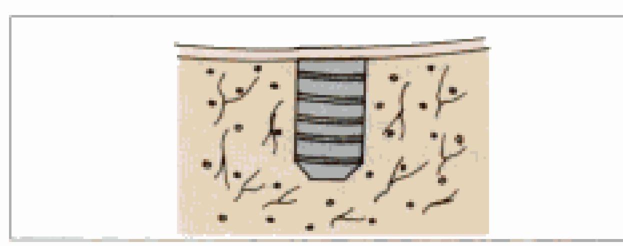

Fig. 39.17: Two stage implant body placed submucosally during the first surgery

fixture is uncovered so that the prosthetic component can be placed over the implant (Fig. 39.18). The advantage of this technique is that it offers superior primary stability.

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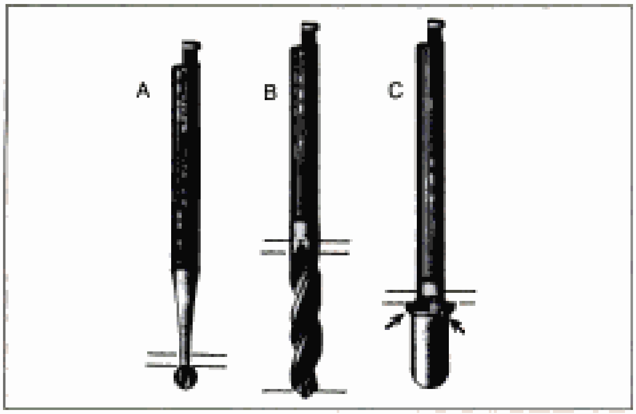
- A suitable incision is made according to the requirement.

- Special drills are available in the implant kit to drill a space for the implant (Fig. 39.22).



Figs 39.22a to c: (a) Pilot drill (b) Twist drill (available in various diameter) (c) Counter sink drill used to prepare the countersink

- The body of the implant is placed. Self-threading implants should be screwed into position.
- After implant placement, the flap is sutured to cover the fixture.
- After a waiting period of four to six weeks, the site is re-opened to expose the fixture.
- Impression posts are placed into the implant fixture.
- Final impression is made using a rubber base impression material.
- Healing caps are placed and the soft tissues are allowed to heal.
- The impression post that comes with the impression will simulate the implant body in the cast.
- The final prosthesis is fabricated with this master cast.
- The intraoral healing caps are removed and the abutment screw is fixed to the implant body. This component helps to retain the final superstructure.

Hygiene Protocol

- Proper home care is needed to prevent plaque accumulation around the implant. The use of interdental brushes or a rotary unitufted brush is recommended for better access.
- Antimicrobial agents like chlorhexidine gluconate (0.12%) should used to control pathogenic bacteria.
- Regular recall visits should be done every three months.
- Peri-apical radiographs should be taken every six months.

The soft tissue around an implant heals and forms the peri-mucosal seal. Periodontal disease can progress around an implant just like in natural teeth. Plaque accumulation leads to gingivitis and breakdown of the peri-mucosal seal, which may lead to peri-implantitis.

The removal of plaque and calculus around the implant should be done with titanium-coated curettes. These curettes do not damage the implant surface.

FAILURES IN IMPLANTS

An implant can be a long-term prosthesis when placed in ideal situations, but the possibility of failure does exist. The causes can be classified as follows:

- Failure due to systemic factors.
- Failure due to surgical complications.
- Failure in the implant-prosthetic component.
- Failure due poor patient compliance.

Now we shall discuss about each of these failures in detail.

Failure due to Systemic Factors

The types of systemic factors that may affect the implant success include:

- If the patient develops systemic diseases like diabetes mellitus after implant placement, which decreases the prognosis.
- The existing systemic condition may worsen after implant therapy.
- Loss of tissue support due to increased progressive alveolar bone loss could lead to failure.

Management

- All systemic conditions should be controlled and treated.

- Tissue support can be improved by choosing a specific implant system considered ideal for the tissue.

Failure due to Surgical Complications

Implant surgery is an invasive procedure and all precaution to maintain asepsis should be followed. Factors which affect normal wound healing can produce implant failure. Infection of the surgical site can lead to loss of osseo-integration.

Management

Every precaution should be taken until bone and wound healing is complete. Aseptic procedures, antibiotic cover and good post-operative care are essential to ensure proper healing.

Failure Due to Implant Prosthetic Component Failure

The most common problem faced in this category includes screw loosening and framework failure.

Causes

The common causes for an implant prosthetic component failure are:

- *Screw design:* Conical screws in the implant superstructure tend to loosen. This problem can be overcome by using implants wotj flat head screw design.
- *Inadequate torque application:* Torque is the amount of force required to tighten the implant. Proper torque should be applied for all implant prosthesis. If inadequate torque is applied, the screw attachment may get loosened. The torque value for gold screws is about 10 to 20 Ncm.
  In such cases, the implant prosthesis should be removed and thoroughly examined. The loose gold screw should be removed and replaced.
- *Arch form:* The arch form should be maintained because it provides cross-arch splinting and tripod effect, which balance the prosthesis against masticatory forces. Failure to maintain the arch form can lead to loosening of the screw attachment and fracture of the super-structure.
  In such cases, the loosened component of the implant screw attachment should be replaced. The prosthesis should be re-cemented.
- *Implant loss:* It is a rare complication, which occurs due to sudden loss of alveolar bone. If this occurs in edentulous patients, the fixed prosthesis should be converted into a removable implant supported overdenture. In all other cases, an additional implant should be placed.
- *Implant fracture:* In an implant system, the abutment and prosthesis are connected to the implant with screws. The system is designed such that the screws act as stress breakers there by protecting the implant. Causes for fracture include lack of inter-maxillary space and excessive implant loading (Fail and safe mechanism).
  Management includes the use of 2-screw systems. Larger diameter implants with large wide platforms and large screws are recommended.
- *Cantilever extensions:* The greater the cantilever distance, the greater is the chance for implant fracture. The factors, which modify cantilever length, include implant length, arch form, spacing, bone quality, occlusal considerations and parafunctional habits.
  Failure in such cases can be prevented by the use of the recommended cantilever length (15 mm or less in mandible and 10 mm or less in the maxilla)
- *Inaccurate framework-abutment interface:* The prosthetic components are usually designed such that there is a precise junction between the abutment surface and the prosthetic framework. Inaccurate fit can lead to constant tension in the components, which may lead to screw loosening or fracture.
  Management includes the removal, indexing and re-soldering the framework until a proper fit is obtained.
- *Occlusal factors:* There should be an equal dis-

Disadvantages

- May disrupt the inter-facial attachment

Ceramics

They are inorganic, non-metallic and non-polymeric materials manufactured by compacting and sintering the different components at high temperatures.

Ceramic implants are of two types namely, Bio-active (hydroxyapatite, bio-glass) and Bio-inert (aluminium oxide).

General Properties of Ceramics

- High compressive strength upto 500 Mpa
- Less resistance to shear and tensile stress
- Modulus of elasticity is 40 to 120 Gpa (Hydroxyapatite) and 40 to 140 GPa for Bio-glass
- Bending stress for hydroxyapatite is 40 to 300 MPa and for bio-glass, it is 20 to 350 MPa.

Advantages

- Excellent biocompatibility
- Minimal thermal and electrical conductivity
- Modulus of expansion is similar to bone. Hence it can be used for load bearing areas.
- Colour is similar to bone, enamel and dentin.
- Chemical composition is similar to constituents of normal biological tissues

Disadvantages

- Low mechanical, tensile and shear strength under fatigue loading
- Variations in chemical and structural characteristics
- Low attachment strengths for some coatings with substrate interfaces.

Hydroxyapatite

It is hydrated calcium phosphate with a formula $[Ca_{10}(PO_4)_{10}(OH)_2]$ similar to bone (bone apatite) and teeth. It is available in block form and granular form. The major problem with this material is that it tends to get dispersed within the tissues. Hence a collagen based parchment membrane should be placed to confine the material and provide a good environment.

The material is commercially synthesised as dense and porous forms. The porous form contains porosities ranging from 100 to 300 µm, which is sufficient for bone ingrowth.

Properties

- Low strength
- Poor ductility

Uses

- Used as a bone implant for ridge augmentation procedures
- As a coating for titanium sub-structures

Bio-glass

It is a dense ceramic material that contains CaO, Na_2O, P_2O_5 and SiO_2.

Properties

- It is brittle. Hence it cannot be used as a stress bearing material

Use

- Used as a active filler or as a surface coating

Bonding mechanism (osseointegration) It forms a surface gel that reacts favourably with the connective tissues allowing bone formation adjacent to it (Figs 39.23a to f).

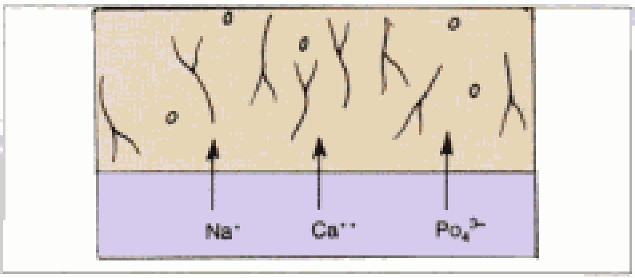


Fig. 39.23a: Ca^{2+}, Na^+ and PO_4^{3-} ions leach out from the hydroxyapatite to the bone

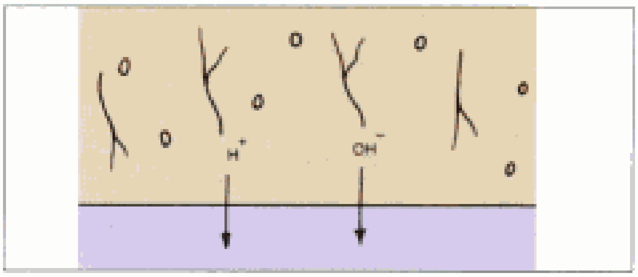


Fig. 39.23b: H^+ and OH^- ions leach into the hydroxyapatite

- Polymers are fabricated in solid and porous forms. They are used for tissue attachments and replacement augmentations respectively.

- They are used as coatings for force transfer from the implants to the tissues.
- They are sensitive to sterilisation and handling techniques.

Advantages

- Long term experience
- Excellent biocompatibility
- Ability to control properties through composite structures

Disadvantages

- Porous polymers undergo elastic deformation and lead to closing or opening of regions intended for tissue ingrowth.
- Difficult to clean the contaminated, porous particles

Other Implant Materials

Early implants were made from gold, tantalum and platinum alloys. Gold and palladium alloys have low strength and hence are not in use. Gold is also avoided because of its cost. Recently zirconium and tungsten are being used as a replacement for Gold.

Carbon compounds were used as root replacements in early 70's. Now they are marketed as coating for metallic and ceramic implants.

Recent Advances

Recently four materials have gained importance in implant dentistry. They include calcium phosphate ceramics, carbon-silicon compounds, structural biomedical polymers and composites.

Calcium phosphate ceramics are being successfully used as a biomaterial surface for many implant systems. Carbon-silicon compounds are used as coating for metal and ceramic implants. They provide better tissue attachment with the help of active bio-molecules.

Structural biomedical polymers are inert polymeric biomaterials, which include Polytetrafluoroethylene (PTFE), Polyethyleneterephthalate (PET), Polymethylmethacrylate (PMMA), Ultra-high molecular weight Polyethylene (UHMW-PE), Polypropylene (PP), Polysulfone (PF) and Polydimethylsiloxane (PDS). They are primarily used as connectors for internal force distribution in osseointegrated implants. They offer superior tissue attachment and force transfer from implants to the tissues. They have poor wear and abrasion resistance, poor creep and poor cold flow characteristics.

Composites have excellent biocompatibility and are in use for a very long time. They can be altered to suit the clinical situations. The primary disadvantage is that they are sensitive to handling and sterilisation and cannot be sterilised using steam or ethylene oxide.

Section Six

Glossary of Prosthodontic Terms—JPD 2001

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Glossary of Prosthodontic Terms

A

Abbe flap [Robert Abbe, New York, NY surgeon, 1851-1928]: *eponym* for a lip switch operation. A triangular, full thickness flap from the lower lip used to fill in a deficit in the upper lip. Specifically applied to the midportion of the upper or lower lip—called also *lip switch operation*.

Abbe, R. A new plastic operation for the relief of deformity due to double harelip. Med Rec 1898;53:477.

ab.duct *vt* (1834): to draw away from the median plane—*comp* ADDUCT

Ab.er.rant *adj* (ca. 1798) **1**: a deviation from the normal or usual course, form, or location **2**: straying from the normal way

ab.frac.tion *n* (1991): the pathologic loss of hard tooth substance caused by biomechanical loading forces. Such loss is thought to be due to flexure and chemical fatigue degradation of enamel and/or dentin at some location distant from the actual point of loading—*comp* ABLATION, ABRASION, ATTRITION, EROSION.

ab.la.tion *n* (15c) **1**: separation or detachment; extirpation; eradication **2**: removal of a part, especially by cutting—see ABFRACTION, EROSION

abrade *vt* (1677): to rub away the external covering or layer of a part—*comp* ATTRITION, EROSION

abra.sion *n* (1656) **1**: the wearing away of a substance or structure (such as the skin or the teeth) through some unusual or abnormal mechanical process **2**: an abnormal wearing away of the tooth substance by causes other than mastication—*comp* ATTRITION, EROSION

[1]**abra.sive** *n* (1853): a substance used for abrading, smoothing, or polishing

[2]**abrasive** *adj* (1875) **1**: tending to abrade **2**: causing irritation—abra-sive-ly *adv*, abra-sive-ness n

ab.ra.siv.i.ty *n* (1998): the property of one material to wear away another material by means of frictional contact

absorbed dose: the amount of energy from ionizing radiation absorbed per unit mass of matter, expressed in gray units

ab.sorp.tance *n* (ca. 1931): the ratio of the radiant energy absorbed by a body to that incident on it

ab.sorp.tion *n* (1741) **1**: the uptake of substances into or through tissues, eg, mucosa, skin, and intestine **2**: in radiology, the uptake of energy by matter with which the radiation interacts—see A. OF RADIATION—*comp* ADSORPTION

Absorption of radiation: collision-like interactions between the individual particulate or quantum components of a beam of radiation and the subatomic parts of matter that occur at random during irradiation. Each interaction may result in partial or complete transfer of energy

abut.ment *n* (1634) **1**: that part of a structure that directly receives thrust or pressure; an anchorage **2**: a tooth, a portion of a tooth, or that portion of a dental implant that serves to support and/or retain a prosthesis—*usage* see ANGULATED A., HEALING A., IMPLANT A., INTERMEDIATE A., ONE PIECE A., PREPARATION PIECE A., STANDARD A., TWO PIECE A.

abutment clamp (1998): any device used for positioning a dental implant abutment upon the dental implant body

ac.cel.er.ant *n* (1916): a substance used to accelerate a process (as in enhancing the speed of a chemical reaction)

ac.cel.er.a.tor *n* (1611) **1**: a substance that speeds a chemical reaction **2**: in physiology, a nerve, muscle, or substance that quickens movement or response

ac.cre.tion *n* (1615) **1**: the process of enlargement or growth by a gradual build-up **2**: in periodontics, the accumulation on teeth or dental implants of foreign material such as plaque, calculus, and materia alba

acentric relation: see ECCENTRIC RELATION

ach.ro.mat.ic *adj* (1766) **1**: lacking in hue and saturation, therefore falling into a series of colors that varies only in lightness or brightness **2**: possessing no hue; being or involving black, gray, or white

achro.ma.top.sia *n* **1**: monochromatism **2**: a type of monochromatism in which all colors are perceived as achromatic, called also *achromatism, total color perception deficiency*

acid.etched bonded splint: see RESIN-BONDED SPLINT

acid.etched bridge: see RESIN-BONDED PROSTHESIS

acid.etched fixed partial denture: see RESIN-BONDED PROSTHESIS

ac.quire *vt* **ac.quired; ac.quir.ing** (15c) **1**: to obtain as one's own; to come to have as a new or additional trait, characteristic or capability **2**: attained with time

acquired centric: see ECCENTRIC RELATION, MAXIMAL INTERCUSPAL POSITION

acquired centric occlusal position: see ECCENTRIC RELATION, MAXIMAL INTERCUSPAL POSITION

acquired centric position: see ECCENTRIC RELATION, MAXIMAL INERCUSPAL POSITION

acquired centric relation: see ECCENTRIC RELATION, MAXIMAL INTERCUSPAL POSITION

acquired eccentric relation: any eccentric relationship position of the mandible relative to the maxilla, whether conditioned or learned by habit, which will bring the teeth into contact

acquired occlusal position: the relationship of teeth in maximum intercuspation regardless of jaw position—see MAXIMAL INTERCUSPAL POSITION

acquired occlusion: see MAXIMAL INTERCUSPAL POSITION

acrylic resin 1: pertaining to polymers of acrylic acid, methacrylic acid, or acrylonitrile; for example, acrylic fibers or acrylic resins **2**: any of a group of thermoplastic resins made by polymerizing esters of acrylic or methylmethacrylate acids

acrylic resin base: a denture base made of acrylic resin

activated resin *obs*: see AUTOPOLYMERIZING RESIN

[1]**ac.ti.va.tor** *n*: a removable orthodontic device intended to stimulate perioral muscles

[2]**activator** (1998): **1**: any chemical agent which triggers an initiator chemical to begin a chemical reaction **2**: a substance used in small proportions to increase the effectiveness of an accelerator chemical

acute closed lock: a form of temporomandibular joint dysfunction characterized by limitation in jaw movement of a short duration with pain, limitation of jaw opening to 25 to 30 mm (as measured in the incisor area) and, with jaw opening, a deflection of the mandible toward the affected joint

acute pain: pain having a brief and relatively severe course

ad.ap.ta.tion *n* (1610) **1**: the act or process of adapting; the state of being adapted **2**: the act of purposefully adapting two surfaces to provide intimate contact **3**: the progressive adjustive changes in sensitivity that regularly accompany continuous sensory stimulation or lack of stimulation **4**: in dentistry, (a) the degree of fit between a prosthesis and supporting structures, (b) the degree of proximity of a restorative material to a tooth preparation, (c) the adjustment of orthodontic bands to teeth

adaptation syndrome: a syndrome characterized by alterations in response as an accommodation to the environment

adaptive occlusion: see MAXIMAL INTERCUSPAL POSITION

additive color mixture: the perceived color that results when the same area of the retina of the eye is illuminated by lights of different spectral distribution such as by two colored lights—*comp* SUBTRACTIVE COLOR SYSTEM

ad.duct *vt* (1836): to draw toward the median plane or toward the axial line—*comp* ABDUCT

ad.her.ence *n* (1531): the act, quality, or action of adhering; persistent attachment

ad.he.sion *n* (1624) **1**: the property of remaining in close proximity, as that resulting from the physical attraction of molecules to a substance or molecular attraction existing between the surfaces of bodies in contact **2**: the stable joining of parts to each other, which may occur abnormally **3**: a fibrous band or structure by which parts abnormally adhere—*comp* CAPSULAR FIBROSIS, FIBROUS A., INTRACAPSULAR A., MYOFIBROTIC CAPSULAR CONTRACTURE

[1]**ad.he.sive** *adj* (1670): sticky or tenacious

[2]**adhesive** *n* (1912) **1**: any substance that creates close adherence to or on adjoining surfaces **2**: a luting agent—see DENTURE A., MAXILLOFACIAL PROSTHETIC A.

adhesive capsulitis: within the temporomandibular joint, any situation in which the disk is in normal position, joint space volume is decreased, and motion is restricted

adhesive failure (1998): bond failure at an interface between two materials due to a tensile or shearing force—see COHESIVE FAILURE

adi.a.do.cho.ki.ne.sia *n*: inability to perform rapid alternating movements such as opening and closing the jaws or lips, raising and lowering the eyebrows, or tapping the finger

adipose atrophy: reduction of fatty tissue

adjustable anterior guidance: an anterior guide on an articulator whose surface may be altered to provide desired guidance of the articulator's movement mechanism; the guide may be programmed (calibrated) to accept eccentric interocclusal records

adjustable articulator: an articulator that allows some limited adjustment in the sagittal and horizontal planes to replicate recorded mandibular movements—see ARTICULATOR

adjustable axis face-bow: see FACE-BOW

adjustable occlusal pivot *obs*: an occlusal pivot that may be adjusted vertically by means of a screw or other device (GPT4)

ad.just.ment *n* (1644) **1**: the act or process of modifying physical parts **2**: in dentistry, a modification made on a dental prosthesis or natural tooth to enhance fit, function, or acceptance by the patient—see OCCLUSAL A.

ad.sorp.tion *n* (1882): the adhesion, in an extremely thin layer, of molecules to the surfaces of liquids or solids with which they are in contact—*comp* ABSORPTION—**ad.sorp.tive** *adj*

adult speech aid prosthesis: a definitive prosthesis that can improve speech in adult cleft palate patients either by obturating (sealing off) a palatal cleft or fistula or occasionally by assisting an incompetent soft palate. Both mechanisms are necessary to achieve velopharyngeal competency—*syn* PROSTHETIC SPEECH APPLIANCE, SPEECH AID, SPEECH BULB

af.ter.im.age *n* (1874): in visual acuity, a prolongation or renewal of a visual sensory experience, ascribable to residual excitation after external stimuli have ceased to operate

afterloading technique: in therapeutic radiology, the use of applicators for brachytherapy so designed that they may be quickly loaded with radioactive sources after placement within the patient

agar *n* (1889): a complex sulfated polymer of galactose units, extracted from Gelidium cartilagineum, Gracilaria confervoides, and related red algae. It is a mucilaginous substance that melts at approximately 100°C and solidifies into a gel at approximately 40°C. It is not digested by most bacteria and is used as a gel in dental impression materials and a solid culture media for microorganisms

age atrophy: the normal diminution of all tissues due to advanced age

agen.e.sis *n* (ca. 1879): absence, failure of formation, or imperfect development of any body part—see CONDYLAR AGENESIS

ag.na.thia *n*: a developmental anomaly characterized by absence of the mandible

ag.no.sia *n* (ca. 1900): diminution or loss of the ability to recognize the import of sensory stimuli; the varieties correspond with the senses and are distinguished as auditory, gustatory, olfactory, tactile, and visual

ag.o.nist *n* (ca. 1626) **1**: In physiology, a muscle that is controlled by the action of an antagonist with which it is paired **2**: in anatomy, a prime mover **3**: in pharmacology, a drug that has an affinity for and stimulates physiologic activity in cell receptors normally stimulated by naturally occurring substances

air abrasion: see AIRBORNE PARTICLE ABRASION

air.bone gap: in audiology, the difference in patient acuity to sound produced by air and through bone that reflects hearing loss due to middle ear dysfunction or pathology

airborne particle abrasion: the process of altering the surface of a material through the use of abrasive particles propelled by compressed air or other gases

air chamber: see RELIEF AREA

air conduction: the normal process of conducting sound waves through the ear canal to the tympanic membrane

air dose: in therapeutic radiology, the amount of energy absorbed per unit mass of tissue at a given site, in air

Akers clasp [Polk E. Akers, Chicago, Ill, dentist]: *eponym* for a one-piece cast partial denture with cast clasps. He is said to have improved and standardized the one-piece casting method for fabricating gold partial dentures in the early 1920s—see SUPRABULGE CLASP

Akers PE. Partial dentures. J Amer Dent Assoc 1928;15:717-22.

ala *n, pl* **alae** (1738): a wing or a wing like anatomic part or process—**alar** *adj*

ala nasi *n*: in anatomy, the cartilaginous processes forming the wing-like flares of each nares

ala.tragus line: a line running from the inferior border of the ala of the nose to some defined point on the tragus of the ear, usually considered to be the tip of the tragus. It is frequently used, with a third point on the opposing tragus, for the purpose of establishing the ala tragus plane. Ideally, the ala-tragus plane is considered to be parallel to the occlusal plane. The occlusal plane is at an angle of approximately 10 degrees relative to the Frankfort horizontal plane, when viewed in the midsagittal plane—see CAMPER'S LINE

al.gi.nate *n* (ca. 1909): see IRREVERSIBLE HYDROCOLLOID

al.lo.dyn.ia *n*: pain resulting from a non-noxious stimulus to normal skin or mucosa

al.lo.ge.ne.ic *adj* (1963): in transplantation biology, denoting individuals (or tissues) that are of the same species however antigenically distinct—called also *homologous*

allogeneic graft: see HOMOGRAFT

al.lo.graft *n* (1964): a graft of tissue between genetically dissimilar members of the same species—called also *allogeneic graft* and *homograft*

al.lo.plast *n* **1**: an inert foreign body used for implantation within tissue **2**: a material originating from a nonliving source that surgically replaces missing tissue or augments that which remains

alloplastic graft: a graft using an inert material

alloplastic material: any nonbiologic material suitable for implantation as an alloplast

al.loy *n* (14c): a mixture of two or more metals or metalloids that are mutually soluble in the molten state; distinguished as binary, ternary, quaternary, etc., depending on the number of metals within the mixture. Alloying elements are added to alter the hardness, strength, and toughness of a metallic element, thus obtaining properties not found in the pure metal. Alloys may also be classified on the basis of their behavior when solidified—*usage* see BASE METAL, NOBLE METAL

an.nu.lar *n* (1571): a term used to describe a ringlike anatomic structure

an.odon.tia *n*: a rare dental condition characterized by congenital absence of all teeth (both deciduous and permanent)—*comp* HYPODONTIA, OLIGODONTIA

an.odon.tism *n*: see ANODONTIA

anomalous trichromatic vision: a form of defective color vision in which three stimuli are required for color matching, but the proportions in which they are matched differ significantly from those required by the normal trichromat. There are three forms of anomalous trichromatic vision: protanomalous, deuteranomalous and tritanomalous

anom.a.ly *n, pl.***lies** (1664) **1**: something different, abnormal, peculiar, or not easily classified **2**: an aberration or deviation from normal anatomic growth, development, or function **3**: marked deviation from the normal standard, especially as a result of congenital defects

ANS: *acronym* for *Anterior Nasal Spine*. The outline of the anterior nasal spine as seen on the lateral cephalometric radiograph. It is used as a cephalometric landmark

an.tag.o.nist *n* (1599) **1**: a tooth in one jaw that articulates with a tooth in the other jaw—called also ***dental antagonist*** **2**: a substance that tends to nullify the actions of another, as a drug that binds to cell receptors without eliciting a biologic response **3**: a muscle whose action is the direct opposite of another muscle

Ante's Law [Irwin H: Ante, Toronto, Ontario, Canada, dentist]: *eponym, in* fixed partial prosthodontics for the observation that the combined pericemental area of all abutment teeth supporting a fixed partial denture should be equal to or greater in pericemental area than the tooth or teeth to be replaced; as formulated for removable partial prosthodontics, the combined pericemental area of the abutment teeth plus the mucosa area of the denture base should be equal to or greater than the pericemental area of the missing teeth

Ante IH. The fundamental principles, design and construction of crown and bridge prosthesis. Dent Item Int 1928;50:215-32.

an.te.ri.or *adj* (1541) **1**: in front of or the front part; situated in front of **2**: the forward or ventral position **3**: a term used to denote the incisor or canine teeth or the forward region of the mouth anterior determinant of occlusion—see DETERMINANTS OF MANDIBULAR MOVEMENT

anterior disk displacement: see DISK DISPLACEMENT

anterior guidance 1: the influence of the contacting surfaces of anterior teeth on tooth limiting mandibular movements **2**: the influence of the contacting surfaces of the guide pin and anterior guide table on articulator movements—*usage* see ANTERIOR GUIDE TABLE **3**: the fabrication of a relationship of the anterior teeth preventing posterior tooth contact in all eccentric mandibular movements—see ANTERIOR PROTECTED ARTICULATION, GROUP FUNCTION, MUTUALLY PROTECTED ARTICULATION

anterior guide: see ANTERIOR GUIDE TABLE

anterior guide pin: that component of an articulator, generally a rigid rod attached to one member, contacting the anterior guide table on the opposing member. It is used for the purpose of maintaining the established vertical separation. The anterior guide pin and table, together with the condylar elements, direct the movements of the articulators separate members

anterior guide table: that component of an articulator on which the anterior guide pin rests to maintain the occlusal vertical dimension and influence articulator movements. The guide table influences the degree of separation of the casts in all relationships—see also ANTERIOR PROGRAMMING DEVICE

anterior nasal spine: a sharp median bony process, adjacent to the inferior margin of the anterior aperture of the nose, formed by the forward prolongation of the two maxillae

anterior open bite (obs): see ANTERIOR OPEN OCCLUSAL RELATIONSHIP

anterior open occlusal relationship: the lack of anterior tooth contact in any occluding position of the posterior teeth

anterior programming device: an individually fabricated anterior incisal guide table that allows mandibular motion without the influence of tooth contacts and facilitates the recording of maxillomandibular relationships; also used for deprogramming—see also DEPROGRAMMER

anterior protected articulation: a form of mutually protected articulation in which the vertical and horizontal overlap of the anterior teeth disengage the posterior teeth in all mandibular excursive movements—see CANINE PROTECTED ARTICULATION.

anterior reference point: any point located on the midface that, together with two posterior reference points, establishes a reference plane

anterior teeth: the maxillary and mandibular incisors and canines

anterior tooth arrangement: the positioning of the anterior teeth for esthetics and phonetics

anterior tooth form: the outline form as viewed in any selected plane and other contours of an anterior tooth

anteroposterior curve: the anatomic curve established by the occlusal alignment of the teeth, as projected onto the median plane, beginning with the cusp tip of the mandibular canine and following the buccal cusp tips of the premolar and molar teeth, continuing through the anterior border of the mandibular ramus, ending with the anterior most portion of the mandibular condyle. First described by Ferdinand Graf Spee, German anatomist, in 1890—see CURVE OF SPEE

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Bennett NG. A contribution to the study of the movements of the mandible. Proc Roy Soc Med (Lond) 1908;1:79-98 (Odont Section)

Bennett's side shift [Sir Norman Godfrey Bennett, British dental surgeon, 1870-1947]: see MANDIBULAR LATERAL TRANSLATION

Bennett NG: A contribution to the study of the movements of the mandible. Proc Roy Soc Med (Lond) 1908;1:79-98 (Odont Section)

[1]**bevel** *n* (1611): a slanting edge

[2]**bevel** *vt*: the process of slanting the finish line and curve of a tooth preparation

Bezold.Brucke effect [Helmholtz, 1867]: the apparent change in hue that accompanies a change in luminance

BID: *acronym* for L *Bis in Di'e*, twice a day

bifid condyle: a condyle anomaly where an exaggerated central depression exists

bi.fur.ca.tion *n* (1615) **1**: division into two branches **2**: the site where a single structure divides into two parts, as in two roots of a tooth

bilaminar zone: see RETRODISCAL TISSUE

bi.lat.er.al *adj* (1775): having or pertaining to two sides

bilateral distal extension removable partial denture: a removable partial denture replacing the distal most tooth or teeth on each side of one arch of the mouth—see KENNEDY CLASSIFICATION OF REMOVABLE PARTIAL DENTURES

bimaxillary protrusion: a dental or skeletal protrusion of both the maxillary and mandibular jaws and/or teeth simultaneously

bi.meter *n* (20c): a gnathodynamometer equipped with a central bearing plate of adjustable height—see GNATHODYNAMOMETER

bio.ac.cept.abil.i.ty (1998): the quality of compatibility in a living environment despite adverse or unwanted side effects

bio.com.pat.i.ble *adj*: capable of existing in harmony with the surrounding biologic environment

bio.feed.back *n* (1971) **1**: the process of furnishing an individual information, usually in an auditory or visual mode, on the state of one or more physiologic variables such as blood pressure, skin temperature, or heart rate; this procedure often enables an individual to gain some voluntary control over the variable being sampled **2**: the instrumental process or technique of learning voluntary control over automatically regulated body functions

biofunctional orthopedics: see FUNCTIONAL JAW ORTHOPEDICS

bio.in.te.gra.tion *n* (1998): the benign acceptance of a foreign substance by living tissue—see OSSEOUS INTEGRATION

biologic width (1998): the combined width of connective tissue and epithelial attachment superior to the crestal bone

Gargiulo AW *et al.* J Periodontology 1961;32:261-7.

Cohen DW. Lecture at Walter Reed Army Medical Center, June 3, 1962.

bio.ma.te.ri.al *n* (1966): any substance other than a drug that can be used for any period of time as part of a system that treats, augments, or replaces any tissue, organ, or function of the body

bio.me.chan.ics *n, pl but sing or pl in constr* (1933) **1**: the application of mechanical laws to living structures, specifically the locomotor systems of the body **2**: the study of biology from the functional viewpoint **3**: an application of the principles of engineering design as implemented in living organisms—see also DENTAL B

bi.om.e.try *n* (1831): the science of the application of statistical methods to biologic facts, as the mathematical analysis of biologic data

bi.op.sy *n, pl* **.sies** (1895): the removal of tissue for histologic examination and diagnosis

bio.sta.tis.tics *n, pl but sing in constr* (1950): the science of the application of statistical methods to biologic facts, as the mathematical analysis of biologic data—see BIOMETRY

biphasic pin fixation: the use of extraoral pin fixation in the treatment of bone fractures

biscuit bite *slang*: see MAXILLOMANDIBULAR RELATIONSHIP RECORD

bisque bake: a series of stages of maturation in the firing of ceramic materials relating to the degree of pyrochemical reaction and sintering shrinkage occurring before vitrification (glazing)—called also *biscuit bake*

bite *vb, obs*: the act of incising or crushing between the teeth—see OCCLUSION RECORD

bite analysis: see OCCLUSAL ANALYSIS

bite block: see OCCLUSION RIM, RECORD RIM

bite closing: see DECREASED OCCLUSAL VERTICAL DIMENSION

bite guard: see OCCLUSAL DEVICE

bite opening: see OCCLUSAL VERTICAL DIMENSION

bite plane: see OCCLUSAL PLANE

bite plate: see OCCLUSION RIM, RECORD RIM

bite raising: see OCCLUSAL VERTICAL DIMENSION

bite rim: see OCCLUSION RIM, RECORD RIM

biting force: see OCCLUSAL FORCE

biting pressure: see OCCLUSAL FORCE

biting strength: see OCCLUSAL FORCE

blade endosteal dental implant: a faciolingual narrowed, wedge-shaped dental implant body with openings or vents through which tissue may grow

blade implant: see BLADE ENDOSTEAL DENTAL IMPLANT

blockout ***adj*** **1**: elimination of undesirable undercuts on a cast, **2**: the process of applying wax or another similar temporary substance to undercut portions of a cast so as to leave only those undercuts essential to the planned construction of a prosthesis. A blocked out cast may also include other surface modifications needed relative to the construction of the prosthesis

bo.lus ***n*** (1562): a rounded mass, as a large pill or soft mass of chewed food

blowout fracture: a fracture of the orbital floor caused by a sudden increase in intraorbital pressure due to traumatic force

board-certified prosthodontist: in the United States, as defined by the American Board of Prosthodontics, a prosthodontist who has passed the certifying examination administered by the American Board of Prosthodontics

board-eligible prosthodontist: in the United States, as defined by the American Board of Prosthodontics, a prosthodontist whose application for examination for certification is current and has been accepted for examination by the American Board of prosthodontics

boil out: see WAX ELIMINATION

bond ***n*** (12c) **1**: the linkage between two atoms or radicals of a chemical compound 2: the force that holds two or more units of matter together—see SECONDARY BONDS, VANDERWALL'S BOND

bond strength: the force required to break a bonded assembly with failure occurring in or near the adhesive/adherens interface

bonded bridge: see RESIN-BONDED PROSTHESIS

bond.ing ***n*** (1976) **1**: joining together securely with an adhesive substance such as cement or glue **2**: the procedure of using an adhesive, cementing material or fusible ingredient to combine, unite, or strengthen

bonding agent: a material used to promote adhesion or cohesion between two different substances, or between a material and natural tooth structures

bone ***n*** (bef. 12c): the hard portion of the connective tissue which constitutes the majority of the skeleton; it consists of an inorganic or mineral component and an organic component (the matrix and cells); the matrix is composed of collagenous fibers and is impregnated with minerals, chiefly calcium phosphate (approx. 85%) and calcium carbonate (approx. 10%), thus imparting the quality of rigidity to bone—called also *osseous tissue*—see ALVEOLAR B.

BASAL B. CANCELLOUS B. COMPACT B., CORTICAL B.

bone atrophy: bone resorption noted internally by a decrease in density and externally by an alteration in form

bone augmentation: see AUGMENTATION

bone conduction: the conduction of sound to the inner ear through the bones of the skull—called also *cranial conduction, osteotympanic conduction, and tissue conduction*

bone curettage: the surgical shaving or smoothing of the bones external surface

bone expansion: manipulation of a bony ridge by placement of an osteotome to split the cortical ridge and hence enhance bone width

bone factor: relative response of alveolar bone to stimulation or irritation. The ratio of osteogenesis to osteolysis

bone marrow: the soft vascular tissue that fills bone cavities and cancellus bone spaces which consists primarily of fat cells, hematopoietic cells, and osteogenetic reticular cells

Bonwill triangle [William Gibson Arlington Bonwill, American dentist, 1833-1899]: *eponym* for a 4-inch equilateral triangle bounded by lines connecting the contact points of the mandibular central incisor's incisal edge (or the midline of the mandibular residual ridge) to each condyle (usually its mid point) and from one condyle to the other, first described in 1858 while introducing his Anatomical Articulator

Bonwill WGA. Scientific articulation of the human teeth as founded on geometrical, mathematical and mechanical laws. Dental Items Int 1899;21:617-56, 873-80.

bony ankylosis: the union of bones of a joint by proliferation of osteoblasts, resulting in complete immobility

bor.der ***n*** (14c): the circumferential margin, edge or surface, a bounding line, edge, or surface—see DENTURE BORDER

border molding 1: the shaping of the border areas of an impression tray by functional or manual manipulation of the tissue adjacent to the borders to duplicate the contour and size of the vestibule **2**: determining the extension of a prosthesis by using tissue function or manual manipulation of the tissues to shape the border areas of an impression material

border movement: mandibular movement at the limits dictated by anatomic structures, as viewed in a given plane

border position: see POSTERIOR B.P.

border seal: the contact of the denture border with the underlying or adjacent tissues to prevent the passage of air or other substances

border tissue movements: the action of the muscles and other tissues adjacent to the borders of a denture

boxing an impression: the enclosure of an impression to produce the desired size and form of the base of the cast and to preserve desired details

boxing wax: wax used for boxing an impression

brac.ing ***adj***: the resistance to horizontal components of masticatory force

brack.et ***n***: an orthodontic device attached to an individual tooth to hold arch wires

brazing investment: an investment having a binding system consisting of acidic phosphate such as monoammonium phosphate and a basic oxide such as magnesium oxide

brazing material: an alloy suitable for use as a filler material in operations with which dental alloy(s) are joined to form a dental restoration

braze *vt* (1677): to join with a nonferrous alloy that melts at a lower temperature than that of the metals being joined

breakdown potential: the last noble potentia where pitting and/or crevice corrosion will initiate and propagate

bridge *n, slang*: see FIXED PARTIAL DENTURE

bridge work *slang*: see FIXED PARTIAL DENTURE

brittle 1: easily broken or shattered; fragile on crisp **2**: prone to fracture or failure; the fracture that occurs when the proportional limit of a material is exceeded

brux.ism *n* (ca. 1940) **1**: the parafunctional grinding of teeth **2**: an oral habit consisting of involuntary rhythmic or spasmodic nonfunctional gnashing, grinding, or clenching of teeth, in other than chewing movements of the mandible, which may lead to occlusal trauma—called also *tooth grinding, occlusal neurosis*

bruxo.ma.nia *vb, obs*: the grinding of teeth occurring as a neurotic habit during the waking state (GPT-4)

buc.cal *adj* (ca. 1771): pertaining to or adjacent to the cheek

buccal flange: the portion of the flange of a denture that occupies the buccal vestibule of the mouth

buccal vestibule: the portion of the oral cavity that is bounded on one side by the teeth, gingiva, and alveolar ridge (in the edentulous mouth, the residual ridge) and on the lateral side by the cheek posterior to the buccal frenula

buccolingual relationship: any position of reference relative to the tongue and cheeks

buc.co.ver.sion *n*: a deviation toward the cheek

bulb *n, slang*: see OBTURATOR, SPEECH AND PROSTHESIS

BULL: *acronym* for Buccal of the *Upper, Lingual* of the *Lower* (cusps); applies to Clyde H. Schuyler's rules for occlusal adjustment of a normally related dentition in which those cusps contacting in maximum intercuspation (mandibular buccal and maxillary lingual) are favored by adjustment of those cusps which are not in occlusal contact in maximum intercuspation (maxillary buccal and mandibular lingual)—called also the BULL RULE

bur *n* (14c): a steel or tungsten carbide rotary cutting instrument

bur head: the cutting portion of a dental bur

bur head length: the axial dimension of the bur head

bur head shape: the geometrical outline form of the cutting surface edges, usually described successively by proximity from the shank to the tip end

bur shank: that component of a dental bur which fits into the hand piece; the shaft section of the dental but that may be friction gripping or latch-type in form

bur.nish *vt* (14c): to make shiny or lustrous by rubbing; also to facilitate marginal adaptation of restorations by rubbing the margin with an instrument

bur.nish.i.bil.i.ty *n*: the ease with which a material can be burnished

burn out *adj*: see WAX ELIMINATION

butt *v* (14C): to bring any two flat-ended surfaces into contact without overlapping, as in a butt joint

butt margin: see SHOULDER FINISH LINE

button implant: see MUCOSAL IMPLANT

C

Ca: *acronym* for Carcinoma or Cancer

CAD-CAM: *acronym* for *Computer Aided Design-Computer Aided Manufacturer (or Computer Assisted Machining)*

calcium hydroxide: an odorless white powder that is very slightly soluble in water and insoluble in alcohol. Aqueous and nonaqueous suspensions of calcium hydroxide are often used as cavity liners to protect the pulp from the irritant action of restorative materials; also used in pulp capping, pulpotomy and apexification procedures

calcium sulfate: a product obtained by calcination of gypsum under steam pressure. The *alpha* form is composed of regularly shaped grains, with low porosity, and requiring little water for a satisfactory mix. Forms include *alpha, alpha-modified* and *beta*.

calcium sulfate plaster: compounds occurring in anhydrous form as anhydrite, and in the natural form as gypsum or gypsum dihydrate. The term "plaster" also applies to a mixture consisting of water and calcium sulfate hemihydrate ($CaSO_4 \frac{1}{2} H_2O$)

cameo surface: the viewable portion of a denture; the portion of the surface of a denture that extends in an occlusal direction from the border of the denture and includes the facial, lingual, and palatal surface. It is the part of the denture base that is usually polished and includes the buccal and lingual surfaces of the teeth

Camper's line: see ALA-TRAGUS LINE

Camper's plane 1: a plane established by the inferior border of the right or left ala of the nose and the superior border of the tragus of both ears **2**: a plane passing from the avanthion to the center of the bony external auditory meatus; called also *acanthion-external auditory meatus plane*—see also ALA-TRAGUS LINE

can.cel.lous bone (1836): the reticular, spongy or lattice-like portion of the bone; the spongy bone tissue located in the medulla of the bone; this bone is composed of a variable trabecular network containing interstitial tissue that may be hematopoietic

can.dle *n* (12c): a unit of luminous intensity, equal to 1/60 of the luminous intensity of a square centimeter of a black body heated to the temperature of the solidification of platinum (1773°C)

candle power: luminous intensity expressed in candles

canine eminence: the labial prominence on the maxillary alveolar process corresponding to the position of the root of the canine tooth

canine guidance: see CANINE PROTECTED ARTICULATION

canine protected articulation: a form of mutually protected articulation in which the vertical and horizontal overlap of the canine teeth disengage the posterior teeth in the excursive movements of the mandible—*comp* ANTERIOR PROTECTED ARTICULATION

canine protection: see CANINE PROTECTED ARTICULATION

can.ti.lever *n* (1667): a projecting beam or member supported on one end

cantilever bridge *slang*: see CANTILEVER FIXED PARTIAL DENTURE

cantilever fixed partial denture: a fixed partial denture in which the pontic is cantilevered, i.e., is retained and supported only on one end by one or more abutments

cap splint: a plastic or metallic device used in the treatment of maxillary or mandibular fractures and designed to cover the crowns of the teeth and usually luted to them

capillary attraction: that quality or state which, because of surface tension, causes elevation or depression of the surface of a liquid that is in contact with the solid walls of a vessel

cap.su.lar *adj* (ca. 1730): pertaining to a capsule

capsular contracture: see CAPSULAR FIBROSIS

capsular fibrosis: fibrotic contracture of the capsular ligament of the temporomandibular joint

capsular ligament: within the temporomandibular joint, a ligament that separately encapsulates the superior and inferior synovial cavities of the temporomandibular articulation

cap.sule *n* (1693): a fibrous sac or ligament that encloses a joint and limits its motion. It is lined with synovial membrane

capsulitis *n*: the inflammation of a capsule, as that of the joint, lens, liver, or labyrinth

car.at *n* (15c): a standard of gold fineness. The percentage of gold in an alloy, stated in parts per 24. Pure gold is designated 24 carat

car.ti.lage *n* (15c): a derivative of connective tissue arising from the mesenchyme. Typical hyaline cartilage is a flexible, rather elastic material with a semitransparent glass-like appearance. Its ground substance is a complex protein through which there is distributed a large network of connective tissue fibers

case *n*, *substand* (13c): a dental patient

[1]**cast** *vb* (13c): to produce a shape by thrusting a molten liquid or plastic material into a mold possessing the desired shape

[2]**cast** *n* (14c): a life-size likeness of some desired form. It is formed within or is a material poured into a matrix or impression of the desired form—*comp* MODEL—see DENTAL C, DIAGNOSTIC C, FINAL C, PRELIMINARY C, REFRACTORY C, REMOUNT C

cast relator: a mechanical device that orients opposing casts to each other without reference to anatomic landmarks—see ARTICULATOR

castable *n* (1998): any refractory material that has a bonding agent added and can be mixed with water or other liquid agents and poured in a mold to set

castable ceramic: for dental applications, a glass-ceramic material that combines the properties of a restorative material for function with the capability to be cast using the lost wax process

[1]**cast.ing** *n* (14c): something that has been cast in a mold; an object formed by the solidification of a fluid that has been poured or injected into a mold

[2]**cast.ing** *vt*: the act of forming an object in a mold—see VACUUM C.

casting flask: a metal tube in which a refractory mold is made for casting dental restorations

casting ring: the inferior portion of a refractory flask that provides a negative likeness or dimple into which a metal is cast in the refractory investment

casting wax: a composition containing various waxes with desired properties for making wax patterns to be formed into metal castings

cat.a.lyst *n* (1902): a substance that accelerates a chemical reaction without affecting the properties of the materials involved

cath.ode *n* (1834): the negative pole in electrolysis

CAT: *acronym* for *Computerized Axial Tomography*

cau.tery *n*, *pl*-**ter.es** (15c): the application of a caustic substance, hot instrument, electric current, or other agent used to burn, scar, or destroy tissue

cavity varnish: a combination of copal resin or other synthetic resins dissolved in an organic solvent such as chloroform or ether

CD: *acronym* for *Complete Denture*

CDA: *acronym* for *Certified Dental Assistant*

CDL: *acronym* for *Certified Dental Laboratory*

CDT: *acronym* for *Certified Dental Technician*

cel.lu.li.tis *n* (1861): diffuse and especially subcutaneous inflammation of connective tissue

[1]**ce.ment** *n* (14c) **1**: a binding element or agency used as a substance to make objects adhere to each other, or something

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centric relation position: see CENTRIC RELATION

centric relation record: a registration of the relationship of the maxilla to the mandible when the mandible is in centric relation. The registration may be obtained either intraorally or extraorally

centric slide *obs*: the movement of the mandible while in centric relation, from the initial occlusal contact into maximum intercuspation (GPT-4)

centric stop: opposing cuspal/fossae contacts that maintain the occlusal vertical dimension between the opposing arches

ceph.a.lo.gram *n*: see CEPHALOMETRIC RADIOGRAPH

ceph.a.lo.m.e.ter *n*: an instrument for measuring the head or skull, an orienting device for positioning the head for radiographic examination and measurement

cephalometric radiograph: a standardized radiograph of the skull

cephalometric tracing: a line drawing of structural outlines of craniofacial landmarks and facial bones, made directly from a cephalometric radiograph

cephalometry *n*, **cephalometric** *adj* **1**: the science of measurement of the dimensions of the head **2**: in dentistry, certain combinations of angular and linear measurements developed from tracing frontal and lateral radiographic head films used to assess craniofacial growth and development on a longitudinal basis and to determine the nature of orthodontic treatment response

ceph.a.lo.stat *n*: an instrument used to position the head to produce spatially oriented, reproducible radiographs or photographs

ce.ram *n*: heat treatment process that converts a specially formulated glass into a fine grained glass-ceramic material

[1]**ce.ram.ic** *adj* (1850): of or relating to the manufacture of any product made essentially from a nonmetallic mineral (as clay) by firing at a higher temperature

[2]**ce.ram.ic** *n* (1859): the product of ceramic manufacture

ceramic crown: a ceramic restoration that restores a clinical crown without a supporting metal substructure

ceramic flux: a glass modifier; metallic ions such as calcium, potassium or sodium; usually as carbonates, which interrupt the oxygen/silica bond, thus enhancing fluidity

ce.ram.ics *n* **1**: compounds of one or more metals with a nonmetallic element, usually oxygen. They are formed of chemical and biochemical stable substances that are strong, hard, brittle, and inert nonconductors of thermal and electrical energy **2**: the art of making porcelain dental restorations

ce.ram.ist or **cer.am.i.cist** *n* (1855): one who engages in ceramics

ceramometal restoration: see METAL CERAMIC RESTORATION

cermet (1998): fused glass powder with silver particles through high temperature sintering of a mixture of the two particles

cervical *adj* (1681) **1**: in anatomy, pertaining to the cervix or neck **2**: in dentistry, pertaining to the region at or near the cementoenamel junction

cer.vix *n*, *pl* **cer.vi.ces** (15c) **1**: the neck **2**: a constricted portion of a part or organ

[1]**cham.fer** *n* **1**: a finish line design for tooth preparation in which the gingival aspect meets the external axial surface at an obtuse angle **2**: a small groove or furrow **3**: the surface found by cutting away the angle of intersection of two faces of a piece of material (i.e. stone, metal, wood): a beveled edge

[2]**cham.fer** *vt* **cham.fer.ed; cham.fer.ing; cham.fers 1**: to cut a furrow in **2**: to make a chamferon; to cut or reduce to a chamfer bevel **3**: generally thought of as producing a curve from the axial wall to the cavosurface

chamfer angle *n*: the angle between a chamfered surface and one of the original surfaces from which the chamfer is cut

char.ac.ter.ize: to distinguish, individualize, mark, qualify, singularize, or differentiate something

characterized denture base: a denture base with coloring that simulates the color and shading of natural oral tissues

check bite *slang*: see INTEROCCLUSAL RECORD

che.ili.tis: inflammation of the lip

che.ilo.sis: a fissured condition of the lips and angles of the mouth often associated with riboflavin deficiency

chew.in record: see STEREOGRAPHIC RECORD

chewing cycle: see MASTICATORY CYCLE

chewing force: see MASTICATORY FORCE

Christensen's phenomenon (Carl Christensen, Danish, dentist and educator): *eponym* for the space that occurs between opposing occlusal surfaces during mandibular protrusion

Christensen C. The problem of the bite. D Cosmos 1905;47:1184-95.

chroma *n* (1889) **1**: the purity of a color, or its departure from white or gray **2**: the intensity of a distinctive hue; saturation of a hue **3**: chrome describes the strength or saturation of the hue (color)—see also SATURATION

Munsell AH. A color notation. Baltimore: Munsell Color Co. Inc 1975;14-7.

chromatic stimulus: a stimulus that under prevailing conditions of adaptation gives rise to a perceived chromatic color

chromaticity coordinates: the two dimensions of any color order system that exclude the lightness dimension and describe the chromaticity. Unless otherwise specified, the term refers to the CIE coordinates x, y and z for illuminant C and 2 degrees (1931) Standard Observer—called also *color coordinates*

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clinical remount: see REMOUNT PROCEDURE

cli.nom.e.ter *n* (1811): a device for measuring angles of elevation or inclination—**cli.no.met.ric** *adj*—**cli.nom.e.try** *n*

clip *n* (15c) *slang* **1**: any of numerous devices used to grip, clasp, or hook **2**: a device used to retain a removable prosthesis intraorally to a fixed abutment; i.e., a bar, crown, or other retainer

closed bite *slang*: see DECREASED OCCLUSAL VERTICAL DIMENSION

closed lock: an internal derangement of the temporomandibular joint in which the disk is dislocated anteriorly and, usually, medial to the condyle; displacement or dislocation of the disk without spontaneous reduction—see ACUTE CLOSED LOCK, CHRONIC CLOSED LOCK

closed reduction of a fracture: reduction (repositioning) and fixation of fractured bones without making a surgical opening to the fracture site

closest speaking space: the space between the anterior teeth that, according to Dr Earl Pound, should not be more or less than 1 to 2 mm of clearance between the incisal edges of the teeth when the patient is unconsciously repeating the letter "S" Dr Meyer M silverman termed this *speaking centric*, which was defined as the closest relationship of the occlusal surfaces and incisal edges of the mandibular teeth to the maxillary teeth during function and rapid speech. This was later called *closest speaking level* by Dr Silverman and finally the *closest speaking space*

Silverman MM. Speaking centric. Dent Digest 1950;55:106-11.

Silverman MM. Accurate measurement of vertical dimension by phonetics and speaking centric space. Dent Digest 1951;57:261-5.

Silverman MM. The speaking method in measuring vertical dimension. J Prosthet Dent 1953;3:193-9.

Pound E. Esthetics and phonetics in full denture construction. J Calif Dent Assoc 1950;20:179-85.

Pound E. The mandibular movements of speech and their seven related values. J Prosthet Dent 1966;16:835-43.

Pound E. The vertical dimension of speech, the pilot of occlusion. J Calif Dent Assoc 1975;6:42-7.

Pound E. Let/s/be your guide. J Prosthet Dent 1977;38:482-9.

clutch *n*: a device placed in both the maxillary and mandibular arches for the purpose of supporting components used to record mandibular movement

co.adapt.ed *adj* (1836) **1**: mutually adapted, especially by natural selection **2**: in medicine, the proper realignment of displaced parts—**co.ad.ap.ta.tion** *n*

Coble balancer [Lucian G Coble, North Carolina, US dentist] **1**: an intraoral balancing device used to determine centric relation and the centric relation record **2**: used to equilibrate complete dentures intraorally—see CENTRAL BEARING TRACING DEVICE

Coble LG. Correct centric position must be established for good denture fit and function. Dent Survey 1951;27:1391-3.

Coble LG. A complete denture technique for selecting and setting up teeth. J Prosthet Dent 1960;10:455-8.

co.he.sion *n* (1660) **1**: the act or state of sticking together tightly **2**: the force whereby molecules of matter adhere to one another; the attraction of aggregation **3**: molecular attraction by which the particles of a body are united throughout their mass

cohesive failure: bond failure within a dental material due to a tensile or shearing force—see ADHESIVE FAILURE

Cold curing resin: see AUTOPOLYMERIZING RESIN

collarless metal ceramic restoration: a metal ceramic restoration whose cervical metal collar has been eliminated. Porcelain is placed directly in contact with the prepared finish line

collateral ligaments: two or more ligaments paired to a single joint for the specific purpose of restricting extension and flexion within one plane only

colloid: a material in which is suspended a constituent in a finely divided state that is invisible to the eye but capable of scattering light

col.or *n* (13c) **1**: a phenomenon of light or visual perception that enables one to differentiate otherwise identical objects **2**: the quality of an object or substance with respect to light reflected or transmitted by it. Color is usually determined visually by measurement of hue, saturation, and luminous reflectance of the reflected light **3**: a visual response to light consisting of the three dimensions of hue, value and saturation—see PERCEIVED C, PSYCHOPHYSICAL C.

color blindness: abnormal color vision or the inability to discriminate certain colors, most commonly along the red-green axis

color constancy: relative independence of perceived color to changes in color of the light source

color deficiency: a general term for all forms of color vision that yield chromaticity discrimination below normal limits, such as monochromatism, dichromatism, and anomalous trichromatism

color difference: magnitude and character of the difference between two colors under specified conditions, referred to as delta E

color difference equations: equations that transform CIE (Commission Internationals d'Eclairage) coordinates into a more uniform matrix such that a specified distance between two colors more nearly proportional to the magnitude of an observed difference between them regardless of their hue

color notation: the use of symbols in some orderly fashion by which the attributes of color may be defined or may be set down in written formula

color rendering index: a number from 1 to 100 given to a light source to indicate its relative equivalence to pure white light which has a color rendering index (CRI) of 100. The closer the number is to 100, the more it resembles pure white light

color scale: an orderly arrangement of colors showing graduated change in some attribute or attributes of color as a value scale

color solid: A symbolic figure in three dimensions that represents the relations of all possible colors with respect to their primary attributes of hue, lightness, and saturation. Usually, value (lightness) appears as the vertical axis of the figure with hue and saturation represented in polar coordinates about the lightness axis, saturation being radial. The boundaries of the solid are actually irregular, but it is sometimes represented as a cylinder, a sphere, or a cube

color standard: a color whose psychophysical dimensions have been accurately measured and specified

color stimulus: visible radiation entering the eye and producing a sensation of color, either chromatic or achromatic

color temperature: the temperature in degrees Kelvin (Celsius plus 273°) of a totally absorbing or black body (object) that produces colors as the temperature changes. The range is from a dull red to yellow to white to blue. This term is sometimes used incorrectly to describe the color of "white" light sources. The correct term to describe the color of light sources is correlated color temperature

col.or.im.e.ter *n* (ca. 1863): a device that analyzes color by measuring it in terms of a standard color, scale of colors or certain primary colors; an instrument used to measure light reflected or transmitted by a specimen

col.or.ing *n* (14c) **1**: the act of applying colors **2**: something that produces color or color effects **3**: the effect produced by applying or combining colors—see EXTRINSIC C, INTRINSIC C

combination clasp: a circumferential retainer for a removable partial denture that has a cast reciprocal arm and a wrought wire retentive clasp

combination syndrome: the characteristic features that occur when an edentulous maxilla is opposed by natural mandibular anterior teeth, including loss of bone from the anterior portion of the maxillary ridge, overgrowth of the tuberosities, papillary hyperplasia of the hard palate's mucosa, extrusion of the lower anterior teeth, and loss of alveolar bone and ridge height beneath the mandibular removable partial denture bases—also called *anterior hyperfunction syndrome*.

comminuted fracture: a fracture in which the bone has several lines of fracture in the same region; a fracture in which the bone is crushed and splintered

com.mi.nu.te *vt*-**nut.ed;.nut.ing** (1626) *obs*: the reduction of food into small parts (GPT-4)—**com.mi.nu.tion** *n*

com.mis.sure *n* (15c): a point of union or junction especially between two anatomic parts—**com.mis.sur.al** *adj*

commisure splint: a device placed between the lips that assists in achieving increased opening between the lips—called also *lip splint*

compensating curve 1: the anteroposterior curvature (in the median plane) and the mediolateral curvature (in the frontal plane) in the alignment of the occluding surfaces and incisal edges of artificial teeth that are used to develop balanced occlusion **2**: the curve introduced in the construction of complete dentures to compensate for the opening influences produced by the condylar and incisal guidances during lateral and protrusive mandibular excursive movements—called also *compensating curvature, compensating curve*

compact bone: any bone substance that is dense or hard

complementary colors 1: two colors that, when mixed together in proper proportions, result in a neutral color. Colored lights that are complementary when mixed in an additive manner form white light and follow the laws of additive color mixture. Colorants that are complementary when mixed together form black or gray and follow the laws of subtractive colorant mixture **2**: colors located in directly opposite positions on the color wheel. Colorants that are complementary when mixed together form black or gray and follow the laws of subtractive color.

complete arch subperiosteal implant: a device placed under the periosteum on the residual ridge to provide abutments for supporting a removable or fixed prosthesis in a fully edentulous arch—usage such implants should be described by means of their relationship to their bases of support, the alveolar bone. As such, at placement, such as implant is described as an eposteal dental implant—see EPOSTEAL DENTAL IMPLANT

complete cleft palate: an opening extending through the anterior alveolar ridge, primary and secondary palates—see PALATAL CLEFT

complete crown: a restoration that covers all the coronal tooth surfaces (mesial, distal, facial, lingual, and occlusal)

complete denture: a removable dental prosthesis that replaces the entire dentition and associated structures of the maxillae or mandible

complete denture prosthetics *obs* **1**: the replacement of the natural teeth in the arch and their associated parts by artificial substitutes **2**: the art and science of the restoration of an edentulous mouth (GPT-4)—see COMPLETE DENTURE PROSTHODONTICS

complete denture prosthodontics: that body of knowledge and skills pertaining to the restoration of the edentulous arch with a removable prosthesis

complete facial moulage: an impression procedure used to record the soft tissue contours of the whole face

complicated fracture: a fracture with significant injury to adjacent soft tissue (i.e., neurovascular injury) components of mastication: those factors of food manipulation and comminution that follow ingestion and precede deglutition

com.po.mer (1998): a poly-acid modified composite resin, composed of glass filler, acid-modified dimethacrylate resin, and a photoinitiator

components of occlusion: the various elements that are involved in occlusion, such as the temporomandibular joints, the associated musculature, the teeth, their contacting surfaces and investing tissues, and/or the denture supporting structures—see also DETERMINANTS OF MANDIBULAR MOVEMENT

com.pound *n*, *slang* (19c): see MODELING PLASTIC IMPRESSION COMPOUND

compound joint: a joint involving three or more bones

compression molding: the act of pressing or squeezing together to form a shape within a mold; the adaptation, under pressure, of a plastic material into a mold

compression of tissue: see TISSUE DISPLACEMENT

compressive stress: the internal induced force that opposes the shortening of a material in a direction parallel to the direction of the stresses; any induced force per unit area that resists deformation caused by a load that tends to compress or shorten a body

Computerized tomography (CT): the technique by which multidirectional X-ray transmission data through a body is mathematically reconstructed by a computer to form an electrical cross-sectional representation of a patient's anatomy. CT is used as an acronym to designate any technical field associated with these techniques

con.cres.cence *n*: the union of roots of approximating teeth via deposition of cementum

con.cre.tion *n*: any inorganic mass in a natural cavity or organ

condensable composite resin: a highly filled composite resin in which the filler particles have been altered so that the material is condensable in a manner similar to amalgam

condensation reaction: any chemical reaction between two molecules to form a larger molecule, with the elimination of a smaller molecule

conditional color match: a pair of colors that appear to match only under limited conditions, such as a particular light source and a particular observer, a metameric match

condylar agenesis: a developmental abnormality characterized by the absence of a condyle

condylar articulator: an articulator whose condylar path components are part of the lower member and whose condylar replica components are part of the upper member—called also *nonarcon articulator*

condylar axis: a hypothetical line through the mandibular condyles around which the mandible may rotate

condylar dislocation: a condition in which the mandibular condyle is displaced within the temporomandibular joint, usually forward of the condylar eminence—called also *luxation*

condylar displacement: see MANDIBULAR DISLOCATION

[1]**condylar guidance** *vt*: mandibular guidance generated by the condyle and articular disc traversing the contour of the glenoid fossae

[2]**condylar guidance** *n*: the mechanical form located in the upper posterior region of an articulator that controls movement of its mobile member

condylar guide assembly: the components of an articulator that guide movement of the condylar analogues

condylar guide inclination: the angle formed by the inclination of a condylar guide control surface of an articulator and a specified reference plane—see LATERAL CONDYLAR INCLINATION

condylar hinge position *obs*: the position of the condyles of the mandible in the glenoid fossae at which hinge axis movement is possible (GPT-4)

condylar inclination *obs*: the direction of the lateral condyle path (GPT-4)

condylar path: that path traveled by the mandibular condyle in the temporomandibular joint during various mandibular movements

condylar path element: the member of a dental articulator that controls the direction of condylar movement

condylar path tracing: a graphic registration of the movement of the condyle—see MANDIBULAR TRACING

condylar slant: see CONDYLAR PATH, LATERAL CONDYLAR PATH

condylar subluxation: an incomplete or partial dislocation of the condyle

con.dy.lar.thro.sis *n*: an ellipsoidal articulation, a modification of the ball/socket type of synovial joint in which the articular surfaces are ellipsoid rather than spheroid. Owing to the arrangement of the muscles and ligaments around the joint, all movements are permitted except rotation about a vertical axis—called also *articulation ellipsoidea, condylar articulation, condylar joint, condyloid joint, or ellipsoidal joint*

con.dyle *n* (1634): an articular prominence of a bone, i.e. in the mandible, an ellipsoidal projection of bone, usually for articulation with another bone—**con.dy.lar** *adj*—see CONDYLAR PATH, LATERAL CONDYLAR PATH, MANDIBULAR CONDYLE, NECK OF THE CONDYLE

condyle chord: see CONDYLAR AXIS

condyle head: see CONDYLE

condyle path: see CONDYLAR PATH

cone *n* (1562): one of the receptors of color vision found in the retinal layer of the eye and concentrated in the macula lutea

con.gen.i.tal *adj* (1796): existing at, and usually before birth; referring to conditions that are present at birth, irrespective of their causation

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crep.i.ta.tion *n*: a crackling or grating noise in a joint during movement, liken to the throwing of fine salt into a fire or rubbing hair between the fingers; the noise made by rubbing together the ends of a fractured bone

crep.i.tus *n*: see CREPITATION, JOINT C.

crest *n* (14c): a ridge or prominence on a part of a body; in dentistry, the most coronal portion of the alveolar process

crest of the ridge: the highest continuous surface of the residual ridge—not necessarily coincident with the center of the ridge

crevicular epithelium: the nonkeratinized epithelium of the gingival crevice

crevicular fluid: the fluid that seeps through the crevicular epithelium; this is usually increased in the presence of inflammation

cribriform plate *obs*: in dentistry, the alveolar bone proper

cris.to.ba.lite *n*: an allotropic form of crystalline silica used in dental casting investments

cross arch balance: see CAB ARTICULATION

cross arch balanced articulation: the simultaneous contact of the buccal and lingual cusps of the working side maxillary teeth with the opposing buccal and lingual cusps of the mandibular teeth, concurrent with contact of the nonworking side maxillary lingual cusps with the mandibular buccal cusps

cross arch stabilization: resistance against dislodging or rotational forces obtained by using a removable partial denture design that uses natural teeth on the opposite side of the dental arch from the edentulous space to assist in stabilization

cross bite: see REVERSE ARTICULATION

cross bite teeth: see REVERSE ARTICULATION TEETH

cross bite occlusion: see REVERSE ARTICULATION

Cross pinning: the augmentation achieved in retention of a cast restoration by the placement of a pin through the axial wall of a dental casting into dentin

cross tooth balance: see BALANCED ARTICULATION, CROSS TOOTH BALANCED ARTICULATION

cross tooth balanced articulation: the harmonious contact of opposing working side buccal and lingual cusps

[1]**crown** *n* (12c) **1**: the highest part, as the topmost part of the skull, head or tooth; the summit; that portion of a tooth occlusal to the dentinoenamel junction or an artificial substitute for this **2**: an artificial replacement that restores missing tooth structure by surrounding part or all of the remaining structure with a material such as cast metal, porcelain, or a combination of materials such as metal and porcelain

[2]**crown** *vt* (12c): to place on the head, as to place a crown on a tooth, dental implant or tooth substitute—*usage*: implies fabrication of a restoration for a tooth on a natural tooth or dental implant

crown flask: a sectional, box like case in which a sectional mold is made of artificial stone or plaster of Paris for the purpose of processing dentures or other resinous restorations

crown-fracture: micro or macroscopic cleavage in the coronal portion of a tooth

crown lengthening *slang*: see LENGTHENING OF THE CLINICAL CROWN

crown-root ratio: the physical relationship between the portion of the tooth within alveolar bone compared with the portion not within the alveolar bone, as determined by radiograph

crown slitter *obs*: a mechanical device used to slit the axial surface of a swayed artificial crown to facilitate its removal (GPT-4).

cru.ci.ble *n* (15c): a vessel or container made of any refractory material (as porcelain) used for melting or calcining any substance that requires a high degree of heat

crucible former: the base to which a sprue former is attached while that wax pattern is being invested in refractory investment; a convex rubber, plastic, or metal base that forms a concave depression or crucible in the refractory investment

CT: *acronym for Computerized Tomography*

crypt *n* (1789) **1**: a chamber wholly or partly underground **2**: in anatomy, a pit, depression or simple tubular gland

cuff *n* (14c): something that encircles; a band about any body

cul.de.sac *n* (1738): a blind pouch or tubular cavity closed at one end

cumulative dose: the total accumulated dose resulting from a single or repeated exposure to radiation of the same region or of the whole body; if used in area monitoring, it represents the accumulated radiation exposure over a given period of time

cure *vb* (14c): see POLYMERIZE

[1]**curve** *adj* (15c): bent or formed into a curve

[2]**curve** *vb* **curved; curv.ing** *vi* (1594): to take a turn, change, or deviation from a straight line or plane surface without angularity or sharp breaks; a non-angular deviation from a straight line or surface—see REVERSE C.

curve of Monson [George S Monson, St Paul, Minnesota, US dentist, 1869-1933]: *eponym* for a proposed ideal curve of occlusion in which each cusp and incisal edge touches or conforms to a segment of the surface of a sphere 8 inches in diameter with its center in the region of the glabella

Monson GS. Occlusion as applied to crown and bridgework. J Nat Dent Assoc 1920;7:399-417.

Monson GS. Some important factors which influence occlusion. J Nat Dent Assoc 1922;9:498-503.

curve of occlusion: the average curve established by the incisal edges and occlusal surfaces of the anterior and posterior teeth in either arch

curve of Pleasure [Max A. Pleasure, New York, US dentist, 1903-1965] **1**: *eponym* for a helicoid curve of occlusion that, when viewed in the frontal plane, conforms to a curve that is convex from the superior view, except for the last molars which reverse that pattern **2**: in excessive wear of the teeth, the obliteration of the cusps and formation of either flat or cupped-out occlusal surfaces, associated with reversal of the occlusal plane of the premolar, first and second molar teeth (the third molars being generally unaffected), whereby the occlusal surfaces of the mandibular teeth slope facially instead of lingually and those of the maxillary teeth incline lingually—*syn* ANTIMONSON CURVE, FREQUENCY CURVE, PROBABILITY CURVE, REVERSE CURVE

Pleasure MA. Prosthetic occlusion—a problem in mechanics. J Am Dent Assoc and Dent Cosmos 1937;24:1330-8.

Pleasure MA. Practical full denture occlusion. J Am Dent Assoc Dent Cosmos 1938;25:1606-17.

curve of Spee [Ferdinard Graf Spee, Prosector of Anatomy, Kiel, Germany, 1855-1937]: *eponym* for ANTEROPOSTERIOR CURVE

Spee FG. Die Verschiebrangsbahn des Unterkiefers am Schadell. Arch Anat Physiol (Leipz) 1890;16:285-94.

curve of Wilson [George H Wilson, Cleveland, Ohio, US dentist, 1855-1922] **1**: *eponym* for the MEDIOLATERAL CURVE **2**: in the theory that occlus on should be spherical, the curvature of the cusps as projected on the frontal plane expressed in both arches; the curve in the lower arch being concave and the one in the upper arch being convex. The curvature in the lower arch is affected by an equal lingual inclination of the right and left molars so that the tip points of the corresponding cross-aligned cusps can be placed into the circumferences of a circle. The transverse cuspal curvature of the upper teeth is affected by the equal buccal inclinations of their long axes

Wilson GH. A manual of dental prosthetics. Piladelphia Lea and Febiger; 1911;22-37.

cur.vi.lin.ear *adj* (1710): consisting of or bounded by curved lines; represented by a curved line

cusp angle: the angle made by the average slope of a cusp with the cusp plane measured mesiodistal or buccolingually

cusp height: the perpendicular distance between the tip of a cusp and its base plane

cusp plane: the plane determined by the two buccal cusp tips and the highest lingual cusp of a molar

cusp plane angle: the incline of the cusp plane in relation to the plane of occlusion

cuspal interference: see DEFLECTIVE OCCLUSAL CONTACT

cuspid guidance: see CANINE PROTECTED ARTICULATION

cuspid guided articulation: see CANINE PROTECTED ARTICULATION

cuspid lift: see CANINE PROTECTED ARTICULATION

cuspid lifted articulation: see CANINE PROTECTED ARTICULATION

cuspid protected occlusion: see CANINE PROTECTED ARTICULATION

cuspid rise: see CANINE PROTECTED ARTICULATION

cuspid rise articulation: see CANINE PROTECTED ARTICULATION

cuspless teeth: teeth designed without cuspal prominence on the occlusal surface—see NONANATOMIC TEETH, ZERODEGREE TEETH

custom tray: an individualized impression tray made from a cast recovered from a preliminary impression. It is used in making a final impression

cy.a.no.ac.ry.late *n* (20c): a single component, moisture activated, thermoplastic, group of adhesives characterized by rapid polymerization and excellent bond strength

D

Davis crown [Wallace Clyde Davis, Lincoln, Nebraska, US dentist (1866-1950)] *obs*: *eponym* for a dental restoration supported by a dowel in the root canal over which was cemented a porcelain tube tooth in direct contact with the root face of the tooth. A later modification involved a gold casting that improved the fit between the root and artificial tooth

Davis WC. Essentials of operative dentistry. 1st ed Lincoln, Neb: Author as publisher, 1911.

Davis WC. Essentials of operative dentistry. 2nd ed. St Louis: CV Mosby; 1916.

de.bride.ment *n* (ca. 1842): the removal of inflamed, devitalized, contaminated tissue or foreign material from or adjacent to a lesion

deciduous dentition: see PRIMARY DENTITION

de.cor.ti.ca.tion *n* (ca. 1623) **1**: a process of removing the outer covering (as in enamel, bark, husks, etc.) from something **2**: surgical removal of the cortex of an organ, an enveloping membrane or fibrinous covering—**de.cor.ti.cate** *vt*—**de.cor.ti.cat.or** *n*

decreased occlusal vertical dimension: a reduction in the distance measured between two anatomic points when the teeth are in occlusal contact

deep bite: see VERTICAL OVERLAP

deep beat therapy: see DIATHERMY

defective color vision: the condition in which color discrimination is significantly reduced in comparison with the normal trichromat. The forms of color defective vision can be divided into three main groups—dichromatic vision, anomalous trichromatic vision and monochromatic vision—see COLOR BLINDNESS, COLOR DEFICIENCY

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the most support at initial placement determines which category is used to best describe the dental implant—see also ENDOSTEAL DENTAL IMPLANT, EPOSTEAL DENTAL IMPLANT, TRANSOSTEAL DENTAL IMPLANT—*comp* MUCOSAL INSERT

dental impression: a negative imprint of an oral structure used to produce a positive replica of the structure to be used as a permanent record or in the production of a dental restoration or prosthesis—see IMPRESSION

dental impression wax: any thermoplastic wax used to make impressions for dental use

dental plaster: the beta-form of calcium sulfate hemihydrate. It is a fibrous aggregate of fine crystals with capillary pores that are irregular in shape and porous in character

dental prosthesis: an artificial replacement of one or more teeth and/or associated structures

dental prosthetic laboratory procedures: the steps in the fabrication of a dental prosthesis that do not require the presence of the patient for their completion

dental senescence: that condition of the teeth and associated structures in which there is deterioration due to aging or premature aging processes

dental shade selection: see TOOTH COLOR SELECTION

dental stone: the alpha-form of calcium sulfate hemihydrate with physical properties superior to the beta-form (dental plaster). The alpha-form consists of cleavage fragments and crystals in the form of rods or prisms, and is therefore more dense than the beta-form

den.tin *n* (1840): a calcareous material similar to but harder and denser than bone that comprises the principle mass of the tooth—**den.tin.al** *adj*; also spelled **den.tine**

den.ti.tion *n* (1615): the teeth in the dental arch

dentofacial orthopedics: the branch of dentistry that treats abnormal jaw and tooth relationships

den.to.form: having the likeness of a tooth; a tooth-like substitute

den.tu.lous *adj* (1926) **1**: possessing natural teeth **2**: a condition in which natural teeth are present in the mouth—*syn* DENTATE

den.ture *n* (1874): an artificial substitute for missing natural teeth and adjacent tissues—*usage*: see COMPLETE D., DIAGNOSTIC D., DUPLICATE D., EXTENSION BASE REMOVABLE PARTIAL D., FIXED PARTIAL D., IMMEDIATE D., INTERIM D., OVERDENTURE, PARTIAL D., PROVISIONAL D., REMOVABLE PARTIAL D., ROTATIONAL PATH REMOVABLE PARTIAL D., TRANSITIONAL D., TREATMENT D., TRIAL D., UNILATERAL REMOVABLE PARTIAL D.

denture adhesive: a material used to adhere a denture to the oral mucosa

denture basal surface: see DENTURE BASE

denture base: the part of a denture that rests on the foundation tissues and to which teeth are attached—usage: see TINTED DB

denture base material: any substance of which a denture base may be made

denture base saddle *obs* **1**: the part of a denture that rests on the oral mucosa and to which the teeth are attached **2**: the part of a complete or removable partial denture that rests on the basal seat and to which the teeth are attached (GPT-4)—see DENTURE BASE

denture bearing area: see DENTURE FOUNDATION AREA

denture border 1: the margin of the denture base at the junction of the polished surface and the impression surface **2**: the peripheral border of a denture base at the facial, lingual, and posterior limits

denture characterization: modification of the form and color of the denture base and teeth to produce a more lifelike appearance

denture curing *obs*: the process by which the denture base materials are hardened to the form of a denture mold (GPT-4)—see DENTURE PROCESSING

denture design *obs*: a planned visualization of the form and extent of a dental prosthesis arrived at after study of all factors involved (GPT-4)

denture esthetics: the effect produced by a dental prosthesis that affects the beauty and attractiveness of the person

denture flange: the part of the denture base that extends from the cervical ends of the teeth to the denture border

denture flask: see CASTING FLASK, CROWN FLASK

denture foundation: the oral structures available to support a denture

denture foundation area: the surfaces of the oral structures available to support a denture

denture occlusal surface: the portion of the surface of a denture that makes contact with its antagonist

denture packing: the act of pressing a denture base material into a mold within a refractory flask

denture placement: see PLACEMENT

denture polished surface: the portion of the surface of a denture that extends in an occlusal direction from the border of the denture and includes the palatal surface. It is the part of the denture base that is usually polished, and it includes the buccal and lingual surfaces of the teeth

denture processing 1: the means by which the denture base materials are polymerized to the form of a denture **2**: the conversion of the wax pattern of a denture or a portion of a denture into resin or other material

denture prognosis *obs*: an opinion or judgement given in advance of treatment for the prospects for success in the fabrication of dentures and for their usefulness (GPT-4)

denture prosthetics *obs* **1**: the replacement of the natural

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displacement of the mandible: any abnormal relationship of the mandible when at rest

dis.tal *adj* (1808): remote; farther from the point of reference; away from the median sagittal plane of the face following the curvature of the dental arch

distal extension partial denture: see EXTENSION BASE REMOVABLE PARTIAL DENTURE

dis.to.clu.sion: see ANGLE'S CLASSIFICATION OF OCCLUSION

dis.to.ver.sion *vb*: deviation toward the distal

distraction of the condyle: placement of the condyle farther than normal from the median plane

distributed mandibular lateral translation: see PROGRESSIVE MANDIBULAR LATERAL TRANSLATION

disuse atrophy: diminution in the size of a cell, tissue, organ, or part as a result of inactivity

di.ver.gence *n* (1656) **1**: a drawing apart as a surface extends away from a common point **2**: the reverse taper of walls of a preparation for a restoration—**di.ver.gen.cy** *n, pl* **.cies** (1709)

divergence angle (1998): the sum of the angles of taper of opposing walls of a tooth preparation that diverge away from each other

docking device: see RADIATION CONE LOCATOR

Dolder bar [Eugene J. Dolder, Zurich, Switzerland prosthodontist]: *eponym* for one of many bar attachments that splint teeth or roots together while acting as removable partial denture abutments. The bar is straight with parallel sides and a round top. The sleeve or clip that fits over the bar gains retention by friction only. The bar is of variable sizes and is pear shaped in cross section, as is its accompanying sleeve. This clip allows for some measure of rotational movement about the bar

Dolder EJ. The bar joint mandibular denture. J Prosthet Dent 1961;11:689-707.

donor site: an area of the body from which a graft is taken

double wire clasp *obs*: a back-to-back wire circumferential clasp

dove.tail *n* (1565): a widened portion of a prepared cavity used to increase retention and/or resistance

dow.el *n* (13c): a post, usually made of metal that is fitted into a prepared root canal of a natural tooth. When combined with an artificial crown or core, it provides retention and resistance for the restoration

dowel core crown: see POST-CORE CROWN

dowel crown *obs*: see *DAVIS CROWN, RICHMOND CROWN*

dowel pin: a metal pin used in stone casts to remove die sections and replace them accurately in the original position

drag *n*: the lower or cast side of a refractory flask to which the cope is fitted

draw *vt* (bef. 12c): the taper or convergence of walls of a preparation for a restoration; *slang*—DRAFT, DRAUGHT

duc.til.i.ty *n* (14c): the ability of a material to withstand permanent deformation under a tensile load without rupture; ability of a material to be plastically strained in tension. A material is brittle if it does not have appreciable plastic deformation in tension before rupture

dum.my *n, pl* **dum.mies** (1598) *obs*: the replacement tooth or pontic in a fixed partial denture

duplicate denture: a second denture intended to be a replica of the first

du.rom.e.ter *n* (ca. 1890): an instrument for measuring hardness

DWT: *acronym* for *Dime WeighT*, called also pennyweight a measurement of weight in the troy system equal to 24 grains, or 0.05 ounce. Its metric equivalent is 1.555 gm—abbr *pwt*

dye *n*: a colorant that does not scatter light but absorbs certain wave lengths and transmits others

dynamic relations *obs*: relations of two objects involving the element of relative movement of one object to another; as the relationship of the mandible to the maxillae (GPT-4)

dynamic splint: see FUNCTIONAL OCCLUSAL SPLINT

dys.es.the.sia *n*: an unpleasant abnormal sensation

dys.func.tion *n* (ca. 1916): the presence of functional disharmony between the morphologic form (teeth, occlusion, bones, joints) and function (muscles, nerves) that may result in pathologic changes in the tissues or produce a functional disturbance

dys.geu.sia *n*: any distortion in the sense of taste

dys.ki.ne.sia *n* (ca. 1706): impairment of the power of voluntary movement resulting in fragmentary or incomplete movement—see also INCOORDINATION

dys.la.lia *n*: defective articulation due to faulty learning or to abnormality of the external speech organs and not due to lesions of the central nervous system

dys.ma.se.sis *n*: difficulty in mastication

dys.os.to.sis *n*: imperfect ossification

dys.pha.gia *n*: difficulty in swallowing

dys.pho.nia *n* (ca. 1706): an impairment in the voice; difficulty in speaking

dys.pla.sia *n* (ca. 1923): abnormality of development—see MANDIBULAR D, MAXILLOMANDIBULAR D

dys.to.nia *n*: acute irregular tonic muscular spasms, often with contortions of the tongue, jaw, eyes, neck, and sometimes the entire body

E

ear.bow *n* (20c): an instrument similar to a face-bow that indexes to the external auditory meatus and registers the relation of the maxilary dental arch to the external auditory meatus and a horizontal reference plane. This instrument is used to transfer the maxillary cast to the articulator. The ear-bow provides an average anatomic dimension between the external auditory meatus and the horizontal axis of the mandible—see FACE-BOW

early closing click: a click emanating from the temporomandibular joint that occurs at the initiation of retrusive translation

early mandibular lateral translation: the translatory portion of lateral movement in which the greatest portion occurs early in the forward movement of the nonworking side condyle as it leaves centric relation—see IMMEDIATE MANDIBULAR LATERAL TRANSLATION

early opening click: a temporomandibular joint click that occurs at initiation of the translation of the condyle(s)

eccentric *adj* (14c) **1**: not having the same center **2**: deviating from a circular path **3**: located elsewhere than at the geometric center **4**: any position of the mandible other than that which is its normal position

eccentric checkbite: see ECCENTRIC INTEROCCLUSAL RECORD

eccentric interocclusal record: a registration of any maxillo-mandibular position other than centric relationship

eccentric jaw record: see ECCENTRIC INTEROCCLUSAL RECORD

eccentric jaw relation *obs*: any relationship between the jaws other than centric relation (GPT-4)

eccentric occlusion: an occlusion other than centric occlusion

eccentric position: see ECCENTRIC RELATION

eccentric record: see ECCENTRIC INTEROCCLUSAL RECORD

eccentric relation: any relationship of the mandible to the maxilla other than centric relation—see ACQUIRED ER

ec.top.ic *adj* (1873): occurring in an abnormal position or in an unusual manner or form—**ec.top.i.cal.ly** *adv*

ectopic eruption: eruption of a tooth out of its normal place or position

ede.ma *n* (15c): abnormal accumulation of fluid in the tissues

eden.tics *n, obs*: the art, science, and technique used in treating edentulous patients (GPT-4)

e.den.tu.late *adj, obs*: without teeth, lacking teeth (GPT-4)

e.den.tu.lous *adj* (1782): without teeth, lacking teeth

edentulism (1998): the state of being edentulous, without natural teeth

edge to edge articulation: articulation in which the opposing anterior teeth meet along their incisal edges when the teeth are in maximum intercuspation

edge to edge bite: see EDGE TO EDGE ARTICULATION

edge to edge occlusion: see EDGE TO EDGE ARTICULATION

educationally qualified prosthodontist: in the United States as defined by the American Board of Prosthodontics, a prosthodontist who has successfully completed an advanced educational program accredited by the ADA and is eligible to apply for examination by the American Board of Prosthodontics.

elas.tic *adj* (1653): susceptible to being stretched, compressed, or distorted and then tending to resume the original shape

elastic limit: the greatest stress to which a material may be subjected and still be capable of returning to its original dimensions when such forces are released

elastic modulus: the stiffness or flexibility of a material within the elastic range. Within the elastic range, the material deforms in direct proportion to the stress applied as represented by Hooke's law

elas.tic.i.ty *n* (1664): the quality that allows a structure or material to return to its original form on removal of an external force—see MODULUS OF E

elas.to.mer *n* (ca. 1934): a polymer whose glass transition temperature is below its service temperature (usually room temperature). These materials are characterized by low stiffness and extremely large elastic strains—**elas.to.mer.ic** *adj*

electrical discharge machining 1: the process by which metal(s) is(are) altered in form using electrical current through conductive objects brought into physical contact with the metal surface **2**: a precision metal removal process using an accurately controlled electrical discharge (a spark) to erode metal, usually performed in a liquid dielectric medium—*syn* SPARK EROSION

elec.trode *n* (1834) **1**: a medium used between an electric conductor and the object to which it is to be applied **2**: a X-ray tube component from which electrons emanate or to which they are attracted. The positive electrode is the anode, the negative electrode is the cathode

electromagnetic spectrum: the range of energy waves that extend from gamma rays to radio waves. The eye is sensitive to a very narrow band of wave lengths between about 380 and 760 nm

electromagnetic wave: a disturbance that propagates outward from any electric charge that oscillates or is accelerated, far from the charge, it consists of vibrating electric and magnetic fields that move at the speed of light and are at right angles to each other and to the direction of motion

electromyographic biofeedback: an instrumental process that helps patients learn control over muscle tension levels previously under automatic control

elec.tro.my.og.ra.phy *n* (1948): the graphic recording of the electrical potential of muscle—see NOCTURNAL E

elec.tron *n* (1891): the elemental unit of electricity. A stable elementary particle that is the negatively charged constituent of ordinary matter, having a mass of about 9.11×10^{-28} g (equivalent to 0.511 MeV) and a charge of about -1.602×10^{-19} Coulomb—called also *negative electron, negatron*

electron accelerator: a device used in radiation treatment that accelerates electrons to high energies

electron beam therapy: treatment by electrons accelerated to high energies by a machine such as the betatron

electron volt: a unit of energy equal to the energy acquired by an electron when it passes through a potential difference of 1 volt in a vacuum; it is equal to $(1.602192 \pm 0.000007) \times 10^{-19}$ volt. Abbreviated *eV*

elec.tro.plat.ing *vt* (ca. 1864): the process of covering the surface of an object with a thin coating of metal by means of electrolysis

elec.tro.pol.ish.ing *vt*: the electrolytic removal of a thin layer of metal to produce a bright surface

el.e.ment (1993): any component part of a dental implant abutment elevator muscle: one of the muscles that, on contracting, elevate or close the mandible

e.lon.ga.tion *n* (14c) **1**: deformation as a result of tensile force application **2**: the degree to which a material will stretch before breaking **3**: the over eruption of a tooth

em.bed.ment *n* (1794): the process of using a ceramic powder mixed with water to surround a glass-ceramic casting. The purpose of the procedure is to prevent distortion and limit the shrinkage of the casting

em.bou.chure *n* (1760): the position and use of the lips, tongue, and teeth in playing a wind instrument

em.bra.sure *n* (1702) **1**: the space formed when adjacent surfaces flair away from one another **2**: in dentistry, the space defined by surfaces of two adjacent teeth; there are four embrasure spaces associated with each proximal contact area: occlusal/incisal, mesial, distal, and gingival.

em.brittle *vt*: to make brittle or plastic

emergence angle (1993): the angle of the dental implants' transitional contour determined by the surface of the abutment to the long axis of the implant body

emergence profile: the contour of a tooth or restoration, such as a crown on a natural tooth or dental implant abutment, as it relates to the adjacent tissues

EMG: *acronym* for *ElectroMyoGram*

em.i.nence *n* (15c): a prominence or projection, especially one on the surface of a bone

empty mouth movement: voluntary or reflex movements of the mandible when not engaged in incision or mastication

en.am.el *n* (15c): in dentistry, the hard, thin, translucent layer of calcified substance that envelopes and protects the dentin of the coronal aspect of the tooth; it is the hardest substance in the body—called also *adamantine layer*

enamel projection: an apical extension of enamel, usually toward a furcation in the roots

en.am.el.o.plas.ty *n*: see OCCLUSAL RESHAPING

en.ar.thro.sis *n* (1634): joints with a ball and socket arrangement (e.g., hip)

endodontic endosteal dental implant: a smooth and/or threaded pin implant that extends through the root canal of a tooth into periapical bone and is used to stabilize a mobile tooth

endodontic pin *obs*: a metal pin that is placed through the apex of a natural tooth into the bone to stabilize a mobile tooth (GPT-4)—see ENDODONTIC ENDOSTEAL DENTAL IMPLANT

endodontic stabilizer: see ENDODONTIC ENDOSTEAL DENTAL IMPLANT

en.dog.e.nous *adj* (1830): developing or originating within the organism

en.do.scope *n* (1861): a flexible or rigid thin tube used for examining the interior of a structure

endosseous blade implant: see BLADE ENDOSTEAL DENTAL IMPLANT

endosseous implant: see ENDOSTEAL DENTAL IMPLANT

endosteal dental implant: a device placed into the alveolar and/or basal bone of the mandible or maxilla and transecting only one cortical plate. The endosteal dental implant is composed of an anchorage component, termed the *endosteal dental implant body*, which, ideally, is within the bone, and a retentive component, termed the *endosteal dental implant abutment*. The dental implant abutment connects to the dental implant body (by means of screws, thread/screw interfacing, compression/luting agent, etc. that can be termed *elements*), passes through the oral mucosa, and serves to support and/or retain the prosthesis (whether fixed or removable). The dental implant abutment may be for *interim* or *definitive* application—*usage*: interim abutment, definitive abutment. Descriptions of the dental implant body or/and the dental implant abutment that use silhouette or geometric forms, such as cylinder, conical, pre-angled, angled, blade, basket, or endodontic, may be used as adjectives to enhance understanding of the geometry of any endosteal dental implant. Also, descriptive adjectives may be used to delineate the materials from which they are made, i.e., a *ceramic* dental implant abutment. *Interim or definitive dental implant abutments* may be composed of one or more individual component parts, each of which is termed an *element*. The dental implant abutment element(s) usually is(are) described by means of their geometric form, function or means of adaptation, i.e., screw, coping, cylinder, lug, friction fitting, pressfit. Hence multiple adjectives may be used to describe both the endosteal dental implant body and abutment—see also BASKET EDI, BLADE EDI, DENTAL IMPLANT, ENDODONTIC EDI, EPOSTEAL DI, SCREW EDI, TRANSOSTEAL DI

endosteal dental implant body (1998): that portion of the dental implant that provides the anchorage to the bone through the process of tissue integration

endosteal dental implant abutment (1998): that portion of the dental implant which passes through the oral mucosa and provides connection between the endosteal dental implant body and the prosthesis

endosteal dental implant abutment element(s) (1998): any component used to secure either the dental implant abutment to the dental implant body or the prosthesis to the dental implant abutment.

end.to.end bite: see EDGE TO EDGE ARTICULATION

end.to.end occlusion: see EDGE TO EDGE ARTICULATION

entrance port: the area of the surface of a patient or phantom on which a radiation beam is incident

envelope of function: the three-dimensional space contained within the envelope of motion that defines mandibular movement during masticatory function and/or phonation

envelope of motion: the three-dimensional space circumscribed by mandibular border movements within which all unstrained mandibular movement occurs

epithelial attachment: see JUNCTIONAL EPITHELIUM

epithelial cuff: a term used to describe the relationship between the mucosal and the dental implant. The use of this term implies a close adherence, but not necessarily a biochemical attachment, between the implant and mucosa

ep.i.the.li.um *n, pl*-**lia** (1748): the mucosal tissue serving as the lining of the intraoral surfaces. It extends into the gingival crevice and adheres to the tooth at the base of the crevice—see CREVICULAR E, JUNCTIONAL E

ep.i.the.li.za.tion *n* (ca. 1934): the process of becoming covered with or converted to epithelium—**ep.i.the.lize** *vt*

eposteal dental implant: any dental implant that receives its primary bone support by means of resting upon the bone—*usage*: a subperiosteal dental implant that conforms to the superior surface of an edentulous area of alveolar bone is an *eposteal dental implant*. Any retaining screws or other *elements* that may secure the eposteal framework to the alveolar bone and pass endosteally represent endosteal dental implant components. Should the eposteal framework penetrate the alveolar bone, technically, the framework becomes an endosteal dental implant—see ENDOSTEAL DENTAL IMPLANT, SUBPERIOSTEAL DENTAL IMPLANT, TRANSOSTEAL DENTAL IMPLANT

epoxy resin: a resin characterized by the reactive epoxy or ethyloxyline groups that possess unique characteristics in terms of adhesion to metals, woods, and glasses

epoxy resin die: a reproduction formed in epoxy resin

equalisation of pressure: the act of equalizing or evenly distributing pressure

equil-i-brate *v*-**brat.ed**; -**brat.ing** *vt* (1635): to bring or to place in equilibrium

equil.i.bra.tion *n* (1635) **1**: the act or acts of placing a body in a state of equilibrium **2**: the state or condition of being in equilibrium—*usage*: see MANDIBULAR E., OCCLUSAL E.

equil.i.bra.tor *n* (19c) *obs*: an instrument or device used in achieving or helping maintain a state of equilibrium (GPT-4)

equi.lib.ri.um (1608) **1**: a state of even adjustment between opposing forces **2**: that state or condition of a body in which any forces acting on it are so arranged that their product at every point is zero **3**: a balance between active forces and negative resistance

e.ro.sion *n* (1541) **1**: an eating away; a type of ulceration **2**: in dentistry, the progressive loss of tooth substance by chemical processes that do not involve bacterial action producing defects that are sharply defined, wedge-shaped depressions often in facial and cervical areas—*comp* ABFRACTION, ABRASION, ATTRITION

Essig splint [Norman S Essig, DDS, Prof of Prosthodontics, Temple University School of Dentistry]: eponym for a stainless steel wire passed labially and lingually around a segment of the dental arch and held in position by individual ligature wires around the contact areas of the teeth; it is used to stabilize fractured or repositioned, teeth and the involved alveolar bone. Variously ascribed to VH Jackson, DDS, (NY), CJ Essig, DDS, NS Essig, DDS (Pa), or WH Atkinson, DDS

Essig CJ, ed. The American textbook of prosthetic dentistry. Philadelphia: Lea Brothers and Co.; 1896;187:208.

Essig NS. Prosthetic dentistry. Brooklyn: Dental Items of Interest Publishing Co.; 1937.

es.thet.ic 1: pertaining to the study of beauty and the sense of beautiful. Descriptive of a specific creation that results from such study; objectifies beauty and attractiveness and elicits pleasure **2**: pertaining to sensation *var of* **AESTHETIC**

esthetic reshaping: modification of the surfaces of teeth to improve appearance

es.thet.ics *adj* (1798) **1**: the branch of philosophy dealing with beauty **2**: in dentistry, the theory and philosophy that deal with beauty and the beautiful, especially with respect to the appearance of a dental restoration, as achieved through its form and/or color. Those subjective and objective elements and principles underlying the beauty and attractiveness of an object, design or principle—see DENTAL E., DENTURE E.—**aes.thet.i.cal.ly** *adj*

Estlander's operation [Jakob August Estlander, Finnish surgeon, 1831-1881]: eponym for a lip switch operation. A triangular flap of tissue borrowed from the lower lip is transferred to the upper lip

[1]etch *vb, vt* (1634) **1a**: to produce a retentive surface, especially on glass or metal, by the corrosive action of an acid **1b**: to subject to such etching **2**: to delineate or impress clearly

[2]etch *n* (1896) **1**: the effect or action of an etching acid on a surface **2**: a chemical agent used in etching

etch.ant *n*: an agent that is capable of etching a surface

etch.ing *vt* (1632) **1**: the act or process of selective dissolution **2**: in dentistry, the selective dissolution of the surface of tooth enamel, metal, or porcelain through the use of acids or other agents (etchants) to create a retentive surface

ethylene oxide: a bactericidal agent occurring as a colorless gas with a pleasant ethereal odor; the chemical in gas sterilization system used for many items that cannot be sterilized in a high heat system; used as a disinfectant, especially for disposable equipment

etiologic factors: the elements or influences that can be assigned as the cause or reason for a disease or lesion—see LOCAL EF, SYSTEMIC EF

eti.ol.o.gy *n* (1555) **1**: the factors implicated in the cause or origin of a disease or disorder **2**: the study or theory of the factors causing disease

evis.cer.a.tion *n*: removal of the viscera or contents of a cavity. In ophthalmology, the removal of the contents of the eyeball, leaving the sclera

evul.sion *n* (1611): extraction; removed, usually of a sudden nature

ex.am.in.a.tion *n* (14c): scrutiny or investigation for the purpose of making a diagnosis or assessment

ex.cur.sion *n* (1577) **1**: a movement outward and back or from a mean position or axis; also, the distance traversed **2**: in dentistry, the movement occurring when the mandible moves away from maximum intercuspation

ex.cur.sive *adj* (1673): constituting a digression; characterized by digression

excursive movement: movement occurring when the mandible moves away from maximum intercuspation

ex.en.ter.a.tion *n*: removal of an organ. Used in connection with the eye, an *orbital exenteration* denotes the removal of the entire eye and surrounding structures

exercise prosthesis: a temporary, removable dental prosthesis, usually without teeth and always without occluding contact, used for the purpose of reconditioning the supporting structures (especially the residual ridge) by means of light, intermittent biting pressure applied against bilaterally interposed fingers

expansion prosthesis: a prosthesis used to expand the lateral segment of the maxilla in a unilateral or bilateral cleft of the soft and hard palates and alveolar processes

ex.po.sure *n* (1606) **1**: the act of laying open, as a surgical or dental exposure **2**: in radiology, a measure of the roentgen rays or gamma radiation at a certain place based on its ability to cause ionization. The unit of exposure is the roentgen, called also exposure dose—see ROENTGEN RAY

ex.ten.sion *n* (15c) **1**: the movement by which the two elements of any jointed part are drawn away from each other, the process of increasing the angle between two skeletal levers having end-to-end articulation with each other. The opposite of flexion **2**: in maxillofacial prosthetics, that portion of a prosthesis added to fill a defect or provide a function not inherent in a dental restoration, e.g., palatal extension, pharyngeal extension—see SECTION

extension base removable partial denture: a removable partial denture that is supported and retained by natural teeth only at one end of the denture base segment and in which a portion of the functional load is carried bythe residual ridge

extension bridge: see CANTILEVER FIXED PARTIAL DENTURE

extension outline *obs* **1**: the outline of the area of the entire basal seat of a denture **2**: the outline on the surface of a cast or mucous membrane that includes the entire area to be covered by a denture (GPT-1)

external oblique ridge: a smooth ridge on the buccal surface of the body of the mandible that extends from the anterior border of the ramus, with diminishing prominence, downward and forward to the region of the mental foremen. This ridge changes very little in size and direction throughout life

ex.tir.pate *vt* **-pat.ed; .pat.ing** (1539) **1**: to pull up or out to destroy completely **2**: to cut out by surgery—**ex.tir.pa.tion** *n*

extracapsular ankylosis: ankylosis due to rigidity of any structure external to the joint capsule

extracapsular disorder: a problem associated with the masticatory system in which the etiological factors are located outside of the temporomandibular joint capsule

ex.tra.coro.nal *adj*: that which is outside or external to, the crown portion of a natural tooth; e.g., an extracoronal preparation, restoration, partial or complete crown

extracoronal retainer: that part of a fixed partial denture uniting the abutment to the other elements of a fixed partial denture that surrounds all or part of the prepared crown

extraoral tracing: a tracing of mandibular movements made by means of devices that extend outside the oral cavity; a tracing made outside the oral cavity

ex.tra.ver.sion: see LABIOVERSION

ex.trin.sic *adj* (1613): external, extraneous, as originating from or on the outside—**ex.trin.si.cal.ly** *adv*

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by artificial substitutes that are not readily removed from the mouth

[1]**fix.ture** *n*: something that is fixed or attached, as a structural part of a permanent prosthesis

[2]**fix.ture** *substand* (1982): an endosteal dental implant body—see ENDOSTEAL DENTAL IMPLANT, IMPLANT BODY

fixture cover *substand* (1982): the component placed over a dental implant during the healing phase to prevent tissue from proliferating into the internal portion of the implant body—see COVER SCREW

flabby tissue *obs*: excessive movable tissue (GPT-4)

[1]**flange** *n* (ca.1688): a rib or rim used for strength, for guiding or attachment of another object—see BUCCAL F., DENTURE F. LABIAL F.

[2]**flange** *vt*, **flang.ed; flang.ing** (ca. 1864): to furnish with a flange

flange contour *obs*: the design of the flange of a denture (GPT-4)

[1]**flask** *n*: a metal case or tube used in investing procedures—see CASTING F., CROWN F.

[2]**flask** *v*: to flask or surround; to invest

flask closure: the procedure of bringing two halves or parts, of a flask together—see FINAL F.C., TRIAL F.C.

flask.ing *vt* (20c) **1**: the act of investing in a flask **2**: the process or investing the cast and a wax replica of the dsired form in a flask preparatory to molding the restorative material into the desired product

flipper *obs*: see INTERIM PROSTHESIS; PROVISIONAL PROSTHESIS

flowable composite resin (1998): composite resin that is less highly filled than conventional composite resin and has improved wettability

flu.o.res.cence *n* (1852): a process by which a material absorbs radiant energy and emits it in the form of radiant energy of a different wave length band, all or most of whose wave lengths exceed that of the absorbed energy. Fluorescence, as distinguished from phosphorescence, does not persist for an appreciable time after the termination of the excitation process

flu.o.res.cent *adj* (1853): having or relating to fluorescence

fluoride gel carrier (20c): a device that covers the teeth and is used to apply topical fluoride in close proximity to tooth enamel and dentin for several minutes daily—*syn* FLUORIDE APPLICATOR

flux *n* (14c) **1**: in physics, the rate of flow of a liquid, particles or energy **2**: in ceramics, an agent that lowers the fusion temperature of porcelain **3**: in metallurgy, a substance used to increase fluidity and to prevent or reduce oxidation of a molten metal **4**: any substance applied to surfaces to be joined by brazing, soldering or welding to clean and free them from oxides and promote union

FMA: *acronym* for *Frankfort Mandibular* plane *Angle*

foil *n* (14c): an extremely thin, pliable sheet of metal, usually of variable thickness—see GOLD F., PLATINUM F., TINFOIL

force *n* (14c): an agency or influence that, when exerted on a body tends to set the body into motion or to alter its present state of motion. Force applied to oany material causing deformation of that material—see MASTICATORY F., OCCLUSAL F.

forces of mastication *obs*: the motive force created by the dynamic action of the muscles during the physiologic act of mastication (GPT-4)

[1]**form** *n* (13c): the shape or configuration of anything, as distinguished from its material

[2]**form** *vt* (13c): to give shape, to mold, to adapt

for.nix *n*, *pl* for **for.ni.ces** (1681): an anatomical arch or fold

forward protrusion *obs*: a protrusion forward of centric position (GPT-3)

fossa *n*, *pl* **fossae** (1771): an anatomical pit, groove or depression

foveae palatinae: two small pits or depressions in the posterior aspect of the palate, one on each side of the midline, at or near the attachment of the soft palate to the hard palate

[1]**frac.ture** *n* (15c): the process or act of breaking; state of being broken—see AVULSION F., BLOWOUT F., CEMENTUM F., CLOSED REDUCTION OF AF., COMMINUTED F., COMPLICATED F., DISLOCATED F., FISSURED F., GREEN STICK F., GUERIN'S F., IMPACTED F., INDIRECT F., INTRACAPSULAR F., MIDFACIAL F., OPEN F., PYRAMIDAL F., ROOT F., SECONDARY F., SIMPLE F., SPONTANEOUS F., SUBCONDYLAR F., SUBPERIOSTEAL F.

[2]**frac.ture** *v*, **frac.tured; frac.tur.ing** *vt* (1612): to cause a fracture in; to break, rupture, or tear

fracture strength: strength at fracture based on the original dimensions of the specimen

frame.work *n* (1644): the skeletal portion of prosthesis (usually metal) around which and to which are attached the remaining portions of the prosthesis to produce a finished restoration

Frankfort mandibular plane angle: *eponym* for the angle formed by the intersection of the Frnakfort horizontal plane with the mandibular plane

Frankfort horizontal plane 1: *eponym* for a plane established by the lowest point in the margin of the right or left bony orbit and the highest point in the margin of the right or left bony auditory meatus **2**: a horizontal plane represented in profile by a line between the lowest point on the margin of the orbit to the highest point on the margin of the auditory meatus; adopted at the 13th General Congress of German Anthropologists (the "Frankfort Agreement") at Frankfort am Main, 1882, and finally by the International Agreement for the Unification of Craniometric and Cephalometric

Measurements in Monaco in 1906; called also *auriculo-orbital plane, eye-ear plane, Frankfort horizontal (FH), Frankfort horizontal line*

Frankfort plane: see FRANKFORT HORIZONTAL PLANE

free gingiva: the part of the gingiva that surrounds the tooth and is not directly attached to the tooth surface

free gingival margin: the unattached gingiva surrounding the teeth in a collar-like fashion and demarcated from the attached gingiva by a shallow linear depression, termed the *free gingival groove*

free mandibular movement 1: any mandibular movement made without interference **2**: any uninhibited movement of the mandible

free support *obs*: support that does not permit translation of the beam perpendicular to its axis and presumably offers no restraint to the tendency of the beam to rotate at the support (GPT-4)

freedom in intercuspal position: see INTERCUSPAL CONTACT AREA

freeway space *obs*: see INTEROCCLUSAL REST SPACE

frem.i.tus *n* (1879): a vibration perceptible on palpation; in dentistry, a vibration palpable when the teeth come into contact

fren.u.lum *n, pl* **-la** (1706): a connecting fold of membrane serving to support or retain a part

fren.um *n, pl* **fren.ums** or **fre.na**: see FRENULUM

frictional attachment: a precision or semiprecision attachment that achieves retention by metal to metal contact, without springs, clips or other mechanical means of retention—see PRECISION ATTACHMENT

friction retained pin: a metal rod driven into a hole drilled into dentin to enhance retention; retained solely by dentinal elasticity

[1]**frit** *n* (1662) **1**: the calcined or partly fused matter of which glass is made **2**: a mass of fused porcelain obtained by firing the basic constituents and plunging them into water while hot. The frit is ground to make porcelain powders

[2]**frit** *vt* **fri.tted; frit.ing** (1805) **1**: to prepare substances for glass by heating; to fuse **2**: to convert into a frit

frontal plane: any plane parallel with the long axis of the body and at right angles to the median plane, thus dividing the body into front and back parts. So called because this plane roughly parallels the frontal suture of the skull

fulcrum line 1: a theoretical line passing through the point around which a lever functions and at right angles to its path of movement **2**: an imaginary line, connecting occlusal rests, around which a removable partial denture tends to rotate under masticatory forces. The determinants for the fulcrum line are usually the cross arch occlusal rests located adjacent to the tissue borne components—see F.L. OF A REMOVABLE PARTIAL DENTURE, RETENTIVE F.L.

fulcrum line of a removable partial denture: a theoretical line around which a removable partial denture tends to rotate

full denture: see COMPLETE DENTURE

full denture prosthetics *obs* **1**: the replacement of the natural teeth in the arch and their associated parts by artificial substitutes **2**: the art and science of the restoration of an edentulous mouth (GPT-4)—see COMPLETE DENTURE PROSTHODONTICS

full thickness graft: a transplant of epithelium consisting of skin or mucous membrane with a minimum of subcutaneous tissue

full veneer crown: see COMPLETE CROWN

fully adjustable articulator: an articulator that allows replication of three dimensional movement of recorded mandibular motion—called also *Class IV articulator*

fully adjustable gnathologic articulator: an articulator that allows replication of three dimensional movement plus timing of recorded mandibular motion—called also *Class IV articulator*

functional articulation: the occlusal contacts of the maxillary and mandibular teeth during mastication and deglutition

functional chew.in record *obs*: a record of the movements of the mandible made on the occluding surface of the opposing occlusion rim by teeth or scribing studs and produced by simulated chewing movements (GPT-4)

functional dislocation: dislocation of the articular disk of the condyle due to a seriously impaired disk-condyle complex function

functional jaw orthopedics: use of orthodontic appliances that rely on the patient's own musculature for force application and that attempt to alter the skeletal structure of the face

functional mandibular movements: all normal, proper, or characteristic movements of the mandible made during speech, mastication, yawning, swallowing, and other associated movements

functional occlusal harmony *obs*: the occlusal relationship of opposing teeth in all functional ranges and movements that will provide the greatest masticatory efficiency without causing undue strain or trauma on the supporting tissues (GPT-4)

functional occlusion *obs*: the contacts of the maxillary and mandibular teeth during mastication and deglutition (GPT-4)

functional record: a record of lateral and protrusive movements of the mandible made on the surface on an occlusion rim or other recording surface

functional occlusion splint: a device that directs the movements of the mandible by controlling the plane and range of motion

functional wax: see DENTAL IMPRESSION WAX

functionally generated path: a registration of the paths of movement of the occlusal surfaces of teeth or occlusion rims of one dental arch in plastic or other media attached to the teeth or occlusal rims of the opposing arch

functioning condyle: see WORKING SIDE CONDYLE

fur.ca.tion *n*: the anatomic region of a multirooted tooth where the roots diverge

G

gag *n* (1553) **1**: an involuntary contraction of the muscles of the soft palate or pharynx that results in retching **2**: a surgical device for holding the mouth open

galvanic skin response: the change in the electrical resistance of skin in response to diverse stimuli

galvanic stimulation: stimulation of muscles through the application of varying amplitudes and pulsations of electrical current; used in the treatment of muscle disorders

gal.va.nism *n* (1797): accelerated corrosion of a metal due to electrical contact with a more noble metal in a corrosive electrolyte. The resulting current flow can produce nerve stimulation, unpleasant tastes, and other physiological reactions commonly associated with this term

ga.vage *n* (1889): forced feeding especially through a tube passed into the stomach

generated occlusal path: see FUNCTIONALLY GENERATED PATH

ge.nial *adj* (1566): pertaining to the chin

genial tubercles: mental spines; rounded elevations (usually two pairs) clustered around the midline on the lingual surface of the lower portion of the mandibular symphysis. These tubercles serve as attachments for the genioglossus and geniohyoid muscles

ge.nio.plas.ty *n* **1**: a surgical procedure performed to alter the contour of the mandibular symphysis **2**: plastic surgery of the chin

ger.i.at.rics *n, pl* **but sing in constr** (1909): the branch of medicine that treats all problems peculiar to the aging patient, including the clinical problems of senescence and senility—see DENTAL G., GERODONTICS, GERODONTOLOGY

ger.odon.tics *n, pl but sing in constr*: the treatment of dental problems of aging persons; also spelled *geriodontics*

gerodontology *n*: the study of the dentition and dental problems in aged or aging persons

Gillett bridge [Henry W. Gillett] *obs*: *eponym* for a partial denture utilizing a Gillett clasp system, which was composed of an occlusal rest notched deeply into the occlusal-axial surface with a gingivally placed groove and a circumferential clasp for retention. The occlusal rest was custom made in a cast restoration

Kennedy E. The techniques of Gillett clasps in partial denture construction. Brooklyn: Dental Items of Interest Publishing Co.; 1928-292-317.

Cohn LA. The physiologic basis for tooth fixation in precision-attached partial dentures. J Prosthet Dent 1956;6:220-44.

gin.gi.va *n, pl* **-e**: the fibrous investing tissue, covered by epithelium, which immediately surrounds a tooth and is contiguous with its periodontal membrane and with the mucosal tissues of the mouth—see ATTACHED G., FREE G., MARGINAL G.

gingival crevice: a shallow fissure between the marginal gingiva and the enamel or cementum. It is bounded by the tooth surface on one side, the crevicular epithelium on the other, and the coronal end of the junctional epithelium at its most apical point—called also *gingival sulcus*

gingival denture contour: the form of the denture base or other material around the cervical regions of prosthetic teeth

gingival displacement: the deflection of the marginal gingiva away from a tooth

gingival retraction: see GINGIVAL DISPLACEMENT

ginglymus joint: a hinge joint

gin.gly.mus *n*: a type of synovial joint which allows movement in one plane only (i.e., forward and backward), such as the hinge of a door; called also ginglymoid or hinge joint

glare *v* (13c): the disturbance of the sensitivity of the eye, experienced when portions of the field of view have a brightness or intensity greatly in excess of that of the average for the field of view

glass.ceramic: a solid material, partly crystalline and partly glassy, formed by controlled crystallization of a glass

glass ionomer (1998): a cement, luting or restorative agent composed of an acid-soluble glass, polyacrylic acid, and water that sets via an acid-base reaction

glaze *vb* **glazed; glaz.ing** *vt* (14c) **1**: to cover with a glossy, smooth surface or coating **2**: the attainment of a smooth and reflective surface **3**: the final firing of porcelain in which the surface is vitrified and a high gloss is imparted to the material **4**: a ceramic veneer on a dental porcelain restoration after it has been fired producing a nonporous, glossy or semi-glossy surface—see NATURAL G., OVERGLAZE

gliding movement: see TRANSLATION

gliding occlusion *obs*: used in the sense of designating contacts of teeth in motion (GPT-4)—see ARTICULATION

glos.sal.gia *n*: pain in the tongue

glos.sec.to.my *n*: partial or total resection of the tongue

glos.so.plas.ty *n*: plastic surgery of the tongue

glos.so.py-nia *n*: plainful or burning tongue

glos.so.py.ro.sis *n*: a form of paresthesia characterized by pain, burning, itching, and stinging of the mucosa of the tongue, without noticeable lesions; called also burning tongue

gnath.ic *adj* (1882): of or pertaining to the jaw or cheek

gnath.i-on *n*: the lowest bony point, in the median plane of the mandible

gnatho.dy.na.mom.e.ter *n* **1**: an instrument for measuring the force exerted in closing the jaws **2**: an instrument used for measuring biting pressure

gnath.ol.o.gy *n*: the science that treats the biology of the masticatory mechanism as a whole: that is, the morphology, anatomy, histology, physiology, pathology, and the therapeutics of the jaws or masticatory system and the teeth as they relate to the health of the whole body, including applicable diagnostic, therapeutic, and, rehabilitation procedures

Goddard's linear occlusion [William H. Goddard, Louisville, Kentucky, US dentist, 1808-1883]: see LINEAR OCCLUSION

gold foil 1: pure gold rolled into extremely thin sheets **2**: a precious metal foil used in restoration of carious or fractured teeth

gothic arch tracer *obs*: the device that produces a tracing that resembles an arrowhead or a gothic arch. The device is attached to the opposing arches. The shape of the tracing depends on the relative location of the marking point and the tracing table. The apex of a properly made tracing is considered to indicate the most retruded, unstrained relation of the mandible to the maxillae, i.e., centric relation (GPT-4)—see CENTRAL BEARING TRACING DEVICE

gothic arch tracing: see CENTRAL BEARING TRACING

graft *n* (14c): a tissue or material used to repair a defect or deficiency—see ALLOGRAFT, ALLOPLASTIC G., AUTOGENOUS G., AUTOGRAFT, FULL THICKNESS G., HETEROGRAFT, HOMOGRAFT, ISOGRAFT, SPLIT-THICKNESS G., XENOGENIC G.

Grassman's laws [author unknown]: *eponym* for three empirical laws that describe the color-matching properties of additive mixtures of color stimuli **1**: to specify a color match, three independent variables are necessary and sufficient **2**: for an additive mixture of color stimuli, only their tri-stimulus values are relevant, not their spectral compositions **3**: in an additive mixture of color stimuli, if one or more components of the mixture are gradually changed the resulting tri-stimulus values also change gradually. (Laws do not hold for all observing conditions)

GRAY: a unit of absorbed radiation dose equal to 100 RADS. Abbreviated *Gy*

greenstick fracture *n* (1885): a fracture inwhich the break in the bone is not complete. The bone appears to be bent on one side while the other side of the bone is broken

Griffith flaws: *eponym*—see MICROCRACK

grinding.in *obs*: a term used to denote the act of correcting occlusal disharmonies by grinding the natural or artificial teeth (GPT-1)—see OCCLUSAL RESHAPING

groove *n*: a long narrow channel or depression, such as the indentation between tooth cusps or the retentive features placed on tooth surfaces to augment the retentive characteristics of crown preparations

group function: multiple contact relations between the maxillary and mandibular teeth in lateral movements on the working side whereby simultaneous contact of several teeth acts as a group to distribute occlusal forces

groove *n* (1998): a long narrow channel or depression, such as the indentation between tooth cusps or the retentive features placed on tooth surfaces to augment retention and resistance characteristics of crown preparations

Guerin's fracture [Alphonse Francois Marie Guerin, French surgeon, 1816-1895]: *eponym*—see LE FORT I FRACTURE

guid.ance *n* (1590) **1**: providing regulation or direction to movement; a guide **2**: the influence on mandibular movements by the contacting surfaces of the maxillary and mandibular anterior teeth **3**: mechanical forms on the lower anterior portion of an articulator that guide movements of its upper member—see ADJUSTABLE ANTERIOR G., ANTERIOR GUIDANCE, CONDYLAR G.

guide pin: the component of a dental implant system that is placed within the surgically prepared osseous site for an endosteal implant. It assists in determination of location and angulation of the site relative to other soft tissue or bony landmarks

guide plane *obs* **1**: the plane developed in the occlusal surfaces of the occlusion rims (viz. to position the mandible in centric relation) **2**: a plane which guides movement (GPT-4)

guide table: the anterior element of an articulator on which the incisal pin rests. It may be custom contoured or mechanically adjusted—see ANTERIOR G.T.

guided tissue regeneration: any procedure that attempts to regenerate lost periodontal structures through differential tissue responses. Barrier techniques, using synthetic materials that may or may not resorb, to exclude epithelial in growth that is believed to intefere with regeneration

guiding occlusion *obs*: used in the sense of designating contacts of teeth in motion (GPT-4)

guiding planes: vertically parallel surfaces on abutment teeth oriented so as to contribute to the direction of the path of placement and removal of a removable partial denture

guiding surfaces: see GUIDING PLANES

gum contour *obs*: form of supporting structures of the teeth or of the flanges of dentures around the teeth (GPT-1)

gums *n*, *obs*: the fibrous and mucosa covering of the alveolar process or ridges (GPT-4)—see GINGIVA

Gunning's splint [Thomas Brian Gunning, English-born American dentist, 1813-1889]: *eponym* for a device fabricated from casts of edentulous maxillary and mandibular arches to aid in reduction and fixation of a fracture. His initial work described four types of splints used in treating jaw fractures (1866-67), which allowed openings for saliva flow, nourishment, and speech—called also *occlusal splint*

Fraser-Moodie W. Mr. Gunning and his splint. Br J Oral Surg 1969;7:112-5.

gus.ta.tion *n* (1599): the act of perceiving taste

gyp.sum *n* (14c): the natural hydrated form of calcium sulfonate, $CaSO_4 2H_2O$ gypsum dihydrate

H

habitual centric: see MAXIMAL INTERCUSPAL POSITION

habitual occlusion: see MAXIMAL INTERCUSPAL POSITION

Hader bar [after the Swiss dental laboratory technician, Helmut Hader]: *eponym* for a rigid bar connecting two or more abutments, which, when viewed in cross section, resembles a keyhole, consisting of a rectangular bar with a rounded superior (occlusal) ridge that creates a retentive undercut for the female clip within the removable prosthesis

Breim SL, Renner RP. An overview of tissue bars. Gen Dent 1982:406-15.

hamular notch: see PTERYGOMAXILLARY NOTCH

Hanau's quint [Rudolph L. Hanau, (1881-1930) Buffalo, New York, US engineer, born Capetown, South Africa]: rules for balanced denture articulation including incisal guidance, condylar guidance, cusp length, the plane of occlusion, and the compensating curve described by Rudolph Hanau in 1926

Hanau R. Articulation defined, analyzed, and formulated. J Am Dent Assoc 1926;13:1694-709

hard palate: the bony portion of the roof of the mouth

healing abutment: see INTERIM ENDOSTEAL DENTAL IMPLANT ABUTMENT

healing component: see INTERIM ENDOSTEAL DENTAL IMPLANT ABUTMENT

healing screw: the component of an endosteal dental implant system used to seal, usually on an interim basis, the dental implant body during the healing phase after surgical placement. The purpose of the healing screw is to maintain patency of the internal threaded section for subsequent attachment of the abutment during the second stage surgery

heel *n*: see DISTAL

height of contour: a line encircling a tooth and designating its greatest circumference at a selected axial position determined by a dental surveyor; a line encircling a body designating its greatest circumference in a specified plane

hemi.glos.sec.to.my *n*: resection of one side of the tongue

hemi.sec.tion *n*: the surgical separation of a multirooted tooth, especially a mandibular molar, through the furcation in such a way that a root and the associated portion of the crown may be removed

heterograft *n*: a graft taken from a donor of another species—called also *xenograft*

heterotopic pain: a general term designating pain felt in an area other than the true originating site

high lip line: the greatest height to which the inferior border of the upper lip is capable of being raised by muscle function

hinge axis: see TRANSVERSE HORIZONTAL AXIS

hinge axis of the mandible: see TRANSVERSE HORIZONTAL AXIS

hinge axis point: see POSTERIOR REFERENCE POINTS

hinge bow: see KINEMATIC FACE-BOW

hinge joint: a ginglymus joint; a joint that allows motion around one axis

hinge movement: see TRANSVERSE HORIZONTAL AXIS

hinge position *obs*: the orientation of parts in a manner permitting hinge movement between them (GPT-4)

homograft *n* (1923): a graft taken from one human and transplanted to another—called also *allograft*

horizontal axis of the mandible: see TRANSVERSE HORIZONTAL AXIS

horizontal plane: any plane passing through the body at right angles to both the median and frontal planes, thus dividing the body into upper and lower parts; in dentistry, the plane passing through a tooth at right angles to its long axis

horizontal plane of reference: a horizontal plane established on the face of the patient by one anterior reference point and two posterior reference points from which measurements of the posterior anatomic determinants of occlusion and mandibular motion are made

horizontal overlap: the projection of teeth beyond their antagonists in the horizontal plane

horizontal reference plane: see HORIZONTAL PLANE OF REFERENCE

horseshoe plate *obs*: a horseshoe or V-shaped removable prosthesis

host site: see RECIPIENT SITE

hue *n* (bef. 12c): often referred to as the basic color, hue is the quality of sensation according to which an observer is aware of the varying wave lengths of radiant energy. The dimension of color dictated by the wave length of the stimulus that is used to distinguish one family of color from

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im.pres.sion *n* (14c): a negative likeness or copy in reverse of the surface of an object; an imprint of the teeth and adjacent structures for use in dentistry—see ALTERED CAST PARTIAL DENTURE I., DENTAL I., DIRECT BONE I., I. AREA, I. MATERIAL, I. TRAY, MASTER I., PARTIAL DENTURE I., PRELIMINARY I., SECTIONAL I., TUBE I.

impression area: the surface that is recorded in an impression

impression coping (1998): any device that registers the position of the dental implant body or dental implant abutment relative to adjacent structures; most such devices are indexed to assure reproducible three-dimensional location

impression compound *slang*: see MODELING PLASTIC I.C.

impression coping: the component of a dental implant system that is used to provide a spatial relationship of an endosteal dental implant to the alveolar ridge and adjacent dentition or other structures. Impression copings can be retained in the impression or may require a transfer from intraoral usage to the impression after attaching the analog or replicas

impression material: any substance or combination of substances used for making an impression or negative reproduction

impression surface *obs*: the portion of the denture surface that has its contour determined by the impression (GPT-4)—see IMPRESSION AREA

impression technique *obs*: a method and manner used in making a negative likeness (GPT-4)

impression tray 1: a receptacle into which suitable impression material is placed to make a negative likeness **2**: a device that is used to carry, confine, and control impression material while making an impression

impression wax: see DENTAL IMPRESSION WAX

incisal guidance 1: the influence of the contacting surfaces of the mandibular and maxillary anterior teeth on mandibular movements **2**: the influence of the contacting surfaces of the guide pin and guide table on articulator movements

incisal guide *obs*: the part of an articulator that maintains the incisal guide angle (GPT-4)—see ANTERIOR GUIDE TABLE

incisal guide angle 1: anatomically, the angle formed by the intersection of the plane of occlusion and a line within the sagittal plane determined by the incisal edges of the maxillary and mandibular central incisors when the teeth are in maximum intercuspation **2**: on an articulator, that angle formed, in the sagittal plane, between the plane of reference and the slope of the anterior guide table, as viewed in the sagittal plane

incisal guide pin: see ANTERIOR GUIDE PIN

incisal guide table: see ANTERIOR GUIDE TABLE

incisal rest: a rigid extension of a removable partial denture that contacts a tooth at the incsal edge

incisal restoration: any restoration extending along the incisal edge of a tooth

incisive foramen: a foramen located in the midline on the anterior of the hard palate. It transmits the nasopalatine nerves and vessels—called also *nasopalatine foramen*

incisive papilla: the elevation of soft tissue covering the foramen of the incisive or nasopalatine canal

inclined plane: any of the inclined cuspal surfaces of a tooth

incomplete cleft palate: a cleft involving only a part of the hard or/and soft palate

in.co.or.di.na.tion *n* (1876): inability to move in a smooth, controlled, symmetrical movement

in.dex *n* (1571): a core or mold used to record or maintain the relative position of a tooth or teeth to one another, to a cast, or to some other structure

indirect fracture: a fracture at a point distant from the primary site of injury due to secondary forces

indirect pulp capping: a procedure that seeks to stimulate formation of reparative dentin by placing a material over sound or carious dentin

indirect retainer: the component of a removable partial denture that assists the direct retainer(s) in preventing displacement of the distal extension denture base by functioning through lever action on the opposite side of the fulcrum line when the denture base moves away from the tissues in pure rotation around the fulcrum line

indirect retention: the effect achieved by one or more indirect retainers of a removable partial denture that rerduces the tendency for a denture base to move in an occlusal direction or rotate about the fulcrum line

in.du.rate *vb* **-rat.ed; -rat.ing** (1538): to make hard—**in.du.ra.tion** *n*—**in.du.ra.tive** *adj*

in.du.rat.ed *adj* (1604): having become firm or hard, especially by an increase in fibrous elements

in.fra.bulge *n*: that portion of the crown of a tooth apical to the survey line

infrabulge clasp: a removable partial denture retentive clasp that approaches the retentive undercut from a cervical or infrabulge direction

in.fra.erup.tion *n*: failure in eruption of a tooth to the established plane of occlusion

in.fra.oc.clu.sion *n*: malocclusion in which the occluding surfaces of teeth are below the normal plane of occlusion

infrared radiation: electromagnetic radiation of wave lengths between 760 nm and 1000 nm

in.fra.struc.ture *n*: a metal framework onto which a second framework or prosthesis will be placed

ingot *n*: **1**: a mold in which metal is cast **2**: a mass of metal cast into a shape convenient for storage and measure that can be remelted for later casting

initial occlusal contact: the first or initial contact of opposing teeth

injection molding: the adaptation of a plastic material to the negative form of a closed mold by forcing the material into the mold through appropriate gateways—see COMPRESSION MOLDING

in.lay *n* (1667): a fixed intracoronal restoration; a dental restoration made outside of a tooth to correspond to the form of the prepared cavity, which is then luted into the tooth

inlay wax: see CASTING WAX

in.ser.tion *vb*: see PLACEMENT

instantaneous axis of rotation: the hypothetical center of rotation of a moving body, viewed in a given plane, at any point in time; for any body that has planar motion, there exists, at any instant, some points that have zero velocity and will be fixed at a given instant. The line joining these points is the instantaneous axis of rotation. The intersection of this line with the plane of motion is called the instantaneous center of rotation

in.stru.ment *n*: a tool or implement, especially one used for delicate work or for artistic or scientific purposes—see DEVICE

in.tagl.io *n*, *pl* **-ios** (1644) **1**: an incised or engraved figure in stone or any hard material depressed below the surface of the material such that an impression from the design would yield an image in relief **2**: something carved in intaglio

intaglio surface: the portion of the denture or other restoration surface that has its contour determined by the impression; the interior or reversal surface of an object

integration: see FIBROUS I., OSSEOUS I., TISSUE I.

interalveolar space: see INTERARCH DISTANCE

interarch distance: the interridge distance; the vertical distance between the maxillary and mandibular dentate or edentate arches under specified conditions—see REDUCED I.D.

interarch expansion device: see TRISMUS APPLIANCE

interceptive occlusal contact: see DEFLECTIVE OCCLUSAL CONTACT

in.ter.con.dy.lar *adj*: situated between two condyles

intercondylar axis: see CONDYLAR AXIS

intercondylar distance: the distance between the rotational centers of two condyles or their analogues

intercuspal contact: the contact between the cusps of opposing teeth

intercuspal contact area: the range of tooth contacts in maximum intercuspation

intercuspal occlusion: see MAXIMAL INTERCUSPAL POSITION

intercuspal position: see MAXIMAL INTERCUSPAL POSITION

in.ter.cus.pa.tion *n*, *obs*: the interdigitation of cusps of opposing teeth (GPT-4)

in.ter.den.tal *adj*: between the proximal surfaces of the teeth within the same arch

interdental papilla: a projection of the gingiva filling the space between the proximal surfaces of two adjacent teeth

interdental space: see DIASTEMA, INTERARCH DISTANCE and INTERPROXIMAL SPACE

interdental splint: a splint for treatment of fractures and consisting of metal or acrylic resin prostheses wired to the teeth in the maxilla and mandible and joined to keep the segments immovable—see GUNNING'S SPLINT

interdigitated occlusion: see MAXIMAL INTERCUSPAL POSITION

in.ter.dig.i.ta.tion *n*: see MAXIMAL INTERCUSPAL POSITION

in.ter.fer.ence *n* (1783): in dentistry, any tooth contacts that interfere with or hinder harmonious mandibular movement

interim denture: see INTERIM PROSTHESIS

interim endosteal dental implant abutment: any dental implant abutment used for a limited time to assist in healing or modification of the adjacent tissues

interim obturator: a prosthesis that is made several weeks or months following the surgical resection of a portion of one or both maxillae. It frequently includes replacement of teeth in the defect area. This prosthesis, when used, replaces the *surgical obturator* that is placed immediately following the resection and may be subsequently replaced with a *definitive obturator*.

interim ocular prosthesis: an interim replacement generally made of clear acrylic resin for an eye lost due to surgery or trauma. No attempt is made to reestablish esthetics—*syn* CONFORMER EYE SHELL, SHELL

interim platal lift prosthesis: see PALATAL LIFT PROSTHESIS

interim prosthesis: a fixed or removable prosthesis, designed to enhance esthetics, stabilization and/or function for a limited period of time, after which it is to be replaced by a definitive prosthesis. Often such prostheses are used to assist in determination of the therapeutic effectiveness of a specific treatment plan or the form and function of the planned for definitive prosthesis—*syn* PROVISIONAL PROSTHESIS, PROVISIONAL RESTORATION

interlock *n* (1874): a device connecting a fixed unit or a removable prosthesis to another fixed unit

intermaxillary relation: see MAXILLOMANDIBULAR RELATIONSHIP

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man.di.ble *n* (15c): the lower jawbone

man.dib.u.lar *adj*: of or pertaining to the mandible

mandibular anteroposterior ridge slope: the slope of the crest of the mandibular residual ridge from the third molar region to its most anterior aspect in relation to the lower border of the mandible as viewed in profile

mandibular axis: see SAGITTAL AXIS, TRANSVERSE HORIZONTAL AXIS, VERTICAL AXIS

mandibular condyle: the articular process of the mandible—see also CONDYLE

mandibular dislocation: displacement of the mandible

mandibular dysplasia: disharmony in size or form between the right and left halves of the mandible

mandibular equilibration 1: the act or acts performed to place the mandible in equilibirum **2**: a condition in which all of the forces acting on the mandible are neutralized

mandibular glide *obs*: the side to side, protrusive, and intermediate movement of the mandible occurring when the teeth or other occluding surfaces are in contact (GPT-4)

mandibular guide plane prosthesis: see MANDIBULAR RESECTION PROSTHESIS

mandibular hinge position *obs*: the position of the mandible in relation to the maxilla at which opening and closing movements can be made on the hinge axis (GPT-4)

mandibular impression: an impression of the mandibular jaw or dental structures

mandibular lateral translation: see MANDIBULAR TRANSLATION

mandibular micrognathia: an abnormally small mandible with associated recession of the chin

mandibular movement: any movement of the lower jaw

mandibular nerve: the third division of the trigeminal nerve that leaves the skull through the foremen ovale and provides motor innervation to the muscles of mastication, to the tensor veli palatini m., the tensor tympani m., the anterior belly of the digastric m., and the mylohyoid m. It provides the general sensory innervation to the mandibular teeth and gingivae, the mucosa of the cheek and floor of the mouth, the epithelium of the anterior two thirds of the tongue, the meninges and the skin of the lower portion of the face

mandibular orthopedic repositioning splint: a removable prosthesis that creates a different, yet temporary, dental occlusal position that guides the mandible to close into a predetermined and altered position

mandibular plane: in cephalometrics, a plane that passes through the inferior border of the mandible

mandibular protraction: a type of facial anomaly in which gnathionlies anterior to the orbital plane—see ANGLE'S CLASSIFICATION OF OCCLUSION

mandibular relationship record: any registration of the relationship of the mandible to the maxillae

mandibular repositioning: guidance of the mandible to cause closure in a predetermined, altered position

mandibular resection: the surgical removal of a portion or all of the mandible and the related soft tissues—called also *mandibulectomy*

mandibular resection prosthesis: a maxillary and/or mandibular prosthesis delivered after a mandibular resection to allow the remaining deviated mandibular segment improved occlusal contact with the maxillary dentition. This can require use of a flange, guide, or occlusal platform incorporated in the prosthesis to guide the mandibular segment into optimal occlusal contact—*syn* MANDIBULAR GUIDE PLANE PROSTHESIS, MANDIBULAR RESECTION PROSTHESIS WITH GUIDE MANDIBULAR RESECTION PROSTHESIS WITHOUT GUIDE, RESECTION PROSTHESIS

mandibular rest position: see PHYSIOLOGIC REST POSITION

mandibular retraction: a type of facial anomaly in which gnathionlies posterior to the orbital plane—see also ANGLE'S CLASSIFICATION OF OCCLUSION

mandibular side shift: see MANDIBULAR TRANSLATION

mandibular staple: a transosteal dental implant placed from the inferior border of the mandible with posts (abutments) that extend through the mucosa into the oral cavity in the mandibular anterior region—called also *transmandibular staple*

mandibular tracing: a graphic representation or record of the movements of the mandible within a given plane

mandibular translation: the translatory (medio-lateral) movements of the mandible when viewed in the frontal plane. While this has not been demonstrated to occur as an immediate horizontal movement when viewed in the frontal plane, it could theoretically occur in an essentially pure translatory form in the early part of the motion or in combination with rotation in the latter part of the motion or both—see also EARLY MANDIBULAR LATERAL TRANSLATION, IMMEDIATE MANDIBULAR LATERAL TRANSLATION, PROGRESSIVE MANDIBULAR LATERAL TRANSLATION

mandibular trismus: reduced mobility of the mandible resulting from tonic contracture of the masticatory muscles

mandibulectomy *n*: the removal of part or all of the mandible

man.drel also **man.dril n** (1790) **1a**: usually a taper or cylindrical axle, spindle, or arbor placed in a hole to support it during machining **1b**: a metal bar which serves as a core about which material may be cast, molded, compressed, forged, bent or shaped **2**: the shaft and bearing on which a tool is mounted

Maryland bridge: see RESIN-BONDED PROSTHESIS

Livaditis GJ, Thompson VP: Etched castings: an improved retentive mechanism for resin-bonded retainers. J Prosthet Dent 1982;47: 52-9.

mar.gin *n* (14c): the outer edge of a crown, inlay, onlay, or other restoration. The boundary surface of a tooth preparation and/or restoration is termed the finish line or finish curve

marginal gingiva: the most coronal portion of the gingiva; often used to refer to the free gingiva that forms the wall of the gingival crevice in health

marginal ridge: a component of the tooth structure forming the occlusal proximal margin of a premolar or molar

mask.ing *n*: the process of applying an opaque covering to camouflage the metal component of a prosthesis

master cast: see DEFINITIVE CAST

master impression: the negative likeness made for the purpose of fabricating a prosthesis

masticating cycles *obs*: the patterns of mandibular movements formed during the chewing of food (GPT-1)

mas.ti.ca.tion *n* (1649): the process of chewing food for swallowing and digestion

masticatory apparatus: see MASTICATORY SYSTEM

masticatory cycle: a three-dimensional representation of mandibular movement produced during the chewing of food

masticatory efficiency: the effort required in achieving a standard degree of comminution

masticatory force: the force applied by the muscles of mastication during chewing

masticatory movements: mandibular movements used for chewing food—see MASTICATORY CYCLE

masticatory mucosa: see MUCOSA

masticatory muscle: muscles that elevate the mandible to close the mouth (temporalis m., superficial and deep masseter m., medial pterygoid m.)—see ELEVATOR MUSCLE

masticatory pain: discomfort about the face and mouth induced by chewing or other use of the jaws but independent of local disease involving the teeth and mouth

masticatory performance: a measure of the comminution of food attainable under standardized testing conditions

masticatory system: the organs and structures primarily functioning in mastication. These include the teeth with their supporting structures, craniomandibular articulations, mandible, positioning and accessory musculature, tongue, lips, cheeks, oral mucosa, and the associated neurologic complex

ma.trix *n, pl* **ma.tri.ces** (15c) **1**: a mold or impression in which something is formed **2**: the portion of an attachment system that receives the patrix

max.il.la *n, pl* **max.il.lae** (15c): their regularly shaped bone that, with its contralateral maxilla, forms the upper jaw. It assists in the formation of the orbit, the nasal cavity, and the hard palate; it contains the maxillary teeth

maxillary impression: an impression of the maxillary jaw or dental structures

maxillary micrognathia: abnormally small maxillae with associated retraction of the middle third of the face

maxillary protraction: a type of facial anomaly in which subnasion lies anterior to the orbital plane

maxillary resection: the surgical removal of a part or all of the maxilla—called also *maxillectomy*

maxillary sinus: the anatomic space located superior to the posterior maxillary alveolus

maxillary tuberosity: the most distal portion of the maxillary alveolar ridge

max.il.lec.to.my *n*: the removal of part or all of the maxilla—called also *maxillary resection*

max.il.lo.fa.cial *adj*: pertaining to the dental arches, the face, head and neck structures

maxillofacial stabilization prosthesis: a prosthesis fabricated for the maxillae or mandibule to assist stabilization, retention or function of an opposing or adjacent maxillofacial prosthesis. Generally such prostheses are complete dentures, removable partial dentures or fixed partial dentures

maxillofacial prosthetic adhesive: a material used to adhere external prosthesis to skin and associated structures around the periphery of an external anatomic defect

maxillofacial prosthetics: the branch of prosthodontics concerned with the restoration and/or replacement of the stomatognathic and craniofacial structures with prostheses that may or may not be removed on a regular or elective basis

maxillomandibular dysplasia: disharmony between one jaw and the halves of the mandible

maxillomandibular record: see MAXILLOMANDIBULAR RELATIONSHIP RECORD

maxillomandibular registration: see MAXILLO-MANDIBULAR RELATIONSHIP RECORD

maxillomandibular relation: see MAXILLOMANDIBULAR RELATIONSHIP

maxillomandibular relationship: any spatial relationship of the maxillae to the mandible; any one of the infinite relationships of the mandible to the maxillae

maxillomandibular relationship record: a registration of any positional relationship of the mandible relative to the maxillae. These records may be made at any vertical, horizontal, or lateral orientation

maximal intercuspal contacts: tooth contact in the maximum intercuspal position

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midfacial fracture: fractures of the zygomatic, maxillary, nasal, and associated bones

midopening click: the sound emanating from the temporomandibular joint during mid protrusive translation of the condyles

MIE theory: the theory that relates the scattering of a single spherical particle in a medium to the diameter of the particle, the difference in refractive index between the particle and the medium, and the wave length of radiant energy in the medium that is incident on the particle. This theory relates to the direct observation of the scattering of a single particle as compared with the Kubel-ka-Munk theory and also takes into account the absorption that the particle may also exhibit

¹mill *n*: a machine or device used for working or forming materials into a desired form, to blend materials, or to perform other mechanical opertions

²mill *vt* (1570) **1**: to subject to an operation or process in a mill; to grind **2**: to shape or dress by means of instruments

mill in *v* **1**: the procedure of refining occluding surfaces through the use of abrasive materials—see SELECTIVE GRINDING **2**: the machining of boxes or other forms in cast restorations to be used as retainers for fixed or removable prostheses

milled in curve *obs*: see MILLED IN PATH

milled in path: a contour pattern carved into the occlusal surface of an occlusion rim during various mandibular movements by teeth or studs placed in the opposing arch

mill.ing *v*: the machining of proximal boxes, recesses, or other forms on cast restorations to be used as retainers for fixed or removable prostheses

milling in *obs*: the procedure of refining or perfecting the occlusion of teeth by the use of abrasives between their occluding surfaces while the dentures are rubbed together in the mouth or on the articulator (GPT-3)—see MILL IN

minor connector: the connecting link between the major connector or base of a removable partial denture and the other units of the prosthesis, such as the clasp assembly, indirect retainers, occlusal rests, or cingulum rests

mixed dentition: a stage of development during which the primary and permanent teeth function together in the mouth—*syn* TRANSITIONAL DENTITION

mo.bile *adj* (15c): capable of moving or being moved; movable—**mo.bil.i.ty** *n*

mod.el *n* (1575): a facsimile used for display purposes; a miniature representation of something; an example for imitation or emulation; *com* CAST

modeling composition *obs*: see MODELING PLASTIC IMPRESSION COMPOUND

modeling compound *obs*: see MODELING PLASTIC IMPRESSION COMPOUND

modeling plastic: see MODELING PLASTIC IMPRESSION COMPOUND

modeling plastic impression compound: a thermoplastic dental impression material composed of wax, rosin, resins, and colorants

modeling wax: a wax suitable for making patterns in the fabrication of nonmetallic restoration

modes of appearance: various manners in which colors can be perceived, depending on spatial distributions and temporal variations of the light causing the sensation

modified cast; see ALTERED CAST

modified ridge lap: a ridge lap surface of a pontic that is adapted to only the facial or buccal aspect of the residual ridge

mod.i.fi.er *n*: a substance that alters or changes the color or properties of a substance

mo.dio.lus *n*: the structure near the corner of the mouth where eight muscles converge that functionally separates the labial vestibule from the buccal vestibule

modulus of elasticity: in metallurgy, the coefficient found by dividing the unit stress, at any point up to the proportional limit, by its corresponding unit of elongation (tension) or strain. A ratio of stress to strain. As the modulus of elasticity rises, the material becomes more rigid

modulus of resilience: the work or energy required to stress a cubicinch of material (in one direction only) from zero up to the proportional limit of the material, measured by the ability of the material to withstand the momentary effect of an impact load while stresses remain within the proportional limit

mold *n* (13c) **1**: a cavity in which a substance is shaped, as a matrix for casting metal or plastics; a negative form in which an object is cast or shaped **2**: the size and shape of an artificial tooth or teeth

mold chart: an illustration of the manufacturer's shapes and sizes of denture teeth

mold guide: a selection of denture teeth demonstrating the molds offered by a manufacturer

monochromatic vision: vision in which there is no color discrimination

mon.o.mer *n* (1914): a chemical compound that can undergo polymerization; any molecule that can be bound to a similar molecule to form a polymer

mon.o.plane *adj*: an arbitrary plane for the arrangement of denture teeth that is flat both medio-laterally and anterior-posteriorly

monoplane articulation: the arrangement of teeth by which they are positioned in a single plane

monoplane occlusion: an occlusal arrangement wherein the posterior teeth have masticatory surfaces that lack any cuspal height

Monson curve: see CURVE OF MONSON

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N

NA: *acronym* for *Nasion;* a cephalometric landmark located where the intranasal and nasofrontal sutures meet

nano.me.ter *n* (1903): unit of length to measure the wave length of light. It is equivalent to 1×10^{-9} M or 10 Angstroms. 1 nm = 1/1,000,000 mm

narrative report: a complete description of the clinical findings, diagnosis, and treatment rendered for a given patient

nasal grimace: movements in the tissue of the nares reflecting the attempts of the cronasal system to compensate for palatopharyngeal insufficiency

nasal prosthesis: a removable prosthesis that artificially restores part or the entire nose—*syn* ARTIFICIAL NOSE

nasal turbulence: the excessive "noise" or air passing over resistance in the nasal passages

nasal septal prosthesis: a removable prosthesis to occlude (obturate a hole within the nasal septal wall—*syn* SEPTAL BUTTON, SEPTAL PLUG

nasal spine: a sharp bony protuberance of the lower margin of the anterior aperture of the nares formed by the forward prolongation of the two maxillae

nasal stent: a removable intranasal prosthesis to support the form of the nose

na.sal.i.ty *n* (1656): the quality of speech sounds when the nasal cavity is used as a resonator

nas.ion *n*: a bony cephalometric landmark at which the nasofrontal suture is bisected by the midsagittal plane

nas.o.phar.ynx *n* (1877): the part of the pharynx situated above the soft palate

natural color system: a color order system derived by Anders Hard that defines six color perceptions using the concept of percentage for localizing nuances within the three-part system. The six perceptions are white, black, red, green, yellow, and blue. The dimensions of hue, blackness or whiteness, and chrome are used to relate colors within this system

natural dentition: the natural teeth, as considered collectively, in the dental arch, which may be deciduous, permanent, or mixed

natural glaze: the production of a glazed surface by the vitrification of the material itself and without addition of other fluxes or glasses

neck of the condyle: the constricted inferior portion of the mandibular condyle that is continuous with the ramus of the mandible; that portion of the mandibular ramus to which the condyle is attached

ne.cro.sis *n, pl* **ne.cro.ses** (1665): localized death of living tissue

needlepoint tracing: see CENTRAL BEARING TRACING DEVICE

Nesbit prosthesis [Norman Nesbit, dentist, Boston, [Massachusetts, US] *obs*: *eponym* for a unilateral removable partial denture design that Dr Nesbit introduced in 1918

neu.ral.gia *n* (ca. 1822): neurogenous pain felt along the peripheral distribution of a nerve trunk

neu.ri.tis *n* (1840): inflammation of a nerve

neurogenous pain: pain that is generated within the nervous system as a result of some abnormality of neural structures

neu.rop.a.thy *n* (1857): a general term used to designate an abnormality or pathologic change in a peripheral nerve

neutral zone: the potential space between the lips and cheeks on one side and the tongue on the other; the area or position where the forces between the tongue and cheeks or lips are equal

neu.tro.oc.clus.ion: see ANGLE'S CLASSIFICATION OF OCCLUSION

ni.dus *n, pl* **ni.di** or **ni.dus.es** (1742): a place or substance in an animal or plant where bacteria or other organisms lodge and multiple

night guard: see OCCLUSAL DEVICE

NMR: *acronym* for *Nuclear Magnetic Resonance;* a radiologic procedure that gives images in any plane without radiation or any biologic after effect by picking up signals from resonating hydrogen nuclei

noble metal: those metal elements that resist oxidation, tarnish, and corrosion during heating, casting, or soldering and when used intraorally; examples include gold and platinum—*comp* BASE METAL

no.ci.cep.tive *adj* (1904): receiving injury; applicable to a neuron receptive to painful sensations

nociceptive pathway: an afferent neural pathway that mediates pain impulses

no.ci.cep.tor *n*: a sensory receptor preferentially sensitive to noxious or potentially noxious stimuli

nocturnal electromyography: electromyographic registrations made during sleep

nonadjustable articulator: an articulator that does not allow adjustment to replicate mandibular movements—see also CAST RELATOR

nonanatomic teeth: artificial teeth with occlusal surfaces that are not anatomically formed. The term nonanatomic as applied to artificial posterior teeth, and especially their occlusal forms, means that such teeth are designed in accordance with mechanical principles rather than from the anatomic standpoint. I.R. Hardy, DDS, first introduced nonanatomic teeth with flat occlusal surfaces set to a flat occlusal plane.

Sears VH. Thirty years of nonanatomic teeth. J Prosthet Dent 1953;3:596-617

Hardy IR. Technique for use of nonanatomic acrylic posterior teeth. Dent Digest 1942;48:562-6.

nonfunctioning condyle: see NONWORKING SIDE CONDYLE

nonpivoting condyle: see NONWORKING SIDE CONDYLE

nonprecious metal: see BASE METAL

non.re.sorb.able *adj*: the property exhibited by substances that demonstrate relatively limited *in-vivo* degradation

nonrigid connector: any connector that permits limited movement between otherwise independent members of a fixed partial denture

nonworking side: that side of the mandible that moves toward the median line in a lateral excursion. The condyle on that side is referred to as the nonworking side condyle

nonworking side condyle: the condyle on the nonworking side

nonworking side condyle path: the path the condyle traverses or the nonworking side when the mandible moves in a lateral excursion, which may be viewed in the three reference planes of the body

nonworking side interference: undesirable contacts of the opposing occlusal surfaces on the nonworking side

nonworking side occlusal contacts: contacts of the teeth on the side opposite to the side toward which the mandible moves in articulation

notch *n*: see PTERYGOMAXILLARY N.

noxious stimulus: a tissue damaging stimulus

nu.ance *n*, **nu.anced** *adj* (1781) **1**: a subtle distinction or variation, such as in tone or color **2**: a subtle quality **3**: delicate shading

null detector: a detector of the point at which there is no color difference between two samples. The human eye is an excellent null detector; it is considerably less trustworthy in estimating how large a given difference is

O

oblique ridge: the elevation in the enamel that runs obliquely across the occlusal surface of a maxillary molar

ob.tun.dent *n*: an agent or remedy that lessens or relieves pain or sensibility

ob.tu.ra.tor *n* (ca. 1727): a prosthesis used to close a congenital or acquired tissue opening, primarily of the hard palate and/or contiguous alveolar structures. Prosthetic restoration of the defect often includes use of a surgical obturator, interim obturator, and definitive obturator—see DEFINITIVE O., INTERIM O., SURGICAL O.—*comp* SPEECH AID PROSTHESIS

obturator prosthesis modification: revision or alteration of an existing obturator (surgical, interim, or definitive); possible revisions include relief of the denture base due to tissue compression, augmentation of the seal or border regions to effect adequate sealing or separation between the nasal and oral cavities

oc.clude *vb* **oc.clud.ed; oc.clud.ing** *vt* (1597) **1**: to bring together; to shut **2**: to bring or close the mandibular teeth into contact with the maxillary teeth

occluded gas porosity: a porosity produced in castings due to the inability of gases in the mold to escape

oc.clud.er *n*: a name given to some articulators—see CAST RELATOR

occluding centric relation record *obs*: a registration of centric relation made at the established occlusal vertical dimension (GPT-4)

occluding frame *obs*: a name given to a device for relating casts to each other for the purpose of arranging teeth (GPT-1)

occluding jaw record: the registration of centric relation made at the occlusal vertical dimension

occluding relation *obs*: the jaw relation at which the opposing teeth occlude (GPT-4)

oc.clu.sal *adj* **(1897)**: pertaining to the masticatory surfaces of the posterior teeth, prostheses, or occlusion rims

occlusal adjustment 1: any change in the occlusion intended to alter the occluding relation **2**: any alteration of the occluding surfaces of the teeth or restorations—see also OCCLUSAL RESHAPING

occlusal analysis: an examination of the occlusion in which the interocclusal relations of mounted casts are evaluated

occlusal balance: a condition in which there are simultaneous contacts of opposing teeth or tooth analogues (i.e., occlusion rims) on both sides of the opposing dental arches during eccentric movements within the functional range

occlusal clearance: see INTEROCCLUSAL CLEARANCE

occlusal contact 1: the touching of opposing teeth on elevation of the mandible **2**: any contact relation of opposing teeth—see DEFLECTIVE O.C, INITIAL O.C

occlusal correction: see OCCLUSAL ADJUSTMENT, OCCLUSAL RESHAPING

occlusal curvature: the curve of a dentition in which the occlusal surfaces lie, when viewed in the frontal and sagittal planes

occlusal device: any removable artificial occlusal surface used for diagnosis or therapy affecting the relationship of the mandible to the maxillae. It may be used for occlusal stabilization, for treatment of temporomandibular disorders, or to prevent wear of the dentition

occlusal disharmony: a phenomenon in which contacts of opposing occlusal surfaces are not in harmony with other

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os.te.ot.o.my *n*: the surgical cutting of a bone; frequently used to also describe smoothing, leveling, or altering external contours of the bone

os.teo.po.ro.sis *n, pl* **-ro.ses** (1846): a medical condition characterized by a decrease in bone mass with diminished density and concurrent enlargement of bone spaces, which produces porosity and fragility—**os.teo.po.rot.ic** *adj*

o.ver.bite *n*, *slang*: see VERTICAL OVERLAP

o.ver.clo.sure *n*: an occluding vertical dimension at a reduced interarch distance; an occluding vertical dimension that results in excessive interocclusal distance when the mandible is in the rest position; it results in a reduced interridge distance when the teeth are in contact

o.ver.den.ture *n*: a removable partial denture or complete denture that covers and rests on one or more remaining natural teeth, the roots of natural teeth, and/or dental implants; a prosthesis that covers and is partially supported by natural teeth, natural tooth roots, and/or dental implants—called also *overlay denture, overlay prosthesis, superimposed prosthesis*

o.ver.glaze *adj* (1879): the production of a glazed surface by the addition of a fluxed glass that usually vitrifies at a lower temperature

o.ver.hang *n* (1864): excess restorative material projecting beyond a cavity or preparation margin

o.ver.jet *n*: see HORIZONTAL OVERLAP

o.ver.jut *n*: see HORIZONTAL OVERLAP

o.ver.lap *n* (1726): see HORIZONTAL OVERLAP, VERTICAL OVERLAP

overlay denture: see OVERDENTURE

overlay prosthesis: see OVERDENTURE

P

pack *vt* (14c) **1a**: to make into a compact form **1b**: to completely fill **2a**: to crowd together **2b**: to compress—**pack.a.bil.i.ty** *n*—**pack.able** *adj*

packing *vt*: the act of filling a mold—see DENTURE P.

pain *n* (13c): a subjective unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage—see ACUTE P., CHRONIC P., HETEROTOPIC P., MASTICATORY P., MUSCULOSKELETAL P., MYOGENOUS P., NEUROGENOUS P., ODONTOGENOUS P., PRIMARY P., PROJECTED P., SECONDARY P., VASCULAR P., VISCERAL P.

palatal augmentation prosthesis: a palatal prosthesis that allows reshaping of the hard palate to improve tongue/palate contact during speech and swallowing due to impaired tongue mobility as a result of surgery, trauma, or neurologic/motor deficits

palatal bar: see PALATAL BAR CONNECTOR

palatal bar connector: a major connector of a removable partial denture that crosses the palate and is characterized by being relatively narrow anterior and posteriorly

palatal cleft 1: an opening in the roof of the mouth and/or in the functional soft palate. A deformity of the palate from improper union or lack of union during the second month of intrauterine development of the maxillary process with the median nasal process **2**: a cleft in the palate between the two palatal processes. If both the hard and soft palate are involved, it is termed *uranostaphyloschisis*, if only the soft palate is divided, it is termed *uranoschisis*—see CLEFT PALATE, COMPLETE CLEFT PALATE, OCCULT CLEFT PALATE

palatal drop prosthesis: see PALATAL AUGMENTATION PROSTHESIS

palatal expansion: the lateral movement of the maxillae to increase palatal width

palatal incompetence: the inability of an anatomically intact soft palate to effect a functional palatopharyngeal closure

palatal insufficiency: an anatomical inadequacy of the soft palate in which the palatopharyngeal sphincter is incomplete

palatal lift prosthesis: a removable prosthesis that aids in velopharyngeal closure by elevating an incompetent soft palate that is dysfunctional due to clefting, surgery, trauma, or unknown paralysis—*usage*. palatal lift prosthesis can be divided into *definitive p.l.p.* and *interim p.l.p.* based on expectations of length of utilization, materials in fabrication, and intended use

palatal lift prosthesis modification: alterations in the adaptation, contour, form, or function of an existing palatal lift necessitated due to tissue impingement, lack of function, poor clasp adaptation, or the like

palatal plate: a major connector of a removable partial denture that covers a significant portion of the palatal surface

palatal seal: see POSTPALATAL SEAL

palatal stent: see SURGICAL STENT

palatal strap *slang*: a maxillary major connector having an anterior/posterior dimension of ½" to ¾" that directly or obliquely traverses the palate and is generally located in the area of the second premolar and first molar

palatal vault 1: the deepest and most superior part of the palate **2**: the curvature of the palate

pal.ate *n* (14c): see HARD P., SOFT P.

pal.a.to.gram *n*: a graphic representation of the area of the palate contacted by the tongue during a specified activity, usually speech

palatopharyngeal closure: a sphincteric action sealing the oral cavity from the nasal cavity during swallowing and phonation by the synchronous movement of the middle third of the soft palate in a superior and posterior direction, the lateral pharyngeal wall medially, and the posterior walls of the pharynx anteriorly—*syn* VELOPHARYNGEAL CLOSURE

palatopharyngeal inadequacy: a condition where there is lack of effective closure between the soft palate and one or more of the pharyngeal walls during swallowing or speech sounds that require high intraoral pressure. Nasal reflux escape of air during speech or hyper nasality may result. This lack of closure may be due to palatopharyngeal incompetence, insufficiency or from lack of movement of the pharyngeal walls—see PALATOPHARYNGEAL INCOMPETENCE, PALATOPHARYNGEAL INSUFFICIENCY

palatopharyngeal incompetence: the inability or an anatomically intact soft palate to contribute to a functional palatopharyngeal closure usually due to disease or trauma of a neurogenic or muscular nature—see PALATOPHARYNGEAL INADEQUACY, PALATOPHARYNGEAL INSUFFICIENCY

palatopharyngeal insufficiency: an acquired or congenital anatomic defect of the soft palate that makes the palatopharyngeal sphincter incomplete—see PALATOPHARYNGEAL INADEQUACY, PALATOPHARYNGEAL INCOMPETENCE

palatopharyngeal sphincter: the functional sphincter that separates the nasopharyngeal and oropharynx during swallowing and phonation, formed by the posterior and superior movement of the middle third of the soft palate, the anterior movement of the posterior pharyngeal wall, and the medial movement of the lateral pharyngeal walls—see PALATOPHARYNGEAL CLOSURE—*syn* VELOPHARYNGEAL SPHINCTER

pal.lia.tive *adj* (1543): affording relief but not a cure

pal.pate *vt* **pal.pat.ed; pal.pat.ing** (1849): to examine by touch—**pal.pa.tion** *n*

panoramic radiograph: a radiograph produced by a panoramic machine—called also *orthopantograph*

panoramic radiography: a method of radiography by which continuous radiographs of the maxillary and/or mandibular dental arches and their associated structures may be obtained. The X-ray source may be placed intraoral or extraoral

Panorex *adj*—trademark (1966): see PANORAMIC RADIOGRAPH

pan.to.gram *n*: see PANTOGRAPHIC TRACING

pan.to.graph *n* (1723) **1**: an instrument used for copying a planar figure to any desired scale **2**: in dentistry, an instrument used to graphically record in one or more planes or paths of mandibular movement and to provide information for the programming of an articulator

pantographic tracing: a graphic record of mandibular movement in three planes as registered by the styli on the recording tables of a pantograph; tracings of mandibular movement recorded on plates in the horizontal and sagittal planes

pa.pil.la *n, pl* **pa.pil.lae** (1713): any small, nipple-shaped elevation—see INCISIVE P., INTERDENTAL P.

para.func.tion *adj*: disordered or perverted function

par.al.lax *n*: a difference in the perceived location of an object when observed from two different points not on a straight line with the object

parallel attachment: see PRECISION ATTACHMENT

par.al.lel.o.me.ter *n* **1**: an instrument used for determining the exact parallel relationships of lines, structures, and surfaces in dental casts and prostheses **2**: an apparatus used for making one object parallel with another object, as in paralleling attachments and abutments for fixed partial dentures or precision attachments for removable partial dentures

pa.ral.y.sis *n* (1525): loss or impairment of motor function as the result of a trauma or pathosis

paresthesia *n*: lacking normal sensation, such as tingling or burning; morbid or perverted sensation; abnormal sensation

partial denture: a dental prosthesis that restores one or more but not all of the natural teeth and/or associated parts and that is supported in part by natural teeth, dental implant supported crowns, abutments, or other fixed partial dentures and/or the mucosa; *usage*: a partial denture should be described as a *fixed partial denture* or *removable partial denture* based on the patient's capability to remove or not remove the prosthesis. If the prosthesis is a fixed partial denture that can only be removed by a clinician, i.e. a fixed partial denture supported by dental implants that has been retained by means of a mechanical system (i.e., screw[s]), this prosthesis is a *fixed partial denture*. An adjective may be added to the clinical description, if needed, to designate the means of mechanical retention, i.e. a *screw retained fixed partial denture*. Any such prosthesis luted to dental implants (in the same manner as luting a fixed partial denture to natural teeth) needs no additional designation as to its means of retention—see BILATERAL DISTAL EXTENSION REMOVABLE P.D., FIXED P.D., REMOVABLE P.D., UNILATERAL REMOVABLE P.D.

partial denture construction *obs*: the science and technique of designing and constructing partial dentures (GPT-4)

partial denture impression: a negative likeness of a part or all of a partially edentulous arch

partial denture rest: a rigid extension of a fixed or removable partial denture that prevents movement toward the mucosa and transmits functional forces to the teeth

partial denture retention: the ability of a partial denture to resist movement away from its foundation area and/or abutments

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plane of occlusion: see OCCLUSAL PLANE

plane of reference: any plane with defined landmarks from which measurements can be made—see HORIZONTAL PLANE OF REFERENCE

plas.ter *n*: a paste-like composition (usually of water, lime, and sand) that hardens on drying and is used for coating walls, ceilings, and partitions—*slang*: in dentistry, a colloquial term applied to dental plaster of paris

plaster of paris (15c): a white, powdery, slightly hydrated calcium sulfate made by calcination of gypsum, used for making casts and molds when combined with water to form a quick-setting paste.

plaster wash *obs*: a thin mix of plaster used to improve the accuracy of a preliminary impression (GPT-4)

¹plas.tic *adj* (1632) **1**: capable of being shaped or formed **2**: pertaining to the alteration or reformation of living tissues

²plas.tic *n* (ca. 1909): any of numerous organic synthetic or processed materials that generally are thermoplastic or thermosetting polymers, usually of high molecular weight. They can be cast, extruded, molded, drawn, or laminated into films, filaments, and objects

plastic base *obs*: a denture or record base made of a plastic material (GPT-4)

plate *n*, *slang*: see PROSTHESIS

platinum foil: a precious-metal foil with a high fusing point that makes it suitable as a matrix for various soldering procedures as well as to provide an internal form for porcelain restorations during their fabrication

Pleasure curve [Max Pleasure, 1903-1965]: *eponym* for a curve of occlusion which, when viewed in the frontal plane, conforms to a line that is convex in the cephalic direction, except when viewed through the molar region

plunger cusp: a cusp that tends to force food interproximal

po.go.ni.on *n*: the most anterior point on the mandible

point A: a bony landmark representing the deepest point of the premaxillary concavity between the anterior nasal spine and prosthion as viewed on a lateral cephalometric radiograph

point angle: in the development of a cavity preparation, that place of convergence of three planes or surfaces—*comp* LINE ANGLE

point B: see SUPRAMENTALE

¹pol.ish *vb* (14c): to make smooth and glossy, usually by friction; giving luster; the act or process of making a denture or casting smooth and glossy

²polish *n* (1704): a smooth, glossy surface; having luster

polished denture surface *obs*: that portion of the surface of a denture that extends in an occlusal direction from the border of the denture and includes the palatal surfaces. It is that part of the denture base that is usually polished, and it includes the buccal and lingual surfaces of the teeth (GPT-4)

polished layer: see BEILBY LAYER

pol.ish.ing *v*, *obs* **1**: to make smooth and glossy, usually by friction; to give luster to (GPT-1) **2**: *obs*: the act or process of making a denture or casting smooth and glossy (GPT-1)

polishing agents: any material used to impart luster to a surface

poly.ether *adj*: an elastomeric impression material of ethylene oxide and tetra-hydrofurocopolymers that polymerizes under the influence of an aromatic ester

poly.mer *n* (1866): a chemical compound consisting of large organic molecules built by repetition of smaller monomeric units

polymerization *n* (1872): the forming of a compound by the joining together of molecules of small molecular weights into a compound of large molecular weight

po.ly.mer.ize *vb*: to effect a chemical reaction by joining together individual molecules to form large molecules made up of many repeated units

poly.som.nog.ra.phy *n*: the all-night recording of a variety of physiologic parameters (e.g., brain waves, eye movements, muscle tonus, respiration, heart rate) as an aid in the diagnosis of sleep related disorders

poly.sul.fide *n* (1849): an elastomeric impression material of polysulfide polymer (mercaptan) that cross-links under the influence of oxidizing agents such as lead peroxide

poly.vi.nyl.si.lox.ane *n*: an addition reaction silicone elastomeric impression material of silicone polymers having terminal vinyl groups that cross-link with silanes on activation by a platinum or palladium salt catalyst

pon.tic *n*: an artificial tooth on a fixed partial denture that replaces a missing natural tooth, restores its function, and usually fills the space previously occupied by the clinical crown

por.ce.lain *n* (known in Europe, ca. 1540): a ceramic material formed of infusible elements joined by lower fusing materials. Most dental porcelains are glasses and are used in the fabrication of teeth for dentures, pontics and facings, metal ceramic restorations, crowns, inlays-onlays, and other restorations

porcelain fused to metal restoration: see METAL CERAMIC RESTORATION

porcelain labial margin: the extension of ceramic material to the finish line of the preparation without visible metal substructure in the marginal area—*syn* PORCELAIN BUTT MARGIN

po.ros.i.ty *n*, *pl* **-ties** (14c) **1**: the presence of voids or pores within a structure **2**: the state or quality of having minute pores, openings or interstices—see BACK PRESSURE P., OCCLUDED GAS P., SHRINK-SPOT P., SOLIDIFICATION P.

positional record: an intraoral or extraoral registration of a specific mandibular position

post.core: see DOWEL

post.core crown: a restoration in which the crown and cast post in one unit

post dam: see POSTPALATAL SEAL

post dam area: see POSTPALATAL SEAL AREA

posterior *adj* (1534) **1**: situated behind or in back of; caudal **2**: in human anatomy, dorsal

posterior bite collapse: see POSTERIOR OVERCLOSURE

posterior border jaw relation *obs*: the most posterior relation of the mandible to the maxillae at any specific vertical relation (GPT-4)

posterior border movement: movements of the mandible along the posterior limit of the envelope of motion

posterior border position: the most posterior position of the mandible at any specific vertical relation

posterior determinants of mandibular movement: the temporary mandibular articulations and associated structures—see DETERMINANTS OF MANDIBULAR MOVEMENT

posterior determinants of occlusion: see DETERMINANTS OF MANDIBULAR MOVEMENT

posterior open bite *slang*: see POSTERIOR OPEN OCCLUSAL RELATIONSHIP

posterior open occlusal relationship: lack of posterior tooth contact in any occluding position of the anterior teeth

posterior opening movement *obs*: the opening movement of the mandible about the terminal hinge axis (GPT-4)

posterior overclosure: the loss of occluding vertical dimension as result of the loss or drifting of posterior teeth

posterior palatal seal: see POSTPALATAL SEAL

posterior palatal seal area: see POSTPALATAL SEAL AREA

posterior reference points: two points, located one on each side of the face in the area of the transverse horizontal axis, which together with an anterior reference point, establish the horizontal reference plane

posterior tooth form: the distinguishing contours of the occlusion surfaces of posterior teeth

postmenopausal atrophy: atrophy of various tissues, such as oral mucosa, occurring after menopause

postpalatal seal: the seal area at the posterior border of a maxillary prosthesis

postpalatal seal area: the soft tissue area at or beyond the junction of the hard and soft palates on which pressure, within physiologic limits, can be applied by a denture to aid in its retention

postsurgical prosthesis: see DEFINITIVE OBTURATOR INTERIM OBTURATOR

postural contraction: that minimal tonic muscle activity necessary to resist the forces of gravity and thus maintain posture; maintenance of muscle tension (usually isometric) sufficient to maintain posture, dependent on muscle tone

postural position: any mandibular relationship occurring during minimal muscle contraction

pour hole *obs*: an aperture in investment or any other mold material leading to the prosthesis space into which prosthetic material is poured (GPT-4)

precious metal: a metal containing primary elements of the platinum group, gold, and silver

precious metal alloy: an alloy predominantly composed of elements considered precious, i.e., gold, the six metals of the platinum group (platinum, osmium, iridium, palladium, ruthenium, and rhodium), and silver

precision attachment: **1**: a retainer consisting of a metal receptacle (matrix) and a closely fitting part (patrix); the matrix is usually contained within the normal or expanded contours of the crown on the abutment tooth and the patrix is attached to a pontic or the removable partial denture framework **2**: an interlocking device, one component of which is fixed to an abutment or abutments, and the other is integrated into a removable prosthesis to stabilize and/or retain it

precision rest: a prefabricated, rigid metallic extension (patrix) in a fixed or removable partial denture that fits intimately into the box-type rest seat or keyway (matrix) portion of a precision attachment in a cast restoration

preextraction cast: see DIAGNOSTIC CAST

preliminary cast: a cast formed from a preliminary impression for use in diagnosis or the fabrication of an impression tray

preliminary impression: a negative likeness made for the purpose of diagnosis, treatment planning, or the fabrication of a tray

premature contact: see DEFLECTIVE OCCLUSAL CONTACT

pre.ma.tur.i.ty *n*: see DEFLECTIVE OCCLUSAL CONTACT

preoperative cast: a positive likeness of a part or parts of the oral cavity for the purpose of diagnosis and treatment planning—see DIAGNOSTIC CAST

preoperative record *obs*: any record made for the purpose of study or treatment planning (GPT-4)

preoperative wax.up: a dental diagnostic procedure in which planned restorations are developed in wax on a diagnostic cast to determine optimal clinical and laboratory procedures necessary to achieve the desired esthetics and function—called also *diagnostic wax-up, preoperative waxing*

preprosthetic surgery: surgical procedures designed to facilitate fabrication or to improve the prognosis of prosthodontic care

pressure area: a region of mucosa that is being subjected to excessive from a denture

pressure indicating paste: any substance applied to a prosthesis, which, when seated on a structure, demonstrates the adaptation of the prosthesis to the structure it opposes

pressure relief *obs*: alteration of the denture-bearing surface of a denture to reduce force on the underlying tissues (GPT-4)

pressure welding: bonding of two metals together by sufficiently large force applied perpendicular to the surface. Such force must be of magnitude to produce permanent distortions that expose a film-free metal contact

pretreatment records: any records made for the purpose of diagnosis, recording of the patient history, or treatment planning in advance of therapy

primary colors: three basic colors used to make most other colors by mixture, either additive mixture of lights or subtractive mixture of colorants

primary colors additive: three colored lights from which all other colors can be matched by additive mixture. The three must be selected so that no one of them can be matched by mixture of the other two. Generally, red, green, and blue are used. Additive primaries are the complements of the subtractive primaries

primary colours subtractive: colors of three colorants or colored materials which, when mixed together subtract from one another, result in black or a very dark neutral color. Subtractive primaries are generally cyan, magenta, and yellow

primary dentition: the teeth that erupt first and are normally shed to be replaced by permanent (succedaneous) teeth—*syn* DECIDUOUS DENTITION

primary hyperalgesia: stimulation evoked primary pain due to lowered pain threshold

primary impression: see PRELIMINARY IMPRESSION

primary occlusal trauma: the effects induced by abnormal or excessive occlusal forces acting on teeth with normal periodontal support

primary pain: pain that identifies the true source of nociceptive input result from the dispersion of light rays by means of a prism or diffraction grating

pro.cess *n, pl* **pro.ces.ses** (14c) **1**: in anatomy, a prominence or projection of bone **2**; in dentistry, any technical procedure that incorporates a number of steps; the procedure of bringing about polymerization of dental resins for prostheses or bases—see DENTURE PROCESSING

processed denture base: that portion of a polymerized prosthesis covering the oral mucosa of the maxillary and/ or mandible to which artificial teeth will be attached by means of a second processing

process jig: see ANALOG

pro.file *n* (ca. 1656): an outline or contour, especially one representing a side view of a human head

profile record: a registration or record of the facial profile of a patient—see also EMERGENCE PROFILE

prog.na.thic *n*: a protruded position of the mandible in relation to the maxillae—called also *caput progeneum, exognathia, progenia, and prognathia*

prog.na.thism *n* (ca. 1864): an overgrowth of the mandible in an anteroposterior direction; a protrusion of the mandible in relation to the maxillae

prog.no.sis *n* (1655): a forecast as to the probable result of a disease or a course of therapy

progressive loading (1998): the gradual increase in the application of force on a dental implant whether intentionally done with a prosthesis or unintentionally via forces placed by adjacent anatomic structures or parafunctional loading

progressive mandibular lateral translation 1: the translatory portion of mandibular movement when viewed in a specified body plane **2**: the translatory portion of mandibular movement as viewed in a specific body plane that occurs at a rate or amount that is directly proportional to the forward movement of the non-working condyle—see MANDIBULAR TRANSLATION

progressive side shift: see MANDIBULAR TRANSLATION

projected pain: heterotopic pain felt in the anatomical peripheral distribution of the same nerve that mediates the primary pain

proportional limit: that unit of stresses beyond which deformation is no longer proportional to the applied load

pro.prio.cep.tion *n* (1906): the reception of stimulation of sensory nerve terminals within the tissues of the body that give information concerning movements and the position of the body; perception mediated by proprioceptors

prio.the.sis *n, pl* **-the.ses** (1900) **1**: an artificial replacement of an absent part of the human body **2**: a therapeutic device to improve or alter function **3**: a device used to aid in accomplishing a desired surgical result—see DEFINITIVE P., DENTAL P., INTERIM P., PROVISIONAL P., SURGICAL P.

prosthesis placement: see PLACEMENT

pros.thet.ic *adj*, **pros.thet.i.cal.ly** *adv* (ca. 1890): relating to a prosthesis or prosthetics

prosthetic dentistry: see PROSTHODONTICS

prosthetic restoration *obs*: an artificial replacement for an absent part of the human body (GPT-4)

prosthetic speech aid: see ADULT SPEECH AID PROSTHESIS, PEDIATRIC SPEECH AID PROSTHESIS

finishing and polishing **2**: a polishing agent, in powdered form, used for natural teeth and fixed and removable restorations

[2]**pumice** vt **pum.iced; pum.ic.ing** (15th cent.): to finish or dress with pumice

pyramidal fracture: a fracture of the midfacial bones, with the principal fracture lines meeting at an apex in the area of the nasion-called also *Le Fort II fracture*

Q

Q.D.: *acronym* for L. *Qad'que Di'e*, every day

Q.H.: *acronym* for L. *Qua'que Ho'ra*, every hour

Q.I.D.: *acronym* for L. *Qua'ter In Di'e*, four times a day

Q.L.: *acronym* for L. *Quan'tum Li'bet*, as much as desired

Q.Q.H.: *acronym* for L. *Qua'que Quar'ta Ho'ra*, every 4 hours

quad.rant *n* (15c) **1**: any of the four quarters into which something is divided by two real or imaginary lines that intersect each other at right angles **2**: in dentistry, one of the four section; of the dental arches, divided at the midline

quartz *n* (ca. 1631): an allotropic form of silica; the mineral consisting of hexagonal crystals of colorless, transparent silicon dioxide

quick.cure resin: see AUTOPOLYMERIZING RESIN

R

RAD: *acronym* for *Radiation Absorbed Dose*, a unit of measurement of the absorbed dose of ionizing radiation. The biologic effect on one rad varies with the type of radiation tissue is exposed to—also GRAY

ra.di.a.tion *n* (1570): the emission of electromagnetic waves, such light, short wave, radio, ultraviolet, or x-rays, or particulate such as alpha, beta, and gamma rays

radiation carrier: a device used to administer radiation to confined areas by means of capsules, beads, or needles of radiation emitting materials such as radium or cesium. Its function is to hold the radiation source securely in the same location during the enter period of treatment—*syn* CARRIER PROSTHESIS, INTRACAVITY APPLICATOR, INTRACAVITY CARRIER, RADIATION APPLICATOR, RADIUM CARRIER, RADIOTHERAPY PROSTHESIS

radiation cone locator: a prosthesis used to direct and reduplicate the path of radiation to an oral tumor during a split course of irradiation—*syn* CONE LOCATOR, DOCKING DEVICE

radiation shield: an intraoral prosthesis designed to shield adjacent tissues from radiation during orthovoltage treatment of malignant lesions of the head and neck regions—*syn* LEAD SHIELD, RADIATION STENT, TONGUE PROTECTOR

radiation shield/positioner: custom-made prosthesis to align and protect adjacent tissues during irradiation

radiation source device: custom-made prosthesis to align a radiation source to a specific anatomic site

radiation stent: see RADIATION SHIELD

rad.i.cle *n* (1671): the lower part of the axis of an object

rad.ic.u.lar *adj* (1830): pertaining to the root of a tooth

ra.dio.gram *n*: see RADIOGRAPH

ra.dio.graph *n* (1880): an image produced on any sensitive surface by means of electromagnetic radiation other than light; a X-ray photograph

radiograph *vt* (1896): to make a radiograph of

ra.dio.lu.cent: permitting the passage of radiant energy with relatively little attenuation by absorption

ra.di.opaque (1917): a structure that strongly inhibits the passage of radiant energy

ramus endosteal implant: an endosteal dental implant that is attached, in part, to the ramus of the mandible

ramus frame endosteal implant: a dental implant design that consists of a horizontal intraoral supragingival abutment in the form of a bar and endosteal implant body segments that are placed into the rami and symphysis areas as one section (implants fabricated from one piece of metal), or two sections (implants of anterior and horizontal segments that are connected at the time of placement), or five sections (an implant consisting of five sections in which the endosteal implant body segments are independently placed and connected with fitted parts)

range of motion: the range, measured in degrees of a circle, through which a joint can be extended or flexed. The range of the opening, lateral, and protrusive excursions of the temporomandibular joint

ra.phe *n* (1753) **1**: line of union of symmetrical parts **2**: a fibrous band or bands where paired muscles meet

re.at.tach.ment *n*: in periodontics, the reunion of epithelial and connective tissues with root surfaces and bone such as occurs after incision or injury

re.base *n*: the laboratory process of replacing the entire denture base material on an existing prosthesis

receptor sites: specific sites at which molecular binding occurs that results in specific biologic responses

recipient site: the site into which a graft or transplant material is placed

re.cip.ro.cal *adj, obs*: the manner in which one part of a prosthesis is made to counter the effect created by another part (GPT-1)

reciprocal arm: see RECIPROCAL CLASP

reciprocal clasp: a component of the clasp assembly specifically designed to provide reciprocation by engaging a reciprocal guiding plane; it contacts the action of the clasp during removal and insertion of a removable partial denture

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by artificial substitutes that are removable from the mouth

rep.li.ca *n* (1852) **1**: a reproduction or fascimile, especially by the makers, of an original **2**: a copy or duplicate, i.e., a duplicate of the surface of a component of a dental implant used to process a restoration

re.po.si.tion.ing *adj*: the changing of any relative position of the mandible to the maxillae, usually altering the occlusion of the natural or artificial teeth

repositioning splint: an intraoral splinting device constructed to temporarily or permanently alter the relative position of the mandible to the maxillae

residual bone: that component of maxillary or mandibular bone, once used to support the roots of the teeth, that remains after the teeth are lost

residual ridge: the portion of the residual bone and its soft tissue covering that remains after the removal of teeth

residual ridge crest: the most coronal portion of the residual ridge

residual ridge resorption: a term used for the diminishing quantity and quality of the residual ridge after teeth are removed

Ortman HR. Factors of bone resorption of the residual ridge. J Prosthet Dent 1962;12:429-40.

Atwood DA. Some clinical factors related to rate of resorption of residual Ridges. J Prosthet Dent 1962;12:441-50.

re.sil.ient *adj* (1674): characterized or noted by resilience, as **a)** capable of withstanding shock without permanent deformation or rupture or **b)** tending to recover from or easily adjust to change *syn* ELASTIC—**re.sil.ient.ly** *adv*

resilient attachment (1998): an attachment designed to give a tooth-/soft tissue-borne prosthesis sufficient mechanical flexion to withstand the variations in seating of the prosthesis due to deformations of the mucosa and underlying tissues without placing excessive stress on the abutments

res.in *n* (14c) **1**: any of various solid or semisolid amorphous natural organic substances that usually are transparent or translacent and brown to yellow; usually formed in plant secretions; are soluble in organic solvents but not water; are used chiefly in varnishes, inks, plastics, and medicine; and are found in many dental impression materials **2**: a broad term used to describe natural or synthetic substances that form plastic materials after polymerization. They are named according to their chemical composition, physical structure, and means for activation of polymerization—see AUTOPOLYMERIZING R., COPOLYMER R.

resin-bonded prosthesis: a prosthesis that is luted to tooth structures, primarily enamel, which has been etched to provide mechanical retention for the resin cement. Early design incorporated perforations on the lingual plate (Rochette Bridge) through which the resin bonded material passed to achieve a mechanical lock; subsequently, use of acid etching of the metal plate (Maryland Bridge) eliminated the need for perforations.

Rochette, Alain I. Attachment of a splint to enamel of lower anterior teeth J Prosthet Dent 1973;30:418-23.

Livaditis GJ; Thompson VP. Etched castings an improved retentive mechanism for resin-bonded retainers J Prosthet Dent 1982;47:52-9.

resin-bonded splint: a splint of heavy wire or cast metal that is bonded to the labial or lingual surface of natural teeth with an acid etch technique. It is used to stabilize traumatically displaced or periodontally compromised teeth

resin crown: a resin restoration that restores a clinical crown without a metal substructure

resin-retained prosthesis: see RESIN-BONDED PROSTHESIS

resistance form: the features of a tooth preparation that enhance the stability of a restoration and resist dislodgement along an axis other than the path of placement

re.sorp.tion *n* (1818): the loss of tissue substance by physiologic or pathologic process—see ALVEOLAR RESORPTION

rest *n* (15c): a projection or attachment, usually on the side of an object—see CINGULUM R., INCISAL R., LINGUAL R. OCCLUSAL R., PARTIAL DENTURE R., PRECISION R. SEMIPRECISION R.

rest area: see REST SEAT

rest bite: see PHYSIOLOGIC REST POSITION

rest jaw relation *obs*: the habitual postural jaw relation when the patient is resting comfortably in an upright position and the condyles are in a neutral, unstrained position in the glenoid fossae (GPT-4)

rest occlusion: see PHYSIOLOGIC REST POSITION

rest position: see PHYSIOLOGIC REST POSITION

rest relation: see PHYSIOLOGIC REST POSITION

rest seat: the prepared recess in a tooth or restoration created to receive the occlusal, incisal, cingulum, or lingual rest

rest vertical dimension: the distance between two selected points measured when the mandible is in the physiologic rest position

res.to.ra.tion *n* (1660): a broad term applied to any material or prosthesis that restores or replaces lost tooth structure, teeth or oral tissues

re.tain.er *n* (1540): any type of device used for the stabilization or retention of a prosthesis—see DIRECT R., FIXED PARTIAL DENTURE R., INDIRECT R.

re.ten.tion *n* (15c): that quality inherent in the prosthesis acting to resist the forces of dislodgement along the path of placement—see DIRECT R., INDIRECT R.

retention arm: an extension that is part of a removable partial denture and is used to aid in the fixation of the prosthesis; a part of a clasp

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rigid connector: a cast, soldered, or fused union between the retainer(s) and pontic(s)

Roach clasp [Finnis Ewing (Frank) Roach, US prosthodontist, educator and inventor, (1865-1960)]: *eponym*—see INFRABULGE CLASP

Roach FE. Principles and essentials of bar clasp partial dentures. J Am Dent Asso: 1930;17:124-38.

Rochette Bridge [Alain L. Rochette, French physician and dentist]: a resin-bonded prosthesis incorporating holes within the metal framework and lutes to the lingual aspect of teeth adjacent to an edentulous space that replaces one or more teeth—see RESIN-BONDED PROSTHESIS

Rochette, Alain L. Attachment of a splint to enamel of lower anterior teeth.

J Prosthet Dent 1973;30:418-23.

rod *n* (bef. 12c.): the photoreceptor in the retina that contains a light-sensitive pigment capable of initiating the process of scotopic vision, i.e., low intensity for achromatic sensations only

[1]**roent.gen** *adj* [W.C. Roentgen, German physicist (1845-1923)]: relating to X-rays

[2]**roentgen** *n* (ca. 1929): the international unit of measurement of X- or gamma radiation in air—*abb* r or R

roentgen ray *n, often cap 1st R* (1898) **1**: the electromagnetic radiation [greater than 100eV] emitted from a highly evacuated tube, excited by the bombardment of the target anode with a stream of electrons from a heated cathode **2**: electromagnetic radiation produced by the excitation of the inner orbital electron of an atom

roent.gen.o.gram *n* (1904): a photograph made with X-rays

roent.gen.o.graph *n* (ca. 1905): a shadow image record made on a sensitized film or plate by roentgen rays

roentgenographic interpretation *obs*: an opinion formed from the study of a roentgenograph (GPT-1)

root *n* (bef. 12c): the portion of the tooth apical to the cementoenamel junction that is normally covered by cementum and is attached to the periodontal ligament and hence to the supporting bone

root form endosteal dental implant: an endosteal dental implant shaped in the approximate form of a tooth root

root fracture: a microscopic or macroscopic cleavage of the root in any direction

rotating condyle: see WORKING SIDE CONDYLE

ro.ta.tion *n* (1555) **1**: the action or process of rotating on or as if on an axis or center **2**: the movement of a rigid body in which the parts move in circular paths with their centers on a fixed line called the axis of rotation. The plane of the circle in which the body moves is perpendicular to the axis of rotation

rotation center: a point around which all other points in a body move

rotation line *obs*: see FULCRUM LINE

rotational path removable partial denture: a removable partial denture that incorporates a curved, arcuate, or variable path of placement allowing one or more of the rigid components of the framework to gain access to and engage an undercut area

rogue *n* (1753): a compound composed of ferric oxide and binders used for imparting a high luster to a polished surface, glass metal or gems

RPD: *acronym* for *Removable Partial Denture*

RPI: *acronym* for *Rest, Proximal* Plate, and *I-BAR*; the clasp components of one type of removable partial denture clasp assembly

ruga *n, pl* **ru.gae** (ca. 1775): an anatomic fold or wrinkle—usually used in the plural sense; the irregular fibrous connective tissue ridges located in the anterior third of the hard palate

rugae area: see RUGA

rugae zone: see RUGA

S

sad.dle *n, obs*: see DENTURE BASE

sag.it.tal *adj* (1541): situated in the plane of the cranial sagittal suture or parallel to that plane—*usage*: see SAGITTAL PLANE

sagittal axis: an imaginary anteroposterior line around which the mandible may rotate when viewed in the frontal plane

sagittal axis of the mandible: see SAGITTAL AXIS

sagittal plane: any vertical plane or section parallel to the median plane of the body that divides a body into right and left portions

sanitary bridge *obs*: see HYGIENIC PONTIC

sat.u.ra.tion *n* (1554): the attribute of color perception that expresses the degree of departure from gray of the same lightness. All grays have zero saturation

scaf.fold *n* (14c): a supporting surface, either natural or prosthetic, that maintains the contour of tissue; a supporting framework

[1]**scal.lop** *n* (15c): one of a continuous series of circles

[2]**scallop** *vt* (1737): to shape, cut, or finish in scallops; segments or angular projections forming a border

scattered radiation: radiation that, during passage through a substance, has been deviated in direction. It may also have been modified by an increase in wave lengths. It is one form of secondary radiation

scat.ter.ing *n* (14c): diffusion or redirection of radiant energy encountering particles of different refractive index; scattering occurs at any such interface, at the surface, or inside a medium containing particles

scattering coefficient: single scattering coefficient of a particle in a medium of different refractive index, expressed as a ratio between scattering cross section and geometric cross section of the particle. It should properly be called scattering efficiency, but in popular use, called scattering coefficient

scotopic vision: vision that occurs in faint light or dark adaptation and is attributable to the retinal rods. The maximum of the relative spectral visual sensitivity is shifted to 510 nm and the spectrum is seen uncolored

screw endosteal dental implant 1: any dental implant whose implant body configuration resembles a screw **2**: any screw-shaped dental implant; it may be hollow or solid, and usually consists of the dental implant abutment and the dental implant body

scribe *vt*; **scribed; scrib.ing** (1678): to write, trace, or mark by making a line or lines with a pointed instrument

second stage dental implant surgery 1: for eposteal dental implant surgery, the term refers to the procedure involving placement of the eposteal framework fabricated after the first stage implant surgery **2**: for endosteal dental implant surgery, after surgical reflection, the occlusal aspect of the dental implant body is exposed, the cover screw is removed, and either the interim or definitive abutment is placed. After this, the investing tissues are (when needed) anastomosed

secondary bonds: weak interatomic bonds arising from dipoles within atoms or molecules

secondary crown: see TELESCOPIC CROWN

secondary dentition: see PERMANENT DENTITION

secondary fracture: a fracture occurring as a consequence of necrosis or some other disease of the bone

secondary occlusal trauma: the effects induced by occlusal force (normal or abnormal) acting on teeth with decreased periodontal support

secondary pain: heterotopic pain and/or secondary hyperalgesia induced by deep somatic pain as a central excitatory effect

sec.tion *n*: the portion of a maxillofacial prosthesis that serves to fill a defect as a part of the prosthesis

sectional facial moulage: a sectional facial moulage impression is a procedure used to record the soft tissue contours of a portion of the face. Occasionally, several separate sectional impressions are made and then reassembled to provide a full facial contour cast

sectional impression: a negative likeness that is made in sections

seg.ment *n* (1570): any of the parts into which a body naturally separates or is divided either actually or by an imaginary line or plane

selective grinding: see OCCLUSAL RESHAPING

self-curing resin: see AUTOPOLYMERIZING RESIN

self-separating plaster *obs*: an impression plaster that disintegrates in hot water (GPT-4)

self-threading pin: a pin screwed into a hold prepared in dentin to enhance retention

sella turcica: a cephalometric landmark in the geometric center of the pituitary fossa of the spheroid bone; a bony anatomic landmark

semiadjustable articulator: an articulator that allows adjustment to replicate average mandibular movements—called also *Class III articulator*

semiprecious metal alloy: an alloy composed of precious and base metals. There is no distinct ratio of components separating semi-precious alloys from another group

semiprecision rest: a rigid metallic extension of a fixed or removable partial denture that fits into an intracoronal preparation in a case restoration

senile atrophy: see AGE ATROPHY

separating medium 1: a coating applied to a surface and serving to prevent a second surface from adhering to the first **2**: a material usually applied on an impression, to facilitate removal of the case

sep.tum *n*, *pl* **sep.ta** (1726): a dividing wall or membrane, especially between bodily spaces or masses

setting expansion: the dimensional increase that occurs concurrent with the hardening of various materials, such as plaster of paris dental stone, die stone, and dental casting investment

set up *v*, *obs*: see TOOTH ARRANGEMENT

shade *n* **1**: a term used to describe a particular hue, or variation of a primary hue, such as a greenish shade of yellow **2**: a term used to describe a mixture with black (or gray) as opposed to a tint that is a mixture with white—see TOOTH COLOR SELECTION

shade selection: see TOOTH COLOR SELECTION

shearing stress: the internal induced force that opposes the sliding of one plane on an adjacent plane or the force that resists a twisting action

shellac base *obs*: a record base constructed using a shellac-based wafer that has been adapted to the cast with heat (GPT-4)

shell crown *obs* **1**: an artificial full-veneer crown swaged from metal plate **2**: an artificial crown that is adapted like a shell or cap over the remaining clinical crown of a tooth; the space between the crown and the shell is filled with cement—called also *cap crown*

shoulder finish line *n*: a finish line design for tooth preparation in which the gingival floor meets the external axis surfaces at approximately a right angle

shrink-spot porosity: an area of porosity in cast metal that is caused by shinkage of a portion of the metal as it solidifies from the molten state without flow of additional molten metal from surrounding areas

side shift: see MANDIBULAR TRANSLATION

sil.i.ca *n* (ca. 1301): silicon dioxide occurring in crystalline, amorphous, and usually impure forms (as quartz, opal, and sand respectively)

silent period: a momentary electromy graphic observable decrease in elevator muscle activity on initial tooth contact presumably due to the inhibitory effect of stimulated periodontal membrane receptors

simple fracture: a linear bony fracture that is not in communication with the exterior

simple joint: a joint in which only two bones articulate

simulation film: radiographs made with the same field size, source to-skin distance, and orientation as a therapy beam to mimic the beam and for visualization of the treated volume on a radiograph

single crystal sapphire: a material composed of a single crystalline alpha aluminium oxide that is identical in crystalline structure to a gem sapphire

single denture construction *obs*: the making of a maxillary or mandibular denture as distinguished from a set of complete dentures (GPT-1)

[1]**sin.ter** *n* (1780): a deposit formed by evaporation of lake or spring water

[2]**sinter** *vt* (1871): to cause to become a coherent mass by heating without melting

skia.graph *n* (1801) *obs* **1**: a figure formed by shading in the outline of a shadow **2**: a radiograph—called also *skiagram* (GPT-1)

sleeper: *slang* for any dental implant body not used for support and stabilization of a dental prosthesis

sliding movement: see TRANSLATION

slotted attachment: see PRECISION ATTACHMENT

[1]**sluice** *n* (14c): an artificial passage for water fitted with a valve or gate for stopping or regulating the flow

[2]**sluice** *vb* **sluiced; sluic.ing** *vt* (1593) **1**: to draw off by or via a sluice **2**: to wash with or in water through or from a sluice **3**: to drench with a sudden flow

SNA angle: *acronym* for *Sella-Nasion-A* point—in cephalometrics, an angle measuring the anteroposterior relationship of the maxillary basal arch on the anterior cranial base; it shows the degree of maxillary prognathism

snap impression *obs*: see PRELIMINARY IMPRESSION

SNB angle: *acronym* for *Sella-Nasion-B* point—in cephalometrics, an angle showing the anterior limit of the mandibular basal arch in relation to the anterior cranial base

sock.et *n* (15c): any opening or hollow that forms a holder for something, e.g., a tooth

soft palate: the movable part of the palatal anatomy posterior to the hard palate

soft palate obturator: see SPEECH AID PROSTHESIS

soft splint: a resilient device covering either the maxillary or mandibular teeth for the purpose of preventing trauma to the dentition or acting as a deprogrammer

[1]**sol.der** *n* (15c): a fusible metal alloy used to unite the edges or surfaces of two pieces of metal; something that unites or cements

[2]**solder** *v*, **soldered; sol.der.ing, sol.der.abil.i.ty** *n*—**sol.der.er** *n*: to unite, bring into, or restore to a firm union; the act of uniting two pieces of metal by the proper alloy of metals

solidification porosity: a porosity that may be produced by improper spruing or improper heating of either the metal or the investment

so.ma.to.pros.thet.ics *n* (ca. 1950): the art and science of prosthetic replacement of external parts of the body that are missing or deformed

son.i.cate *vt*—**cat.ed;.cat.ing** (1961): to disrupt (i.e. bacteria) by means of aplication of high frequency sound waves—**son.i.ca.tion** *n*

space *n* (14c): a delimited, three-dimensional region; physical space independent of what occupies it—see DENTURE S., INTERPROXIMAL S., INTERRADICULAR S., RETRO-MYLOHYOID S.

space of Donders [F.C. Donders]: *eponym* for the space that lies above the dorsum of the tongue and below the hard and soft palates when the mandible and tongue are in the rest position

Donders FC. Ueber den Mechanismus des Saugens. Pflugers Archiv fur die Gesamte Physiologie Des Menschen Und Der Tiere. 1875;10:91-4.

span length: the length of a beam between two supports

spat.u.la *n* (1525): a flat-bladed instrument used for mixing or spreading materials

[1]**spat.u.late** *adj* (1760): shaped like a spatula

[2]**spat.u.late ed/.ing/.s**: to work or treat with a spatula

spat.u.la.tion the manipulation of material with a spatula to produce a homogenous mass

speaking space: the space that occurs between the incisal or/and occlusal surfaces of the maxillary and mandibular teeth during speech

spectral curve: see SPECTROPHOTOMETRIC CURVE

spectral reflection: reflection in which the angle of reflection is equal to the angle of incidence. Associated with objects

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subtractive color system: the system whereby light is removed by filtration or absorption from a white source. The primary colors of the subtractive system are magenta, cyan, and yellow—called also *pigment mixture color system*

subtractive primary colors: the primary colorant substances for pigment and filtering mixtures typically evoking responses of cyan (blue-green), magenta (red-blue), and yellow (red-green). The complementary colors of the subtractive primary colors are red, green, and blue. Magenta is a mixture of red and blue and is the complement of green. Cyan is a mixture of blue and green and is the complement of red. Yellow is a mixture of red and green and is the complement of blue

suction chamber *obs*: relief provided in the midline palatal area of a maxillary denture in an attempt to obtain additional retention by means of the theoretical vacuum created (GPT-4)

suction cup *obs*: a thin rubber disk, usually with a hole in its center, which fits over a button that is larger in diameter than the hole. This causes the disk to assume a cup shape. When applied to the tissue surface of a denture, the cup attaches itself too the mucous membrane by suction (GPT-1)

sulcular epithelium: see CREVICULAR EPITHELIUM

sul.cus *n*: see GINGIVAL CREVICE

su.per.struc.ture *n*: the superior part of a multipe layer prosthesis that includes the replacement teeth and associated structures

superimposed prosthesis: see OVERDENTURE

[1]**support** *n* (14c): the foundation area on which a dental prosthesis rests

[2]**sup.port** *vt* (14c): to hold up or serve as a foundation or prop for

supporting area *obs* **1**: the surface of the mouth available for support of a denture (GPT-1) **2**: those areas of the maxillary and mandibular edentulous ridges that are considered best suited to carry the forces of mastication when the dentures are in function (GPT-1)

supporting cusps: those cusps or incisal edges of teeth that contact in and support centric occlusion. Usually facial cusps of the mandibular posterior teeth, the maxillary palatal cusps, and the incisal edges of the mandibular anterior teeth

su.pra.bulge *n*: that portion of a tooth crown that converges toward the occlusal surface, i.e. above the height of contour

suprabulge clasp: a removable partial denture retentive clasp that approaches the retentive undercut from an occlusal or suprabulge direction

su.pra.erup.tion *n*: movement of a tooth or teeth above the normal occlusal plane

su.pra.gin.gi.val *adj* **1**: located above the gingiva **2**: that portion of a natural or artificial tooth that is coronal to the gingival crest

su.pra.men.ta.le *n*: a landmark representing the deepest point of the symphyseal cavity between infradentale and pogonion

su.pra.oc.clu.sion *n*: malocclusion in which the occluding surfaces of teeth extend beyond the normal occlusal plane—called also *overeruption*

surgical baseplate: see SURGICAL OBTURATOR

surgical guide: see SURGICAL PROSTHESIS, SURGICAL TEMPLATE

surgical maxillomandibular relation: the establishing and recording of the correct vertical dimension and centric relation between a surgically exposed boen surface and opposite arch at the time of making a surgical bone impression

surgical obturator: a temporary prosthesis used to restore the continuity of the hard palate immediately after surgery or traumatic loss of a portion or all of the hard palate and/or contiguous alveolar structures (i.e. gingival tissue, teeth)—see INTERIM OBTURATOR

surgical occlusion rim: an occlusion rim used in recording surgical maxillomandibular relations

surgical prosthesis: any prosthesis prepared for insertion during a surgical procedure and intended for short-term use

surgical splint: a prosthesis designed to use existing teeth and/or alveolar processes as points of anchorage to assist in stabilization and immobilization of broken bones during healing. They are used to re-establish, as much as possible, normal occlusal relationships during the process of immobilization—*syn* CAST METAL SPLINT, FENESTRATED SPLINT, GUNNING SPLINT, KINGSLEY SPLINT, LABIOLINGUAL SPLINT, MODIFIED GUNNING SPLINT

surgical stayplate: see SURGICAL OBTURATOR

surgical stent: named for the dentist who first described their use, Charles R. Stent, stents are used to apply pressure to soft tissues to facilitate healing and prevent cicatrization or collapse—*syn* COLUMELLAR STENT, PERIODONTAL STENT, SKIN GRAFT STENT

surgical template **1**: a thin, transparent form duplicating the tissue surface of an immediate denture and used as a guide for surgically shaping the alveolar process **2**: a guide used to assist in proper surgical placement and angulation of dental implants

surface tension: a property of liquids in which the exposed surface tends to contract to the smallest possible area, as in the spherical formation of drops; this is a phenomenon attributed to the attractive forces, or cohesion, between the molecules of the liquid

sur.vey *v* **1**: to examine as to condition, value, or situation; to appraise **2**: to determine the form and position of a given entity by means of taking linear and angular measurements

3; to inspect or scrutinize 4: the procedure of locating and delineating the contour and position of the abutment teeth and associated structures before designing a removable partial denture (GPT-1) **sur.vey.ed, sur.vey.ing**

survey line: a line produced on a cast by a surveyor marking the greatest prominence of contour in relation to the planned path of placement of a restoration

sur.vey.ing *n*: an analysis and comparison of the prominence of intraoral contours associated with the fabrication of a prosthesis

sur.vey.or *n* (15c): a paralleling instrument used in construction of a prosthesis to locate and delineate the contours and relative positions of abutment teeth and associated structures

su.tur.ing *vt* (1777): the process of uniting the tissues separated by either a traumatic or surgical wound in a specific manner using an appropriate material

[1]swage *n* (ca. 1812): any tool used for shaping metal by striking with a hammer or sledgehammer

[2]swage *vt* **swaged; swag.ing** (1881): to shape a material by hammering or adapting it onto a die with a swage instrument

swallowing threshold: the critical moment of reflex action initiated by sufficient stimulation before the act of deglutition

sympathetic nervous system: the part of the autonomic nervous system that responds to dangerous or threatening situations by preparing a person physiologically for "fight or flight"—see PARASYMPATHETIC NERVOUS SYSTEM

sym.phy.sis *n, pl* **-phy.ses** (ca. 1578) 1: a type of cartilaginous joint in which the opposed bony surfaces are firmly united by a plate of fibrocartilage 2: the immovable dense midline articulation of the right and left halves of the adult mandible

symp.tom *n* (14c): subjective evidence of disease or physical disturbance; something that indicates the presence of a bodily disorder

syn.chro.ny *n* (1848): the simultaneous appearance of two separate events

syn.drome *n* (1541): a group of symptoms that occur together

synovial fluid: a viscid fluid contained in joint cavities and secreted by the synovial membrane

systemic etiologic factors: generalized biologic factors that are implicated in the causation, modification, and/or perpetuation and of a disease entity

T

ta.ble *n* (bef. 12c): a flat surface; a raised horizontal surface—see GUIDE T., OCCLUSAL T.

tech.nic *n* (1855): a detailed procedure in the fabrication of a prosthesis—spelled also *technique*

tech.nique *n* (1817): a body of technical methods; a method of accomplishing a desired end; the method or procedure and its details

telescopic coping: see COPING

telescopic crown: an artificial crown constructed to fit over a coping

telescopic denture: see OVERDENTURE

tem.plate *n* (1877) 1: a pattern, mold, or gauge used as a guide to form a piece being made 2: a curved or flat surface pattern that is used as an aid in arranging teeth—see also SURGICAL TEMPLATE

temporary base: see RECORD BASE

temporary denture: see INTERIM PROSTHESIS

temporary prosthesis: see INTERIM PROSTHEIS

temporary restoration: see INTERIM PROSTHESIS

temporomandibular articulation: see TEMPOROMANDIBULAR JOINT

temporomandibular disorders 1: abnormal, incomplete or impaired function of the temporomandibular joint(s) 2: a collection of symptoms frequently observed in various combinations first described by Costen (1934, 1937), which he claimed to be reflexes due to irritation of the auriculotemporal and/or chorda tympanic nerves as they emerged from the tympanic plate caused by altered anatomic relations and derangements of the temporomandibular joint associated with loss of occlusal vertical dimension, loss of posterior tooth support, and/or other malocclusions. The symptoms can include headache about the vertex and occiput, tinnitus, pain about the ear, impaired hearing and par about the tongue—*acronym* TMD

temporomandibular dysfunction syndrome: see TEMPOROMANDIBULAR DISORDERS

temporomandibular joint 1: the articulation between the temporal bone and the mandible. It is a diarthrodial, bilateral ginglymus arthrodial joint 2: the articulation of the condylar process of the mandible and the interarticular disk with the mandibular fossa of the squamous portion of the temporal bone; a diarthrodial, sliding hinge (ginglymus) joint. Movement in the upper joint compartment is mostly translational, whereas that in the lower joint compartment is mostly rotational. The joint connects the mandibular condyle to the articular fossa of the temporal bone with the *temporomandibular disk* interposed

temporomandibular joint derangement: see INTERNAL DERANGEMENT

temporomandibular joint hypermobility: excessive mobility of the temporomandibular joint

temporomandibular joint remodeling: see REMODEL

temporomandibular joint syndrome: see TEMPOROMANDIBULAR DISORDERS

TENS: *acronym* for *Transcutaneous Electrical Neural Stimulation*—see TRANSCUTANEOUS ELECTRICAL NEURAL STIMULATION

tensile stress: the internal induced force that resists the elongation of a material in a direction parallel to the direction of the stresses

ten.sion *n* (1533): the state of being stretched, strained, or extended

terminal hinge axis: see TRANSVERSE HORIZONTAL AXIS

terminal hinge position: see RETRUDED CONTACT POSITION

terminal jaw relation record: a record of the relationship of the mandible to the maxillae made in the terminal hinge position

therapeutic prosthesis: see RADIATION CARRIER

thermal expansion: expansion fo a material caused by heat

ther.mo.plas.tic *adj* (1883): a characteristic or property of a material that allows it to be softened by the application of heat and return to the hardened state on cooling—**ther.mo.plas.tic.i.ty** *n*

three.quarter crown *obs*: see PARTIAL VENEER CROWN

tic *n* (ca. 1822): an intermittent, involuntary, spasmodic movement of a group of muscles, often without a demonstrable external stimulus

tid.: acronym for L. *ter in di'e*, three times a day

tin.foil *n* (15c) **1**: paper thin metal sheeting usually of a tin-lead alloy or aluminium **2**: a base-metal foil used as a separating material between the cast and denture base material during flasking and polymerizing

tin.ni.tus *n*(1843): a noise in the ears, often described as ringing or roaring

tinted denture base: a denture base with coloring that simulates the color and shading of natural oral tissues

tis.sue *n* (1771) **1**: the various cellular combinations that make up the body **2**: an aggregation of similarly specialized cells united in the performance of a particular function—see HYPERPLASTIC TISSUE

tissue-bearing area: see DENTURE FOUNDATION AREA

tissue displaceability 1: the quality of oral tissues that permits them to be placed in other than a relaxed position **2**: the degree to which tissues permit displacement

tissue displacement: the change in the form or position of tissues as a result of pressure

tissue integration: as clinically observed, the apparent direct and healthy attachment of living tissue to an alloplastic material, i.e. a dental implant—see OSSEOUS INTEGRATION

tissue molding: see BORDER MOLDING

tissue reaction: the response of tissues to an altered condition

tissue registration *obs***1**: the accurate registration of the shape of tissues under any condition by means of a suitable material (GPT-1) **2**: an impression (GPT-1)

tissue trimming: see BORDER MOLDING

TMD: *acronym for Temporo Mandibular Disorders*—see TEMPORO MANDIBULAR DISORDERS

to.mo.gram *n* (1940): a radiograph made by using a tomograph

[1]**to.mo.graph** *n*: a device for moving a X-ray source in one direction as the film moves in the opposite direction

[2]**to.mo.graph** *n*: a radiograph produced from a machine that has the source of radiation moving in one direction and the film moving in the opposite direction

to.mo.gra.phy *n*: a general term for a technique that provides a distinct image of any selected plane through the body, while the images of structures that lie above and below that plane are blurred. Also, the term *body-section radiography* has been applied to the procedure, although the several ways of accomplishing it have been given distinguishing names

tongue habit: conscious or unconscious movements of the tongue that are not related to purposeful functions. Such habits may produce malocclusion or injuries to tissues of the tongue or the attachment apparatus of the teeth

tongue thrusting: the infantile pattern of suckle-swallow in which the tongue is placed between the incisor teeth or alveolar ridges during the initial stages of deglutition, resulting sometimes in an anterior open occlusion, deformation of the jaws, and/or abnormal function

tooth *n, pl* **teeth** (bef. 12c): any hard calcified structure in the alveolar processes of the maxilla or mandible used for mastication of food, or a similar structure—see ANATOMIC T., CUSPLESS T., METAL INSERT T., NONANATOMIC T., REVERSE ARTICULATION T., BUBE T., ZERO-DEGREE T.

tooth arrangement 1: the placement of teeth on a denture with definite objectives in mind **2**: the placement of teeth on trial bases—see ANTERIOR TOOTH ARRANGEMENT

tooth borne: see TOOTH SUPPORTED

tooth color selection: the determination of the color and other attributes of appearance of an artificial tooth or set of teeth for a given individual

tooth form: the characteristics of the curves, lines, angles, and contours of various teeth that permit their identification and differentiation—see ANTERIOR T.F., POSTERIOR T.F.

tooth placement: see TOOTH ARRANGEMENT

tooth selection: the selection of a tooth or teeth of a shape, size, and color to harmonize with the individual characteristics of a patient

tooth size discrepancy: abnormally sized teeth or groups of teeth

tooth supported: a term used to describe a prosthesis or part of a prosthesis that depends entirely on the natural teeth for support

tooth.supported base: a denture base that restores an edentulous region that has abutment teeth at each end for support. The tissue that it covers is not used for support

tooth.supported denture: see OVERDENTURE

tor.que *n* (ca. 1884): a twisting or rotary force. The movement of a system of forces producing rotation

tor.us *n, pl* **to.ri** (1563): a smooth rounded anatomical protuberance

total elasticity of muscle *obs*: the combined effect of physical and physiologic elasticity of muscle (GPT-4)

tough.ness *n*: the ability of a material to withstand stresses and strains without breaking

toxic dose: the amount of a drug that causes untoward symptoms in most persons

tox.ic.i.ty *n*: the adverse reactions (dose-response-time relationships) of tissues to selected foreign substances resulting in unacceptable *in vivo* interactions. The toxicity can be at the local or systemic level depending on the amount, rate of release, and sepcific type of substance available to the tissues

trac.er *n* (ca. 1552): see ARROW-POINT T.

trac.ing *n* (15c) **1**: a line or lines scribed by a pointed instrument **2**: a traced copy of a drawing, photograph, radiograph, or similar entity—see ARROW POINT T., CEPHALOMETRIC T. EXTRAORAL T., INTRAORAL T., MANDIBULAR T., PANTOGRAPHIC T., STYLUS T.

tracing device: a device that provides a central point of bearing, or support, between maxillary and mandibular occlusion rims or dentures. It consists of a contacting point that is attached to one occlusion rim or denture and a plate attached to the opposing occlusion rim or denture that provides the surface on which the bearing point rests or moves

transcranial oblique radiograph: a flat X-ray projection in which the central beam travels across the cranium and through the temporomandibular joint on the opposite side showing an oblique lateral view of the condyle

transcutaneous electrical neural stimulation: application of low-voltage electrical stimulation through the skin to nerves in order to interfere with the sensation of pain in the brain and increase blood flow to the region—*colloquial* TENS

trans.epi.the.li.al *adj*: penetrating or passing through the epithelium, as in a dental implant

transfer coping: a metallic, acrylic resin, or other covering or cap used to position a die in an impression (GPT-4)

transit dose: a measure of the primary radiation transmitted through the patient and measured at a point on the central ray at some point beyond the patient

transitional contour: with respect to any restoration supported by a dental implant, the relationship between the abutment and the implant body

transitional denture: a removable partial denture serving as an interim prosthesis to which artificial teeth will be added as natural teeth are lost and that will be replaced after postextraction tissue changes have occurred. A transitional denture may become an interim complete denture when all of the natural teeth have been removed from the dental arch—called also *transitional partial denture*

transitional prosthesis: see INTERIM PROSTHESIS, TRANSITIONAL DENTURE

translating condyle: see NONWORKING SIDE CONDYLE

trans.la.tion *n* (14c): that motion of a rigid body in which a straight line passing through any two points always remains parallel to its initial position. The motion may be described as a sliding or gliding motion

translatory movement *obs*: the motion of a body at any instant when all points within the body are moving at the same velocity and in the same direction (GPT-1)

trans.lu.cen.cy *n* (1611): having the appearance between complete opacity and complete transparency; partially opaque

trans.mu.co.sal *adj*: passing through the gingiva or oral mucosa

trans.os.teal *adj*: the penetration of both the internal and external cortical plates of a bone

transosteal dental implant 1: a dental implant that penetrates both cortical plates and passes through the full thickness of the alveolar bone **2**: a dental implant composed of a metal plate with retentive pins to hold it against the inferior border of the mandible that supports transosteal pins that penetrate through the full thickness of the mandible and pass into the, mouth in the parasymphyseal region—called also *staple bone implant, mandibular staple implant, transmandibular implant*

transverse axis: see TRANSVERSE HORIZONTAL AXIS

transverse facial fracture: see LE FORTE III FRACTURE, MID-FACIAL FRACTURE

transverse horizontal axis: an imaginary line around which the mandible may rotate within the sagittal plane

trans.ver.sion *n*: displacement of a tooth from its usual position or proper numerical position in the jaw

trau.ma *n, pl* **trau.ma.ta** or **trau.mas, trau.mat.ic** *adj*—**trau.mat.i.cal.ly** *adv* (1693): an injury or wound, whether physical or psychic

trauma from occlusion: see OCCLUSAL TRAUMA

traumatic occlusion: see OCCLUSAL TRAUMA

trau.ma.to.gen.ic *adj*: capable of producing a wound or injury

traumatogenic occlusion *obs*: an occluding of the teeth that is capable of producing injury to oral structures (GPT-4)

travelling condyle: see NONWORKING SIDE CONDYLE

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X

[1]X-ray *vt* (1896): the process of exposing objects to roentgen rays and projecting their shadow on sensitized surfaces

[2]X-ray *n* (1900): see ROENTGEN RAY

X-ray picture: see ROENTGENOGRAM

xenogenic graft: a graft from one species to another species—called also *heterologous graft*

xer.o.sto.mia *n*: dryness of the mouth from lack of normal secretions

Y

yield strength: the strength at which a small amount of permanent (plastic) strain occurs, usually 0.1% or 0.2%, and most frequent measured in MPa or psi

Z

zero.degree teeth: posterior denture teeth having 0-degree cuspal angles in relation to the horizontal occlusal surface—called also *zero-degree nonanatomic teeth*—see NONANATOMIC TEETH

zy.go.ma *n* (ca. 1684): the area formed by the union of the zygomatic bone with the zygomatic processes of the temporal and maxillary bones

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