Ultrasonic Instrumentation

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1. Introduction

Although ultrasounds (US) were discovered in the 18th Century due to their use in animal kingdom, they were not manufactured until the 19th Century, when certain devices facilitating the reproduction of these non audible for human sounds were developed. They constitute rare frequencies with several properties. First of all they were developed for their use in navy and in medicine. In the 20th Century it was noticed that they could have uses in dentistry, so the first applications for calculus removal were initiated, taking advantage of their mechanical energy and cavitation effect. The different possibilities achieved by conventional US together with those of sonicators, of lower frequency but with similar effects, resulted in a fast development of these technologies.

Since Michigan longitudinal studies demonstrated that the open flap radicular instrumentation techniques were in a long term as effective as the closed ones, the latter were developed, so treatment of periodontitis suffered a change of paradigm. From that moment on, periodontal treatment involved less open flaps and more mechanical treatments, limiting surgeries to very concrete cases, in order to enable access to the deepest pockets and furcations. The result was a reduction in discomfort for patients and a better long term prognosis. Prevention gained more importance and supportive periodontal therapies were regularly done adjusting them to the individual necessities of each patient, depending on the type of periodontitis and the severity of the case. To reduce the number of surgeries, it was crucial to develop instruments able to reach deep pockets. Small curettes and microcurettes were developed, and later on special ultrasonic tips which allowed the instrumentation of pockets of difficult access for Gracey and Universal curettes. Even when effectuating periodontal surgery, clinicians preferred US rather than curettes for the narrow furcations´ instrumentation. The fewer fatigue of the professional and the efficacy of the results have favoured the great development of these instruments during the last years.

A new progress occurred in dentistry with the introduction of piezoelectric US. These US produced less discomfort in patients, and with the development of special tips imitating microcurettes, deep and narrow pockets instrumentation was possible without doing surgery. With the important development of implant rehabilitations during the last twenty years and the subsequent peri-implantitis, the necessity of new instruments has arisen, as traditional and teflon curettes are not suitable for this purpose. To solve this problem, tips of teflon and other materials have emerged to facilitate the elimination of deposits settled over the irregular implants´ surface, with controversial results.

The use of US in endodontics was introduced later to clean and disinfect root canals. It is quite useful basically to make easier the access to the root canals in certain conditions, in endodontic retreatments and to clean before the sealing of the root canal. One of the latest US applications in dentistry is in surgery, as they avoid discomfort of rotary instruments while preserving the soft tissues. The cut precision allows their use in implants´ surgery, ostectomies and especially in those techniques where tearing of soft tissues could be produced due to their proximity, i.e., sinus lift procedures. These techniques are in continuous progress; they are linked to piezo-electric US and to those new materials allowing their use in favourable conditions.

The aim of this chapter is to revise the physical principles of US, the materials used and the historical evolution, their basic uses in perio and endodontics, as well as their efficacy when comparing with other techniques and finally the possibilities in maxilar surgery. Other less frequent applications are also mentioned.

2. History and physics of ultrasounds

Before 1700 man was unaware of ultrasounds because their frequency is below human´s audible frequency. In 1700, Spallanzani described their use by bats when flying and capturing their preys. Later on, it was demonstrated that other animal species had the same faculties, and in the 19^{th} Century, with the discovery of Doppler effect about deformation of light waves in movement, it was observed that this property could also be applied to ultrasounds. In fact, they are sound waves that are not audible for men due to their high frequency (Figure 1).

At the end of the 19^{th} Century, the Curie brothers [1] described the piezoelectric effect (from greek *piezein*, mechanic pressure) of several crystals, property used later for the fabrication of ultrasonic devices with new characteristics. At this time, in 1883, Galton develops a high frequency whistle to find out the human hearing limit, and from that moment on ultrasounds (US) for different applications are developed. Although the first ultrasonic apparatus date from 1950, the first commercial application for dentistry was in periodontics in 1957 with Cavitron®, developed by Dentsply for doing prophylaxis and calculus removal. Its name comes from the cavitation effect produced by ultrasounds when working with water. When a liquid flows through a region where pressure is lower than its steam pressure, the liquid boils and produces

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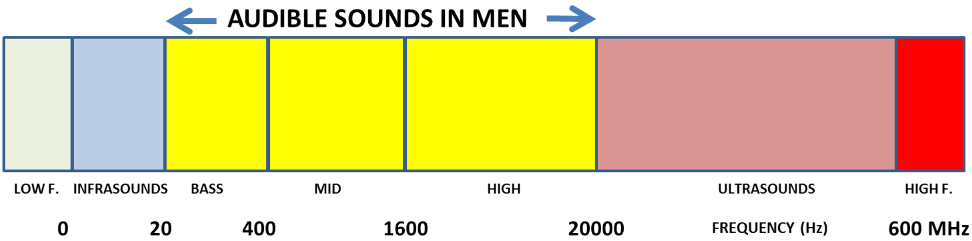

Figure 1. Human audition and ultrasound frequencies in Hz

vapour bubbles. The bubbles will be carried to a higher pressure area, where the steam returns immediately to the liquid phase, imploding the bubbles suddenly. Thus, a change from liquid to gaseous phase takes place, and again to liquid phase with water dissociation and formation of $H^+$and OH^-(Figure 2).

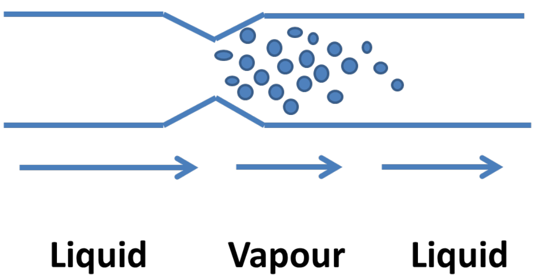

Figure 2. Representation of cavitation effect

Cavitation is defined as the formation of submicroscopic cavities or vacuums as a result of the vibration of a fluid due to the high frequency alternating movement of the tip of an instrument. When these vacuums implode, shock waves which spread through the medium are generated and produce energy (heat) release [2].

The basis of the ultrasonic action consists of an electric generator transmitting vibrations to the tip of the device with frequencies of 25,000 to 30,000 Hz, whose shock waves generate pressures and depressions which detach the calculus and break water molecules by the cavitation phenomenon. To the effect of cavitation it adds an acoustic streaming, with a great cleaning and bactericidal action, which potentiates the bactericidal effect of cavitation, effect that can increase adding an antiseptic product to the irrigation fluid.

There are two types of ultrasonic devices: the classical ones, laminated or magnetostrictive, with elliptical oscillation of the tip, and the piezoelectric ones, of quartz with lineal oscillation. Laminated US are based on the Joule magnetostriction phenomenon. According to this phenomenon, several ferromagnetic materials get deformed when they go through a magnetic field. The deformation degree depends on the material employed, the magnetization strength, the previous treatment of the material and the temperature. The metallic sheets are situated in the handle, i.e. in the handpiece where the insert is placed (Figure 3).

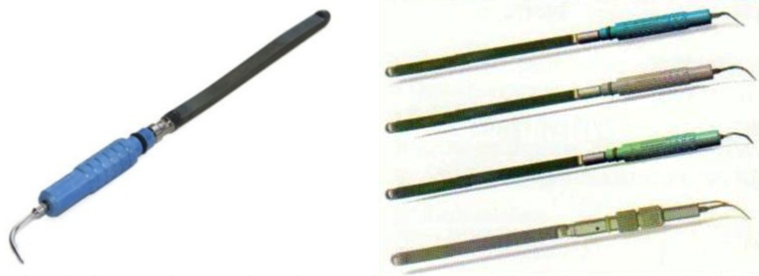

Figure 3. Laminated US device and several ultrasonic inserts for Cavitron

Piezoelectric US (Figure 4) are based on quartz clock principles. When applying an alternating current to the ceramic/quartz discs, changes in polarity produce expansion and contraction trasmitting the oscillation to the tip, applicator or insert. The sound thus generated, presents the same intensity, frequency and wavelength than the material employed in its fabrication (quartz, zinc blende, sodium borate...). Nowadays, the most used crystals are ceramic zirconate discs, which are less sensitive to temperature and blows.

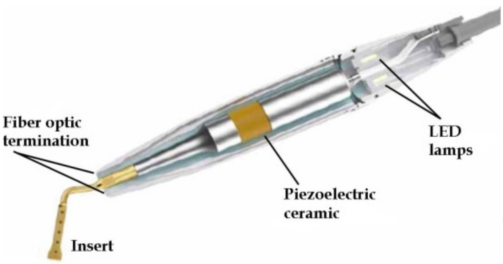

Figure 4. Piezoelectric US for surgery. Modified from Variosurg (NSK) catalogue

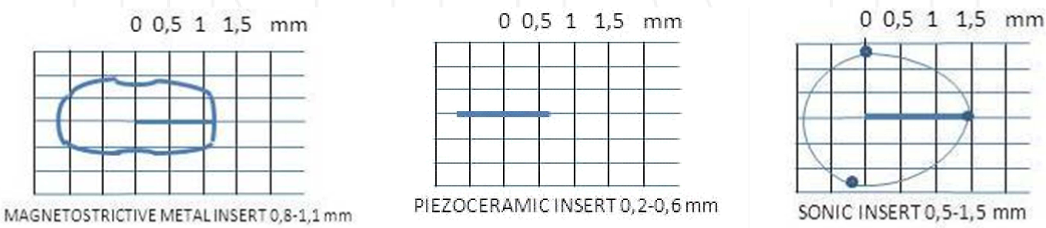

Figure 5. Oscillation of magnetostrictive US, piezoceramic US and sonicators

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3. Biologic actions

US present several effects over the tissues which vary depending on the time, type of US and way of application. These effects are mechanical, thermal, biological, chemical, massage and placebo.

1. Mechanical effects. The most important, as vibration favours the removal of calculus, biofilm and of the cementum surface, damaged by bacterial toxins and sometimes contaminated by bacteria (Figure 6). Inside the root canals, US clean the pulpal detritus.

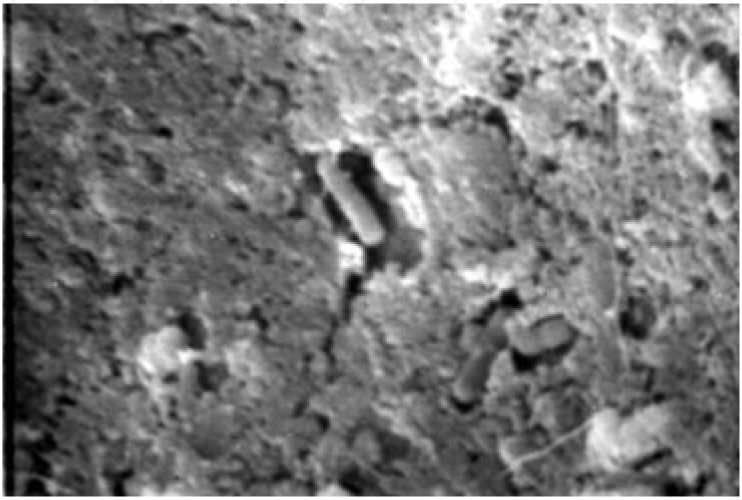

Figure 6. Bacterial presence inside cementum in periodontitis. Original magnification SEM x3000. Bacteria can be identified supragingivally, in the epithelial junction and in apical areas of cementum

2. Thermal effects. US are a way of energy and thus, during their application, heat is generated. This heat can be useful, as it favours the cleaning of the treated area and the elimination of detritus, blood debris, biofilm and calculus; but if it is excessive it could burn the tissues, especially gingiva and periostium. This is the reason why it is crucial to control the irrigation system, checking for possible obstructions of applicator/insert.

3. Biological effects. US produce an increase in permeability of the cellular membrane, known as phonophoresis, which facilitates the cellular function, and thus the recuperation of the inflamed soft tissues.

4. Chemical effects. Ultrasonic vibration favours the chemical processes in the area in which they are applied. Biological exchanges among the treated tissues improve; in addition, an increase of the blood supply takes place, helping to reduce inflammation and to facilitate the arrival of blood cells and anti-inflammatory mediators, favouring tissue normality. It also produces oxidation and macromolecule depolymerization phenomena, due to the ions release.

5. The massage and placebo effects, also associated to US, are of less interest in our field, but they should not be forgotten.

Due to the cavitation effect and the acoustic micro-streaming produced by oscillatory movements of ultrasonic inserts, US are used in humans in different ways for diagnosis and treatment. In the oral cavity they are mainly used for root instrumentation in periodontics, and less in endodontics, ostectomy, and sinus lift procedures. There are also other less frequent applications that we shall describe.

4. US in periodontics and implants

It is well known that periodontal disease is based on the presence of a mature biofilm with more than 700 bacterial species, being only a fraction of them related to periodontitis. The progression of the disease depends on the periodontopathogens, but also on the patient´s immune system and its response to bacterial aggression. The elimination of bacteria, their toxins and calculus produced by saliva, is essential to keep under control the disease. Once local factors are removed, a strict hygiene is required, as well as a supportive periodontal treatment program, in order to eliminate calculus and subgingival biofilm, which is the main responsible of the bone and attachment loss and is formed shortly after its elimination.

Treatment was traditionally based on the mechanical elimination of plaque and calculus, which facilitate biofilm´s survival, mainly using hand instruments and US, directly or by an open flap procedure. Longitudinal studies of the decades of 70´s and 80´s, showed that even most periodontally advanced cases, well treated and maintained, remained stable through the years [3], versus those patients who did not receive any treatment, who suffered a considerable tooth loss and worsening of periodontal parameters [4].

Since Michigan longitudinal studies [5-7] demonstrated that the open flap radicular instrumentation techniques were in a long term as effective as the closed ones [7], the latter were developed, so treatment of periodontitis suffered a change of paradigm. From that moment on, periodontal treatment involved less open flaps and more mechanical treatments, limiting surgeries to very concrete cases, in order to enable access to the most deep pockets and furcations [8]. The result was a reduction in discomfort for patients and a better long term prognosis. Prevention gained more importance and supportive periodontal therapies were regularly done adjusting them to the individual necessities of each patient, depending on the type of periodontitis and the severity of the case.

To reduce the number of surgeries, it was crucial to develop instruments able to reach deep pockets. Small curettes and microcurettes were developed, and later on special ultrasonic tips which allowed the instrumentation of pockets of difficult access for Gracey and Universal curettes.

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The first device used in periodontal prophylaxis was Cavitron®, introduced in 1957 by Dentsply (USA). With the important development of implant rehabilitations during the last twenty years and the subsequent peri-implantitis, the necessity of new instruments has arisen, as traditional and teflon curettes are not suitable for this purpose. Ultrasonic instruments are very comfortable to use, they produce less fatigue in the operator than curettes and allow the combination of different tips and products in order to improve the treatment efficacy. Several authors [9] even demonstrate better results when instrumentation is done with US instead of curettes.

During the 80´s, we demonstrated in several publications that prophylaxis done *in vitro* with US resulted at least equal or even more effective than with curettes [10, 11] (Figure 7).

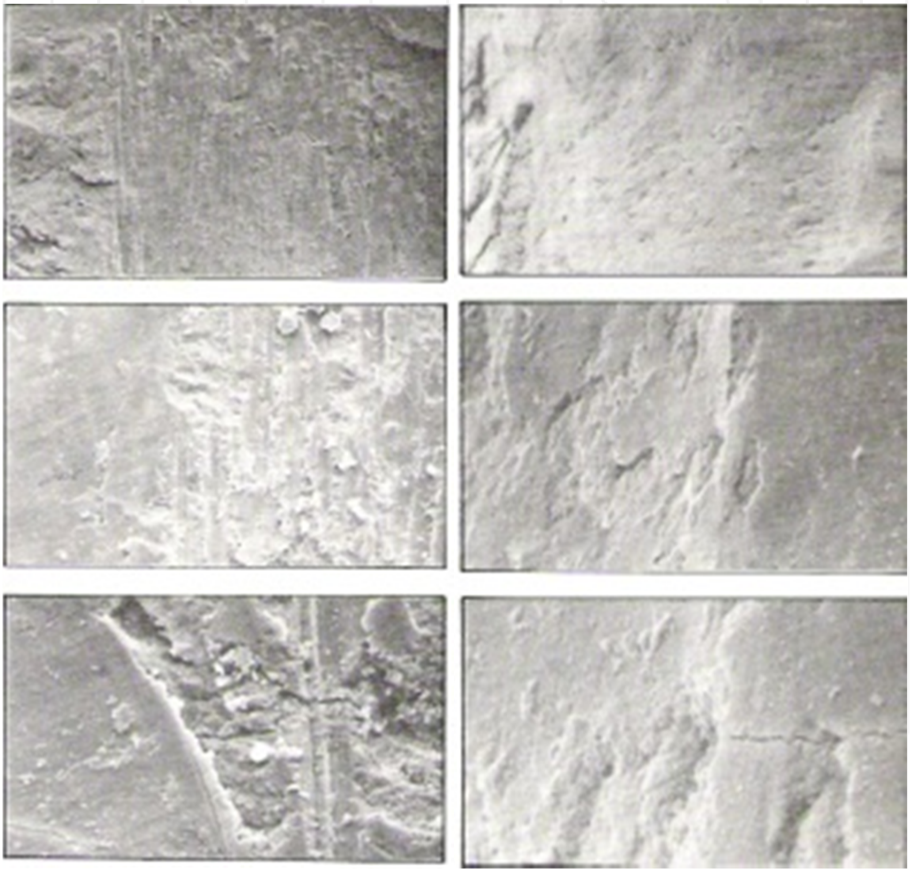

Figure 7. Cementum of the same tooth treated with curettes (left) and US (right). Original magnification SEM x352, x1136 and x3000

In Drisko´s 1993 review, it is suggested that a thorough radicular debridement can be achieved without overinstrumentation, using certain sonic and ultrasonic scalers. The evaluation of residual plaque and calculus after hand and mechanical instrumentation with sonic and ultrasonic scalers, shows that sonic and US instruments obtain similar, and in some cases, better results than those obtained with manual instrumentation. When comparing modified ultrasonic inserts with unmodified ultrasonic inserts and manual scalers, it is observed that the modified ones generate smoother surfaces, better plaque and calculus removal, less damage and better access to the bottom of the pocket, which together with a less operating time lead to a lower fatigue [12].

Several years later, another review of the same author shows that US, through their cavitation effect, are able to eliminate toxins from the cementum surface without damaging it. This, together with the irrigation action, improves healing, as it is not necessary an excessive instrumentation of cementum to achieve satisfactory results. The additional benefits of the chemical irrigation during ultrasonic instrumentation are the weakly attached subgingival plaque removal and a better access to difficult areas such as narrow and deep pockets, root grooves and furcations. Thus, microultrasonic tips, of smaller diameter, allow the penetration 1 mm farther than manual instruments [13].

In a position paper of 2000, US and sonicators were compared, reaching similar results than hand instruments in terms of plaque, calculus and endotoxins removal. Ultrasonic scalers used at medium power produced less damage in root surfaces than manual instruments or sonicators. Furcations seemed to be more accesible when using sonic or ultrasonic scalers than when using manual instruments. It was still not clear if root roughness was more or less pronounced when using US or curettes, and if the roughness produced in radicular cement affected long term wound healing. Although the aim of root instrumentation is the highest as possible elimination of calculus and toxins, it is necessary to preserve cementum. According to the reviewed papers, toxins remain in the root surface, thus being easily removed with US. One of the main problems of the intervention with US and sonicators is the aerosols production, which involves the risk of transmitting infectious diseases, therefore it is essential the use of barriers against aerosols. Concerning the use of chemical agents there is no evidence of their additional clinical benefit [14].

To avoid the potential damage of the cementum surface done by sonic and US instruments and curettes, and looking after an effective treatment of the root surface, a sonic instrument covered by teflon was introduced in order to compare it with the standard instrumentation and with Per-io-Tor in extracted teeth. Per-io-Tor and the mentioned sonic instrument seemed to be adequate for soft deposits´ elimination in the root surface, but not for calculus removal [15].

Another study compared *in vivo* the effect of two piezoelectric US, Vector scaler and Enac scaler, with a hand scaler. Instrumentation was completed until the obtaining of a hard surface. Roughness, amount of remaining calculus and loss of dental substance were examined by SEM. Vectorial US provided a smooth root surface with minimal dental substance loss [16].

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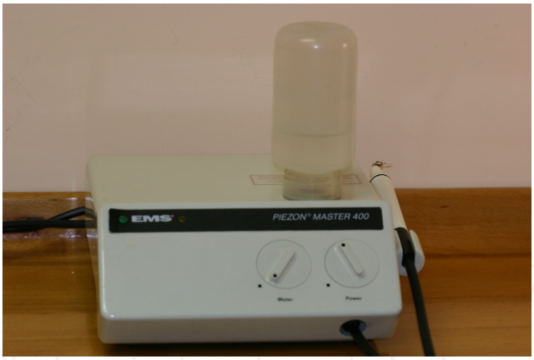

Figure 8. EMS piezoelectric US Piezon Master

The effects of US were described in 1969 by Clark [17]: they depend on the vibratory movement amplitude, the pressure applied, the instrument´s tip sharpness, and the tip´s application angle and time by surface unit. Their effects condition the way of use: they should be used at 40-50% of their power to avoid the metal fatigue and to favour the long-term duration of device and tip, they should be applied tangentially (parallel to the root surface) to avoid damage in the cementum surface (Figure 9), they should never be applied with the tip perpendicular to the cementum and the tip should be in a continuous movement (Figure 10) in order to avoid the production of holes in enamel and cementum. To avoid an excessive increase of temperature, the irrigation should be abundant (Figure 11), and to achieve an optimal efficacy the most suitable tip should be selected for each indication. It should be taken into account that it is different to work over a thick layer of supragingival calculus than over a thin subgingival layer, which is more adhered. This is the reason why large tips are used for superficial calculus, small tips for subgingival calculus, curette-like for scaling and thin and long for narrow and deep pockets (Figure 11).

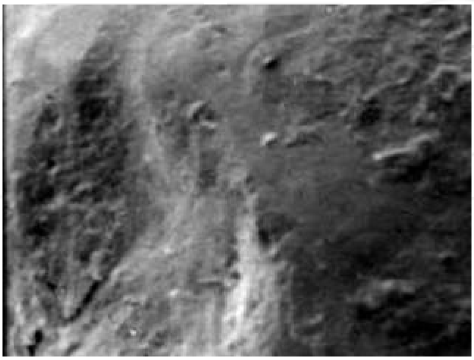

Figure 9. Hole in cementum due to a wrong ultrasonic instrumentation. Original magnification x600

Figure 10. Insert application and displacement for calculus removal

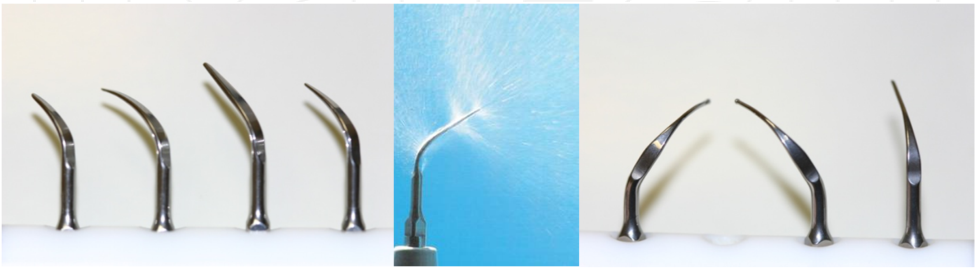

Figure 11. Supra (left) and thin subgingival (right) ultrasonic tips should always work with abundant irrigation

When US are used with complementary water tank and an antiseptic liquid, it is convenient to wash the whole circuit with demineralized water after its use, so the obstruction of tubes with the substances used is avoided. In case of using only water, it is recommended to fill in the deposit with low mineralized water, in order to facilitate the cleaning and prevent obstructions in tubes and inserts.

Due to their lineal oscillation over the dental surface, the actual rounded-tip piezoelectric US, reduce abrasion and obtain a uniform and smooth surface. With 32.000 oscillations per second, they are autoregulated and their cavitation effect and acoustic streaming reduce discomfort and have limited effects over gingival epithelium (Figure 12).

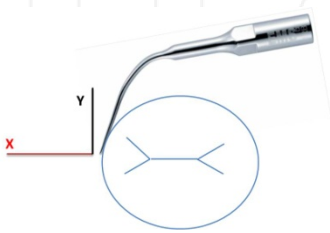

Figure 12. Vector decomposition of ultrasonic oscillation

Some of these US may incorporate two bottles, one for the bactericidal agent and the other for water for clearing or cleaning. They are also equipped with perio and endodontic tips.

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Ultrasounds present few contraindications. They are not recommended in children except in very concrete cases. They should be avoided in the proximity of composite resins, as they could produce roughness or even detachment of the filling. They should not be used directly over ceramic partial fixed prosthesis or veneers, as ceramic could detach or break. In patients with certain types of pacemakers, interferences could be produced with inhibition and increase of the stimulation frequency. It is recommended the intermittent use of ultrasounds, avoiding the support of instruments over the generator as well as deprogramming the frequency modulation during the sessions. With a magnet, the pacemaker, which usually works at demand mode, converts into fixed-rate, not being sensitive to electromagnetic fields. In case of non sensible to electromagnetic interferences pacemakers, US could be used in the same way as in patients without pacemakers. Another option in these patients is the use of sonicators (Figure 13) because they use an air flow so they don´t generate electromagnetic fields.

Figure 13. Sonicator and varied tips

These instruments present certain advantages and disadvantages in relation to ultrasounds. Their oscillation frequency is much lower, of 2,000 Hz, because the oscillation is produced by the air that arrives directly from the equipment and generates an orbital oscillation in the application tip. Their efficacy is similar to that of ultrasounds, but they can only use water instead of antiseptic liquids and the set of tips is much more reduced than the ultrasounds.

Ultrasounds are used as preventive and complementary to surgery treatment in implants. In this case the tip should not be metallic but of teflon, in order to avoid the damage of the implants ´ surface (Figure 14).

Fox *et al*. compared plastic and metal curettes in titanium implants in an *in vitro* study. Plastic instruments produced an insignificant alteration of the implants´ surface after instrumentation, in contrast with metal instruments, which significantly altered this surface [18].

Something similar occurs when using Piezoelectric Ultrasonic Scalers with carbon, plastic and metallic tips on titanium implants. Remaining plaque and calculus index seemed to be similar with the three treatments. When using a laser profilometer and a laser scanning electron

Figure 14. EMS Teflon insert for implants´ instrumentation

microscope to evaluate the treated abutment surface characteristics, implants treated with carbon and plastic tips presented smoother surfaces than those treated with metallic tips, which were more damaged [19].

5. US in endodontics

US were incorporated into this field in 1957 when Richman used them for root canal cleaning and instrumentation [20]. In 1976, Martin improved endodontic treatment adding simultaneous irrigation, but its commercialization and use only were extended from 1980 by Martin *et al*. [21]. There are sonic apparatus in which special files are used, and several ultrasonic devices which work with standard files, with the usual colours and diameters (Figure 15).

Figure 15. EMS ultrasonic handle and several endodontic K-files.

In endodontics US work by a transversal vibration, with a characteristic pattern of nodes and antinodes along the file´s length (Figure 16) [22, 23], and may work in two different ways: with simultaneous ultrasonic instrumentation and irrigation (UI) or with passive ultrasonic irrigation (PUI), which works in an alternating way.

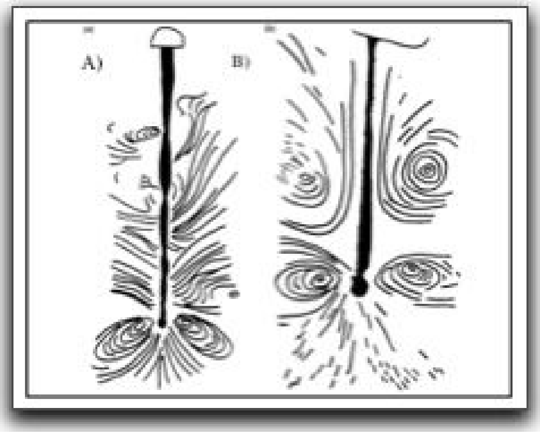

Figure 16. Diagrammatic representation of the current observed in ultrasonic (A) and sonic (B) activated files [24].

As for ultrasonic instrumentation UI, it is discussed if the root canals thus instrumented are significantly cleaner than those prepared with files in the usual way. Some authors support UI cleaning is better [25-29], while other studies affirm the cleaning is similar [30-36]. For Ruddle, these differences could be due to the limited space available in the root canal to let the ultrasonic vibration [37]. Also the lack of space could be responsible of the lesions produced during ultrasonic instrumentation, such as perforations and deficient root canal preparations [38]. This is the reason why this technique is only recommended after the complete root canal preparation [39], by what is known as PUI.

Passive ultrasonic irrigation was described by Weller [40] as a technique in which the effect of the ultrasonic tip reduces the risk of contact with the root canal surface, thus reducing the risk of perforation, while the cavitation and cleaning effects are preserved. As the root canal has already been prepared, the file moves freely and the irrigant penetrates easily in the apical area of the root canal system [41]. In this technique two ways of irrigation may be used: continuous or discontinuous, in which irrigation works intermittently after each ultrasonic cycle. Both of them allow control of irrigation, so they seem to be equally efficient [42].

Sonic instruments may also be used for root canal therapy with similar results. Jensen *et al*. compare the sonic and ultrasonic cleaning efficacy after manual instrumentation in molars with curved roots. Results are analysed with photomicrographs with a grid in order to quantify the debris and evaluate the root canal cleaning level in the three groups. Sonic and ultrasonic treated molars after manual instrumentation seemed to be cleaner than those only manually treated, while the level of cleaning among sonic and ultrasonically treated molars was similar [43].

Another recent *in vitro* study compares the ability of different ultrasound irrigation procedures to eliminate debris and to open the dentine tubules. Previously instrumented with mechanical rotatory technique single-rooted extracted teeth are treated with US. The amount of debris and the number of open dentinal tubules were established by SEM. In the apical third, ultrasonic activation of the irrigation with Irrisafe tips seemed to be the most effective method to eliminate debris and open dentinal tubules [44].

According to Martí-Bowen *et al*., the use of US in periapical surgery with retrograde filling, it is feasible to reach difficult access root canals with sacrifice of few root tissue. Nowadays, good results are obtained in teeth with periapical pathology which previously were condemned to failure [45].

Van der Sluis *et al*. summarize the potential uses of US in endodontics with the following options: to improve the endodontic access (for example elimination of calcifications), irrigation of root canals, to remove broken posts and other obstructions inside the root canals, humectation with sealer of the root canal walls, guttapercha condensation of the obturations of root canals, mineral trioxide aggregate (MTA) application, endodontic surgery, and increase of the dentinal permeability in dental bleaching [46]; also to break fillings due to their shock effect, to remove old fillings and make easier the access to root canals, and in endodontic retreatments. There are available different applicators with the most adequate form for each use (Figures 17, 18).

Figure 17. Satelec EndoSuccess Retreatment Kit. From left to right, tips for dentinal overhangs, calcificatons or filling materials elimination; for treatments in the coronal third; for treatments in the medium and apical thirds; for retreatment in coronal third and isthmus; for canal probing; and for loosening of posts and crowns. (Courtesy of Satelec, Merignac Cedex, France)

Figure 18. Satelec EndoSuccess Apical Surgery Kit. From left to right, universal apical surgery tip; second instrument; complicated cases (up to the coronal third), premolar left-orientated tip; premolar right orientated tip. (Courtesy of Satelec, Merignac Cedex, France)

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6. US in surgery

Another application of US in dentistry is in oral and maxillofacial surgery to cut hard tissues. Experimental studies show that their application present better histological results than the rotary techniques. The precision of the cut with the different available inserts allows their use in our specialization in different fields such as general oral surgery, osseous grafts and implantology.

Although initially their use was reduced to sinus lift procedures, because they preserve the sinus membrane, their use has been extended to obtain bone grafts, osseous distraction and cortical split procedures, inferior dental nerve surgery, implant surgeries, extractions, etc. These biophotonic equipments allow changes in vibration's frequency from standard mode, with constant vibrations and frequency (used over soft tissues), to surgery mode (for hard tissues), where the modulation of amplitude and continuous vibration improves the efficacy over bone. Several applicators are designed for each osseous intervention (Figure 19).

Figure 19. EMS Piezon Master Surgery US presents tips (from left to right) for vertical non-traumatic osseous incision, horizontal non-traumatic osseous incision, non-traumatic osteotomy, detachment of Schneider´s membrane during sinus lift procedures and obtaining of bone fragments for bone augmentation.

The tips are different depending on the application: they present multiple lateral impact for surgery; curved, thin and scalpel-like for osteotomy; thin for non-traumatic extractions; cone-shaped diamond covered and calibrated for guiding during preparation; rounded or flat, diamond covered or scaler-shaped for sinus lift procedures. There are multiple surgical possibilities, as it is possible to do thin incisions for grafts, cysts elimination, sinus lift procedures with alveolar or lateral access, extractions, osteoplasties, osteotomies and other.

The advantages justifying their use are less bleeding and thus better visibility during the intervention, higher cut precision than with traditional instruments and less increase of temperature, less discomfort for patients as ultrasonic vibration is less noisy than drilling, and especially that the action over the soft tissues is minimal when they are accidentally applied over them, without tearing them up.

Basic Kit Piezosurgery

Figure 20. Mectron Piezosurgery´s basic surgery and sinus lift procedure kits.

The action of the tip is effectuated by two mechanical effects: direct and indirect. In the direct mechanical effect, the tissues in contact with the tip are under a very high frequency. It is the effect of a hammer working only over the hard tissues. In the indirect one, positive and negative pressures are generated over the fluids; they are known as cavitation, and they displace the osseous tissue and potentiate the mechanical effects. This produces localized osseous destruction in a continuous or discontinuous way, being the surgeon who decides one or another possibility depending on the osseous density and the required refrigeration. This makes the cut selective without neither microscopic osseous nor soft tissue alterations. Refrigeration should be abundant with saline solution, in order to avoid heating and wash up the field to obtain a better vision.

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Kits are usually available for each type of indication. The insert size and angulation allow the use depending on the necessities of the case. There are basic kits, kits for surgery, osseous distraction, implants, endodontic surgery, alveolar and lateral sinus lift procedures, osteoplasy and ostectomy, etc (Figure 20).

7. US trays

US trays deserve to be mentioned. Their utilization is essential in the dental office as intermediate step between the washing with soap and the sterilization of instrumental. They allow the elimination of organic debris that remain adhered in the instrument gaps facilitating the sterilization (Figure 21).

Figure 21. US tray.

Other applications of ultrasounds in Dentistry are removal of broken screws in implants, posts and crowns removal, etc. (Figure 22), but these applications are less frequent, they are not standardized and each professional acts according to his guidelines.

Figure 22. Set of diverse US tips

8. Conclusion

The evolution of US in dentistry during the last 65 years has been revised. The first laminated devices, only used for supragingival and slightly subgingival tartrectomies, have lead to sonicators and newer piezoelectric US with multiple inserts which allow the performance of tartrectomies reducing patient´s discomfort and subgingival instrumentation. The variety of available tips lets us choose those which better adapt to our necessities and to the clinical situation, even in cases of periimplantitis. In endodontics, tips to facilitate the access, to clean the root canal and to carry out retreatments are available.

The industry offers the clinician optimal possibilities to achieve retrograde fillings more difficult or even impossible to carry out with other techniques. Among the latest applications, new possibilities emerge to effectuate certain surgical treatments, sinus lift procedures, implants placement, removal of fillings and crowns and other clinical situations.

Taking into account the great advance in US technology during the last years, it is reasonable to anticipate a great future for these devices. We are commited to regularly revisit the literature in order to know new opportunities provided by technology so the most suitable device is used in each clinical situation.

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