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ULTRASONIC AND ITS PRINCIPLES IN ENDODONTICS

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ABSTRACT
Ultrasonic devices have been used in industry for removal of unwanted material and debris for many years. In 1957 the use of a barbed broach connected to an ultrasonic delivery system for use in canal preparation and apical resection. Ultrasonic instruments play an ever-increasing role in several aspects of endodontic treatment. This review is an attempt to understand both the ultrasonic equipment and principles along with its rapid technological advances.

KEYWORDS: Endodontics, Rotary instruments, Ultrasonic instruments.

INTRODUCTION
The ultrasonic technique is essentially a non- rotary method of cutting dental hard tissue and restorative materials using piezo-electric oscillations. Cutting dentine structure with ultrasonic tips is analogous to cutting dentine with thinnest bur imaginable. Because the operating field is so restricted, the use of high magnification and proper illumination is essential during the use of these instruments.[1-4] The combination of ultrasonic instruments with magnification and illumination provided by surgical operating microscope has been termed microultrasonics.

Ultrasonic instruments play an ever-increasing role in several aspects of endodontic treatment. Teeth with root canal obstructions are no longer automatically treatment planned for surgical endodontics. Endodontic Retreatment has become a procedure of choice.[5]

In addition, root canal obstructions are being removed in a more conservative manner that does not unnecessarily destroy the tooth structure. The identification of missed and hidden canals has become a predictable outcome rather than a serendipitous discovery. Access cavities are being cut and refined with greater precision, opening up gateways to better endodontics. Above all, these procedures are no longer being performed blindly; instead the clinicians are now able to maintain visual contact with the operating field at all time during ultrasonic procedures.

This review is an attempt to understand both the ultrasonic equipment and techniques along with its rapid technological advances.

TYPES OF ULTRASONIC UNITS
There are two basic methods for producing an ultrasonic wave. First is magnetostriction that converts the electromagnetic energy into mechanical energy. The second method works according to the piezoelectric principle and uses a crystal which changes in size by applying electrical charge. Therefore, without producing heat, the crystal undergoes mechanical oscillation. Magnetostrictive units have two major drawbacks for endodontic application. First they have elliptical movement and oscillate in a figure-eight manner and second, they generate heat, so adequate cooling is required. One major advantage of piezoelectric units over magnetostrictive devices are production of more cycles per second (40 in piezoelectric vs. 24 in magnetostrictive devices). The other advantage is the piston-like linear movement of tip in piezoelectric units from back to front which is ideal for endodontic treatment.[5] The types of ultrasonic units are described as follows in Figure 1.

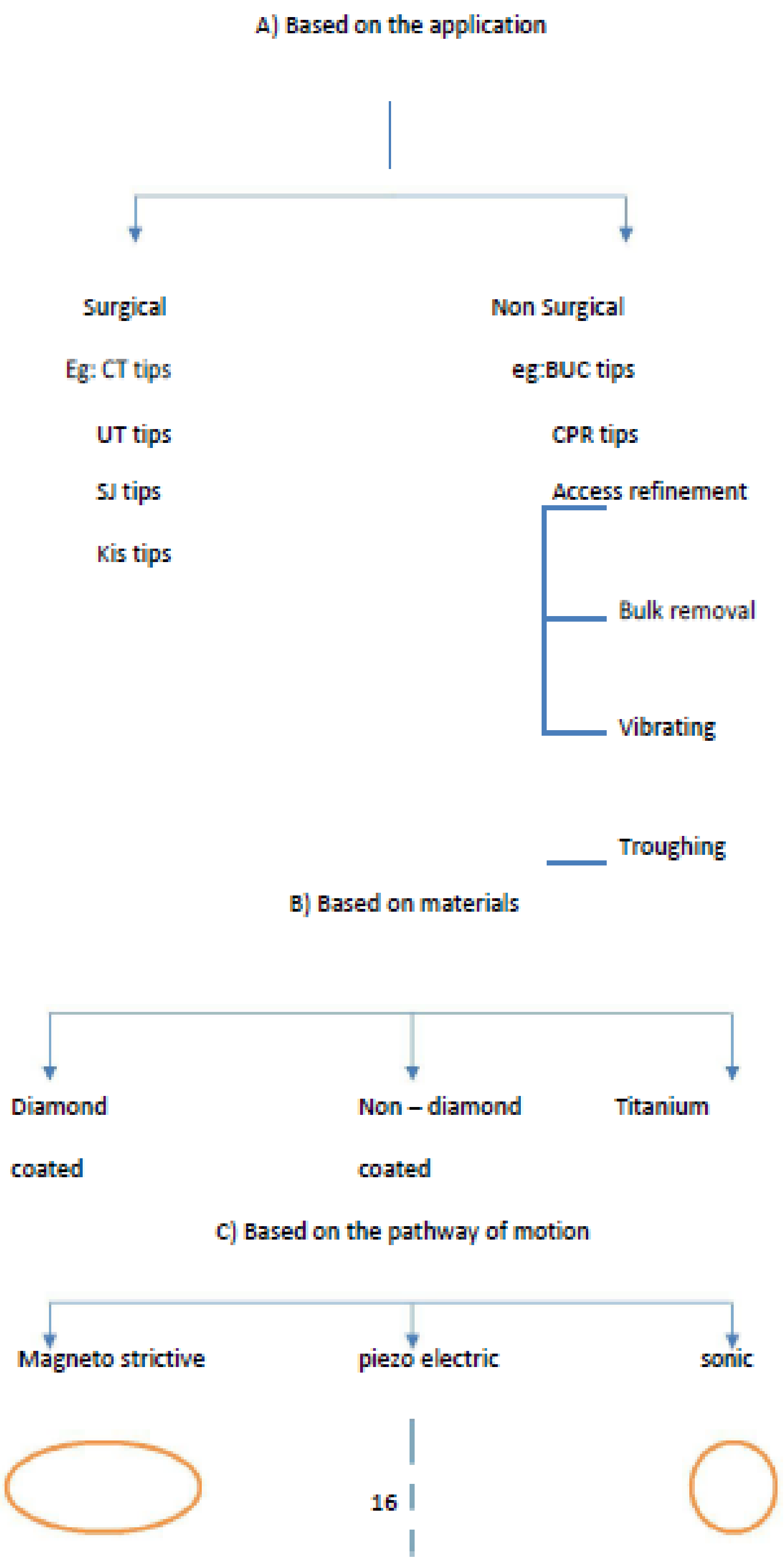

Figure 1: types of ultrasonic units.

The Principles Of Ultrasonic Cleaning[6-13]

1. ULTRASONIC CAVITATION

Ultrasonic cavitation is the phenomenon whereby the principle of ultrasonic cleaning can be understood .In a liquid medium the ultrasonic waves, generated by an apposite electronic ultrasound generator and a special transducer suitably mounted under the bottom of a stainless steel tank produces compression and vacuum waves at a very high speed, the speed depending on the working frequency of the ultrasound generator. They normally work at a frequency between 28 and 50 kHz. The pressure and vacuum waves in the liquid cause the phenomenon known as "ULTRASONIC CAVITATION".

2. SURFACE TENSION, VISCOSITY AND VAPOUR PRESSUREI

In order to gain a better understanding of the phenomenon, we have to refer to some basics concepts such as "surface tension" , "viscosity" and "vapour pressure or tension". Liquids are characterized by the fact that the particles have much greater potential for movement than in solids, albeit subject to much higher forces of attraction than those in gases. More particularly water is a molecular liquid, that evaporates at all temperatures but boils at a well-defined one, i.e at the "boiling point" which for distilled water is 100 degrees centigrade, at which the vapour pressure reaches the value of 1 atmosphere.

3. THE FORMATION OF CAVITIES AND THE IMPLOSION PHENOMENON

What happens when we subject a certain quantity of water at room temperature to an intense ultrasonic field? During the vacuum phase (see Fig. 1 Phase A) numerous bubbles of gas are formed in the liquid which enlarge for the duration of the acoustic vacuum phase (negative pressure).This formation of microscopic bubbles of gas is the start of cavitation (i.e. the formation of gaseous cavities in the liquid). During the second phase of ultrasonic compression (see Fig.1 Phase B), the enormous pressure exerted on the newly expanded bubble compresses the same, hugely increasing the temperature of the gas contained in it (see Fig. 1 Phase C) until the bubble collapses on itself, imploding with a consequent vast release of impact energy (see Fig. 1 Phase D). The impact energy caused by implosion of the gas bubble hits the surface of the object to be cleaned, interacting both physically and chemically .In physical terms a "micro brushing" effect is achieved at very high frequency (around 50,000 times per second of the machine operating at 50 kHz) with, in chemical terms, the cleansing effect of the chemical substance present in the detergent of the ultrasonic bath.

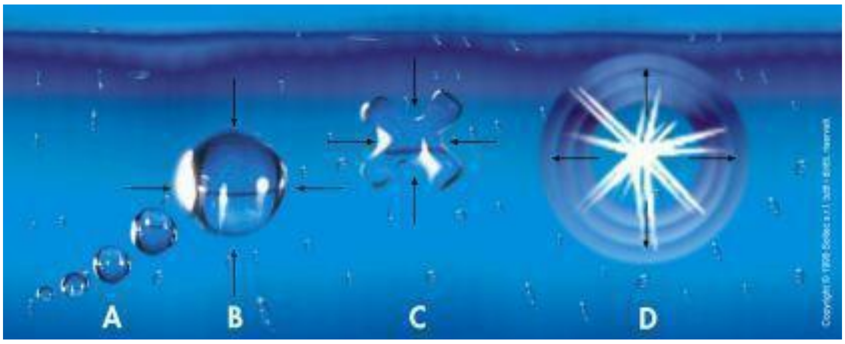

FIG:2

CHOOSING THE TYPE OF DETERGENT AND THE WORKING TEMPERATURE

As we will see, consideration of the chemical and physical aspect of the type of detergent used in an ultrasonic cleaner is of fundamental importance, and account has to be taken of many parameters when choosing an ultrasonic cleaner and detergent. The first is the type of substance to be removed from the soiled object and consequently the choice of the chemical substance which can attack the contaminant. Clearly the chemical Substance(detergent), used in order to cavitate efficiently, must be an aqueous solution, possibly with high vapour pressure and low surface tension, must be used at a working temperature of around 50-60^{0}C.

The temperature of the aqueous solution in an ultrasonic cleaning bath is very important, as the cavitation intensity varies as the temperature varies. It also increases as the temperature increases up to around 70^{0}C and then decreases and stops completely at the temperature of boiling of the liquid.

Another important parameter to be considered is the vapour pressure of the detergent is the solution used. Vapour tension or pressure refers to the following concept : if we consider a liquid in a closed and temperature controlled recipient, the surface molecule which have sufficient energy change to the vapour state and occupy the available space above the liquid. Occasionally some vapour molecules return to the liquid state until, when the state of equilibrium of system is reached. At a constant temperature, the speed of evaporation equals that of condensation. The pressure exerted by the vapour molecules, in these conditions, is defined as vapour tension. Its value does not depend on the quantity of the liquid present but only on the temperature. Therefore, If a liquid is heated, the vapour tension increases with the temperature and when the vapour tension equals the external pressure the phenomenon of boiling takes place.

A proper understanding of the concept of vapour pressure is important as it plays a major role in the cavitation process. The energy required for forming a cavitation bubble is proportional both to the vapour pressure of the liquid and the surface tension value. Cavitation is difficult when the vapour pressure of the liquid is low (cold Water). Contrarily the cavitation bubble implode with greater energy, although the power applied has to be increased considerably in order to reach the minimum cavitation threshold. Therefore the result is generally a smaller formation of bubbles and a smaller number of implosions. For example an increase in temperature of the liquid raises the vapour pressure of the same, making vapour cavitation easier. Therefore a high vapour pressure, lower the minimum cavitation threshold, creating many more bubbles which collapse, imploding with a lower energy in that the difference between internal and external pressure is smaller.

The viscosity of the liquid should also be taken into consideration. High viscosity values prevent cavitation, while low viscosity values allow diffusion of the ultrasonic waves and therefore the formation of cavitation bubbles.

The frequency of the ultrasound generator is important in that it determines the size of the gas bubble in the liquid subjected to ultrasonification. The higher the frequency of the generator, the smaller size of cavitation bubble generated. Clearly a larger bubble will require greater energy to implode and consequently will also have greater impact energy, while a smaller bubble will need less energy to implode and consequently have lower impact energy.

What is the benefit of using ultrasonic cleaning system with high frequencies?

High frequency allows many more bubbles to be generated in unit time, enabling better cavitation distribution per surface unit. For example, in a 40 kHz system, the distance between the nodes and antinodes (or loops) of acoustic wave is practically double, that generated by 20 kHz system. Therefore 40 kHz systems generates in the unit of time many more bubbles, above all smaller in size, allowing even very small points to be reached per surface unit. To give a practical example, we can compare fine cavitation at high frequency to very fine-grained sandpaper, while low frequency cavitation can be obtained according to whether a fine-grained or coarse-grained type is used.

Finally the use of a sweep system generator allows a further improvement in distribution of ultrasonic cavitation. The frequency of the generator is modulated around a central frequency with a 1kHz increase or decrease. For example a transducer piloted at 40 kHz will oscillate at a frequency between 39 and 41 kHz. This frequency variation prevents formation in the liquid of the so-called “stationary waves” which can generate acoustic interference when two (or more) wave trains intersect in a given region of the space. The sweep system therefore reduces cleaning times, prevents damage to delicate parts, considerably increases the distribution of ultrasonic cavitation and facilitates its process in liquids which cavitate with difficulty. The sweep system is normally used in industrial and highly professional cleaning systems, however nowadays some producers are starting to supply it on small ultrasonic cleaning units too.

The type of generator use can be piezoelectric or magnetostrictive. Piezoelectric transducers are normally used so that they can be designed with much higher frequencies compared to the magnetostrictive type. High-power magnetostrictive transducers do not exceed 22 kHz.

CAVITATION OR IMPLOSION

The broadest definition seems to be by Robert E Apfel, who says that “it is any stimulated bubble activity due to flow, decompression, acoustic waves, sudden deposition of electromagnetic or ionizing radiation, or heat. The activity refers to both bubble formation and dynamics.” It is generally agreed that cavitation produces a large concentration of energy.

Acoustic cavitation is when ultrasound is used to induce cavitation. Cavitation thus can concentrate the diffuse energy of sound to produce many effects with many applications. This effect can also influence chemical reaction in many ways, and this field of chemistry is known as sonochemistry.[14]

Scientific applications making use of or giving rise to cavitation:
1) Cleaning:
2) Sonochemistry:
3) Bioacoustic:
4) Degassing:
5) Sonoluminescence:

ACOUSTIC MICROSTREAMING

Ahmed et al stated that the power setting used to energize the endodontic unit was too low to produce cavitation and that the width of the canal space was too small to allow for this condition. They suggested that the principle was that of acoustic streaming, a process by which the vibrating file generates a stream of liquid to produce eddies and flows of oscillation. The dimension of these eddies and flows around the file are consistent and reproducible.

Although the main driver oscillates longitudinally, the file vibrates transversely. This sets up a characteristic pattern of nodes (points of minimum oscillation) and antinodes (points of maximum oscillation). The greatest displacement occurs when the working tip of the file is allowed to work without interference. Transverse motion of the file causes filling of the dentine when the instrument is moved vertically within the root canal space. Files of different thickness and length oscillate differently and the node/ antinode position can vary.

The energy in the transverse oscillation is low, and the file is susceptible to constraint or loading. This, in turn, produces variability in clinical efficiency. To keep such constraint to the minimum the clinician should keep the file in constant motion when it is activated within the root canal. File constraint is more pronounced in curved canals and when pre-curving is necessary. Therefore, the clinician should keep the file moving in an up-and down motion.

The oscillating file in the endosonic system produces streaming field along its length, with the greatest shear stresses being generated around point of maximum displacement such as the tip of the file and the antinodes along its length. This streaming fields are likely to be responsible for many of the beneficial effect attributed to the use of endosonics and are important in moving the irrigant around the root canal. However the efficiency of such forces depends on the amount of damping and file constraint that occurs when the instrument the working within the canal.

Streaming forces occurring around the files which disassociate the clumps of bacteria without disruption. The acoustic streaming generated by the file may play a useful role in reducing the number of bacteria in the canal by removing the smear layer and debris harboring bacteria and loosening aggregates of bacteria, thereby facilitating their mechanical removal.

The main advantage of ultrasonic files is that they move irrigant around the canal and penetrate to the most apical extent of the instrument. The general conclusion is that acoustic micro streaming occurs around the oscillating file. To be effective in this action, the file must be kept moving at all time so that free oscillation can be maintained.

Instruments are generally moved circumferentially within the canal space.

CLINICAL APPLICATIONS IN ENDODONTICS

1) NON SURGICAL APPLICATIONS

a) Access refinement, finding calcified canals and removal of attached pulp stones.
b) Removal of intracanal obstructions.
(eg: Separated instruments, root canal posts, silver points and fractured metallic posts.)
c) Increased action of irrigating solutions.
d) Placement of mineral trioxide Aggregate (MTA)
e) Root canal preparation.
f) Preparation of Isthmus.

2) SURGICAL APPLICATIONS

a) Root end cavity preparation and refinement and placement of root end obturation material
b) Retrograde preparation

Although ultrasonics is used in dentistry for therapeutic & diagnostic applications as well as for cleaning of instruments before sterilization, currently its main use is for scaling & root planning of teeth &in root canal therapy.

NON SURGICAL APPLICATIONS

a) Access refinement, Finding calcified canals & Removal of Attached pulp stones.
One of the challenges in endodontics is to locate canals, particularly in cases in which the orifice has become occluded by secondary dentin or calcified dentin secondary to placement of restorative materials or pulpotomies. With each access preparation in calcified tooth, there is risk of perforating the root or when incorrectly performed, of complicating each subsequent procedure. A lack of straight line access is arguably the leading cause of separation, perforation and the inability to negotiate files to radiographic terminus.

The introduction of microscope, access burs and ultrasonics has greatly reduced these risks. Microscopic visualization & ultrasonic instruments are a safe and effective combination to achieve optimal results.

In conventional access procedures, ultrasonic tips are useful for access refinement, location of MB2 canals in the upper molars and accessory canals in other teeth, location of calcified canals in any tooth and removal of attached pulp stones.

There are numerous variations of rotary access burs available. However, one of the most important advantages of ultrasonic tips is that they do not rotate, thus enhancing safety & control, while maintaining a high cutting efficiency. This is especially important when the risk of perforation is high.

The visual access and superior control that ultrasonic cutting tips provide during access procedures make them a most convenient tool, especially when treating difficult molars. When locating the MB2 canals in upper molars, ultrasonics is excellent means for the removal of secondary dentin on the mesial wall. When searching for hidden canals one should remember that secondary dentin is generally whitish or opaque where as the floor of the pulp chamber is darker & gray in appearance. Ultrasonics works well when breaking through the calcification that covers the canal orifice. A troughing tip is good choice for this task. For these applications, bigger tips with limited diamond coated extension should be used during the initial phases of calcification, interferences, materials and secondary dentin as they offer maximum cutting efficiency and enhance control while working in the pulp chamber.

The diamond coated tips used in orthograde endodontic treatment have shown significantly greater cutting efficiency than either stainless steel tips or zirconium nitride coated tips but they have a tendency to break. Moreover, thinner diamond coated tips seem to be able to transmit the oscillation of ultrasonic unit more efficiently into dentin, this results in a more aggressive cutting action. Ultrasonic cutting seems to be significantly influenced by the power setting, as larger fragments of dentin are removed at higher power and by the type of ultrasonic unit used.

Therefore, care should be exercised while searching for canal orifice, as aggressive cutting may cause an undesired modification of the anatomy of the pulp chamber.

b) Removal of intracanal obstruction
(eg Separated instruments, root canal posts, silver points and fractured metallic posts)

Clinicians are frequently challenged by endodontically treated teeth that have obstructions such as hard impenetrable pastes, separated instruments, silver points or posts in their roots. If endodontic treatment has failed, these obstructions need to be removed to perform non-surgical retreatment.

Many instruments and techniques have been reported, they include appropriate burs, special forceps, ultrasonic instruments in direct or indirect contact, peripheral filling techniques in the presence of solvents, chelators or irrigants, microtube delivery using mechanical adhesion techniques and different kits and excavators.

Ultrasonic energy has been proven to be effective as an adjunct in the removal of silver points, fractured instruments and cemented posts. It has often been advocated for the removal of broken instruments because the ultrasonic tips or endodontic files may be used deep in the root canal system. Furthermore, the use of an ultrasonic endodontic device is not restricted by the position of the fragment in the root canal or the tooth involved.[15-19]

The prognosis of these cases mainly depends on the preoperative condition of the periapical tissues. For this reason an attempt to remove broken instruments should be undertaken in every case. When these obstructions can be removed, successful treatment or retreatment generally occurs. If an instrument can be removed or bypassed and the canal can be properly cleaned and filled, non-surgical endodontics is more desirable and conservative approach. The removal of an obstacle from a root canal must be performed with a minimum of damage of the tooth structure that will complicate the restorative phase and as a result will most likely decrease the overall prognosis.[20-27]

When the obstacle prevents access to the root apex, adequate preparation, disinfection and obturation of the entire root canal system are not possible. Straight line access is essential and allows for maximum visibility of the metallic fragment. For that reason, the use of magnification is essential, as it provides visualization with excellent illumination, allowing instrumentation at high magnification.

Separated Instruments[1,28-30]
Management of a broken instrument requires an orthograde or a surgical approach. The three orthograde approaches are; attempts to remove the instrument; attempt to bypass the instrument; prepare and obturate the fractured segment.

In most cases, removal of broken instruments from the root canal is difficult and often hopeless. Till date, no standardized procedure for safe removal of fractured instruments exists, although various techniques and devices have been suggested. These techniques have been shown only limited success, while often causing considerable damage to the remaining root. Complications as a result of these techniques include excessive loss of root canal dentin, ledging, perforation and extrusion of the fractured instrument fragment through the apex. Therefore, many techniques cannot be used in narrow and curved canals.

Over the years, different techniques have been proposed for the removal of separated instruments from root canals. Recent advances in endodontics have led to the development of the techniques and devices. These are designed specifically for the safe removal of fractured instruments from deep within narrow curved root canals. Ruddel proposed a technique for the removal of broken instruments using GATES GLIDDEN drills to prepare a circumferencial "staging platform" at the coronal aspect of the obstruction. Radiographic evaluation of the residual dentin thickness during preparation of the platform can be misleading because of the inaccuracy of the radiographic interpretation.

Sely, there were two canals present in 60% of the cases. An isthmus was encountered more frequently at a distance of 3-5 mm from the apex. All roots with two canals also had isthmus that either completely or partially connected with canals.

A 2% methylene blue solution is useful not only in histological studies but also in clinical applications to help make an isthmus visible. Application of the dye to the resected root surface stains the canal entrances and the pulp tissue in the connecting corridor, and the latter can then be removed with an ultrasonic retro tip.

The success rate of endodontically treated posterior teeth is lower than that of anterior teeth. Friedman et al (1991) reported success in only 44.1% of premolars and molars retreated by apicoectomy. Other authors indicate clinical success in 71.73% of molars resected root tips(Altonen and Mattila 1976, Joannides and Borstlap 1983). By contrast, the success rate among anterior teeth is 85-90% (Rapp et al1991). The tips of mesiobuccal roots of maxillary first molars are relatively easy to resect, but the success rate is significantly lower than for mandibular first molars, even though surgical procedure can be more difficult for the latter(Nordenram and Svardstrom 1970).

Among the possible causes of these failures are, besides the technical inaccessibility during the course of the operation, untreated canals and insufficient condensation of the filling. One underlying cause of treatment failure that is greatly underestimated is an undiscovered canal isthmus that represents a corridor that is a lateral communication or anastomosis between two separate canals.[31-36]

Importance of locating and treating the isthmus

The dental isthmus was not mentioned in dental textbooks or published journals until 1983, when Cambruzzi and Marshal published an article on isthumi in a Canadian dental journal. The article predated the evolution of apical surgery and was therefore ignored. Evidence of a treated and retrofilled isthmus is virtually absent from the dental literature.

The accepted radiographical "look" after apical surgery and amalgam retrofilling was the previously mentioned radio opaque BB-gun appearance at the apex. Dental professionals who consider a hermetic seal at the apex to be the goal of the surgery have managed poorly in the many cases in which an isthmus was present.

The non microsurgical traditional techniques can neither identify nor treat the isthmus. Therefore management of the isthmus is solely the domain of endodontic micro surgeon, which has been confirmed by the clinical evidence in the previous sections. Many different types of isthumi exist. Surgeons must consider the possible presence of an isthmus before surgery and should be prepared to encounter and treat any of its various types during the surgery.

In posterior teeth the natural unresected root apices are frequently round but after 3 mm resection ,they assume the shape of a peanut shell and show evidence of having an isthmus. The advantage of the microsurgical technique is that the isthmus can be identified using the microscope and micro mirrors and managed with confidence using ultrasonic instruments.

CLINICAL SIGNIFICANCE[3,6,37-40]

The high number of isthumi found during micro surgery was a surprising finding that prompted an anatomical investigation. The results of the study agreed with the clinical observations and corroborated the opinion that untreated isthumi are one of the main causes of surgical treatment failure. The identification of existing isthumi is therefore extremely important for the success of endodontic therapy, but equally important is that isthmus be treated under microscope with ultrasonic techniques and micro instruments. Because of its size and location, it is impossible to prepare an isthmus correctly with traditional large instruments.

Clinical treatment of the isthmus

The existence of an isthmus has been known on a theoretical level for sometime from anatomic and histological studies, but until recently there was no inference that the presence of an isthmus could also have therapeutic consequences and must be taken into considerstion when performing root tip resections in a dental practice.

Because a necrotic root canal contains infectious microorganisms not only in the apical region but also within the isthmus, a thorough cleaning followed by a thorough seal is the primary objective of the micro surgical procedure. Our clinical investigations show that the main cause of the surgical failure in over 80% of cases is an isthmus that was treated either improperly or not at all. There is a wide range of variation in the shape and size of an isthmus. The ultrasonic preparation of this anatomic structure demands a careful and delicate touch, because the isthmus is located in a slender, fragile part of the tooth that can easily become perforated or roughened.

Normally, the isthmus runs in a buccal to lingual direction. Instrumentation is performed initially in short intervals without a cooling spray so that the isthmus can be followed. For retrograde preparation of root canal the entire 3mm length of the active working tip must be used. Finally, the form and cleanliness of isthmus are evaluated at higher magnification(>16X).[38]

Preparation with Ultrasonic Tips

Occasionally a dental surgeon encounters an incomplete isthmus. In this case, providing guidelines for the ultrasonic tip by creating a shallow groove or tracking groove, along the isthmus line with a micro explorer is helpful. The ultrasonic tip is first activated without water coolant to make the tracking groove connecting the two canals, which are usually oriented from buccal to lingual. The groove can be produced quickly by gently guiding the tip along the isthmus. Before preparing the isthmus to full depth, the tracking groove should be examined with magnification for correct positioning.[39]

SURGICAL APPLICATIONS

a) ROOT END CAVITY PREAPARATION AND REFINEMENT AND
PLACEMENT OF ROOT END OBTURATION MATERIAL

Recent developments of new instruments and techniques have significantly enhanced the treatment outcome in apicoectomy with retro filling. As the prognosis of endodontic surgeries is highly dependent on good obturation and sealing of the root canal, an optimal cavity preparation is an essential prerequisite for an adequate root end filling after apicoectomy.

Root end cavities have traditionally been prepared by means of small round or inverted cone burs in a micro hand piece. In the mid 1980s, standardized instruments and alluminium oxide ceramic pins were introduced for retrograde filling, but that system could not be used in cases with limited working space or in teeth with large oval canals. Since sonically or ultrasonically driven microsurgical retro tips become traditionally available in early 1990s, this new technique of retrograde root canal instrumentation has been established as an essential adjunct in pericardial surgery. However, the cutting properties of the retro tips at that time were limited and seem to be dependent on loading, power setting and orientation of the tip to the long axis of hand piece. In some retro tips, cooling of the working tip was insufficient and dentin and done were at risk of overheating.

The first root end preparation using modified ultrasonic inserts following an apicoectomy is attributed to Bertrand et al. Other followed, but it was not until 1887 that Flath and Hicks further reported on the use of ultrasonics and sonics for the root end cavity preparation.[40]

Conventional root end cavity preparation using rotary burs in a micro hand pieces faced with several problems, such as cavity preparation not being parallel to the canal, difficult access to the root end, and risk of lingual perforation of the root. Furthermore, the inability to prepare to a sufficient depth, Thus compromising retention of root end filling material, means that the root end resection procedure requires a longer cutting bevel, thus exposing more dentinal tubules and isthmus tissue, of which the latter is difficult to remove. The development of ultrasonic and sonics retro tips have revolutionized root end therapy, improving the surgical procedures with better access to the root end, resulting in better canal preparation. Ultrasonic retro tips come in a variety of shapes and angles, thus improving some steps during surgical procedures.

At first glance, the most relevant clinical advantages are the enhanced access to root ends in a limited working space. This leads to a smaller osteotomy for surgical access because of the advantage of using various angulations and small size of retro tips

b) RETROGRADE PREPARATION

If any reverse filling are to be used, the root tip (or lateral root surface) must be prepared to receive the filling materials. For many years, preparations we are produced by the burs usually used for restorative dentistry-diamond stone and carbide burs (usually fissure and inverted cone types). Although these burs are still used to bevel the root tip, most of the preparation for the reverse filling itself is being performed with ultrasonic tips by more and more clinicians.[41]

These tips are smaller than the burs that were formerly used, they conserve tooth structure and give more parallel preparations, they probably enhance the cleanliness of the prepared area, and the tip angles give better access. Rubinstein has indicated that a common site for remaining debris or old canal filling materials is the more buccal portion of the preparation .It is difficult to cleanse this area with a hand piece-driven bur.

However, the reverse angle of the ultrasonic tip allows more room to reach, and thus remove, these unwanted materials. Ultrasonic preparation has been used in routine endodontic therapy for several years to give better, cleaner preparation and remove unwanted materials. This application is now available for surgical treatments as well.[42]

The ultrasonic tip has allowed the operator to make very precise preparations because of ease with which it removes old gutta-percha in particular. It also will quickly widen and clean canals narrowed by reparative dentin to make an excellent shape for filling when no old canal filling is present. However, do not cast aside the routine burs when surgery is necessary. Not only are these needed for root beveling but also necessary to cut posts, silver points, and other metallic objects. The ultrasonic tips have little effect on cutting these metallic materials, although they may be used to loosen the materials from their hold in the canal.[43]

The third part of micro surgical triad, the ultrasonic unit, is indispensable for proper cleaning and shaping of the root canal. A series of different ultrasonic inserts, called Carr Tips (CTI-5) after their originator, Gary B. Carr, are available in Germany through satelec and EMS. With these it is possible to operate in the different region of the mouth because the working end of the tips are manufactured with different angulations.[44] The tips are shaped in accordance with the anatomy of the root canal systems so that it will not be necessary to remove additional tooth structure for the sake of achieving good access to the operative site.[45] The wide selection of shapes and sizes of ultrasonic inserts available helps to overcome all the week points of conventional preparations with rotary instruments.

1. Ultrasonic preparation require substantially less bone removal for access
2. The cavity can easily be extended in a buccolingual direction
3. The cutting tip is aligned parallel with the long axis of the root.
4. The isthmus can be prepared easily.

The main problem in conventional endodontic retrosurgery is the inability to follow the direction of the root with the bur because of the relatively immense size of even the smallest hand piece and the excessive length of the burs.[46] For this reason, perforations often occurred in the lingual portion of the apex that lay on the side turned away from the operative field and that could not be seen on the radiograph. Furthermore, Preparations with rotary instruments require a 10-mm osteotomy opening to create enough space for the hand piece and bur. For ultrasonic instrumentation an opening less than 5mm in diameter is adequate because the cutting tip of the ultrasonic insert is only 3 mm long and the shaft is slender causing reduced trauma to the bone and quicker and better healing.[47]

CONCLUSION

The use of ultrasonic instruments has revolutionized the art of endodontic re-treatment. These instruments have multiple uses and have become an integral part of endodontic armamentarium which require specialized knowledge and development of certain skills that may require training before use.[48]

Ultrasonics offers many applications and advantages in clinical endodontics. Improved visualization combined with a more conservative approach when selectively removal of a particular tooth structure, particularly in difficult situations in which a specific angulation of tip design permits access to restricted work areas, offers opportunities that are not possible with conventional treatment.[49] As a result, access refinement, location of calcified canals, and removal of separated instruments or posts has generated more predictable results. In addition, better action of irrigation solutions and condensation of gutta percha have benefited from the use of ultrasonics , root end cavity preparation followed by placement of materials in an area that is more often than not constrained has specially improved the quality of treatment and long term success.[50]

Because of better visualization, operative convenience, and precise cutting ability, the application of ultrasonic instruments has increased greatly.

Following improvements and better designs, ultrasonic instruments can have wide and efficient usage in dental fields. Although some issues must still be considered, like high-frequency noises, interference with pacemakers, and a low cutting efficiency compared with conventional high- or low-speed air turbine instruments, the results of previous studies indicate that ultrasonic instruments have an extremely high potential to become convenient and efficient tools for various dental treatments, and deserve future development.

Its convenience to use and patient friendliness if regularly employed in practice, will ultimately translate into good health care.

Hence, an aware professional who is eager to provide good health care has to adapt himself to the call of time in the present supersonic age.

BIBLIOGRAPHY

1. Gianluco Plotilo, Corneles H.Pameiger, Nicola Maria Grande And Fransesco Somma. Ultrasonics in Endodontics: A Review of The Literature. J Endod; Feb 2007; 33: 2.
2. Sunil Kumar Karumuri; Trisha Rastogi, Kartheeki Beeraka, Mohan Raju Penumatcha & Sanjeeva Rao Olepur. Ultrasound:A revenant therapeutic Modality in dentistry. Jclin Diagn Res., 2016 july; 10(7): 2E08-2E012.
3. Mian K. Iqbal Non Surgical Ultrasonic Endodontic Instruments. Dent Clin of North Am; 2004; 19-34.
4. Ruddel CJ Non Surgical Endodontic Retreatment. J Calif Dent Assoc 1997; 25: 769-799.
5. Fors UGH, Berg JO Endodontic Treatment of Root canals obstructed by foreign objects. Int Endod J 1986; 19: 2-10.
6. Cameron J A The use of ultrasonics in the removal of the smear layer; A scanning Electron microscope study. J Endod 1983 July; 9(7): 289-92.
7. Wiemann AH; Wilcox LR. In vitro evaluation of four methods of sealer placement. J Endod 1991 sep; 17(9): 444-7.
8. Ward JR; Parashos P; Messar H H .Evaluation of an ultrasonic technique to remove fractured rotary Nickel, Titanium endodontic instruments from root canals.; clinical cases. J Endod 2003 Nov; 29(11): 764-7.
9. Aasim S A, Mellor AC, Qualthrough AJ. The effect of pre soaking &time in the ultrasonic cleaner on the cleanliness of sterilized endodontic files. Int Endod J 2006 Feb; 39(2): 143-9.
10. Pera kaki K, Mellor AC, Qualthrough AJ. Composition of an ultrasonic cleaner & a washer disinfector in the cleaning of endodontic files. J Hosp Infect, 2007 Dec; 67(4): 355-9.
11. Tamer Tasdemir, KwsatER, Davut Celik, Tahsin Yildrin, Effect of passive ultrasonic irrigation on Apical entrusion of irrigating solution .Eur J Dent, 2008 Jul; 2: 198-203.
12. Vander Siuis L, W u M K,Wesselink, comparison of two flushing methods used during passive ultrasonic irrigation of the root canal Quintessence Int2009 Nov Dec; 40(10): 875-9.
13. Yelton C, Lawror K, KulildJ C, Walker MP . Comparison of the efficiency of four different ultrasound tips to remove dentin over time. JOE2010; 36(3): 529-531.
14. Klyn SL, KIrkpatrik TC, Rutledge RE In vitro comparisons of debri removal of endoactivator system, the ultrasonic irrigation & naoel irrigation alone after hand rotary instrumentation in human mandibular molars. J Endod, 2010 Aug; 36(8): 1367-71.
15. Rodiq T Sedihi, M, Konietschke F, Lang K, Ziebolz D, Hulsmann M,. Efficiancy of syringe irrigation, passive ultrasonic irrigation, passive in removing debris from irregularities in root canal with different apical sizes. Int EndodJ 2010 Jul; 43(7): 581-9.

16. Jiang L M, Verhaagen B, Versluis M, Landedigic J, Wesselink P Vandel Sluis LW The influence of ultrasonic intensity on the cleaning efficiency of passive ultrasonic irrigation.J Endod 2011 May; 37(5): 688-92.
17. Vassay M, BudgeC, Poolman T, JonesP, PerretD Nayuni N, Bennet P, Grooves P, Smith A, Fulford M, Roven N D. A quantitative assessment of residual protein levels on dental instruments repressesed by manual, ultrasonic & automated cleaning methods. Br Dent J 2011 May 14; 210(9): E14.
18. Guo X, Miao H, Lil, Zhang H, Zou D. Efficiency of four different irrigation technique combined with 60degreec 3% sodium hypochloride & 17% EDTA in smear layer removal BMC oral health, 2014 sep 8; 14: 114.
19. Dickie J, McCrosson J. Post removal techniques part 1. Dent update 2014 jul-aug; 41(6): 490-2,495-8.
20. Chhina H, Hans MK, Chander S. Ultrasonics:a novel approach for retrieval of separated instruments. J clin Diagn Res., 2015 jan; 9(1): ZD 18-20.
21. Duque JA, Duarte MA, Canali LC, Zancan RF, Bramante CM. Comparative effectiveness of new mechanical irrigant, agitating devices for debris removal from canal and isthmus of mesial roots of mandi molars. J Endod 2017 feb; 43(2): 326-331.
22. Yang Q, Shen Y, Huang D, Haapasalo M. Evaluation of two trephine techniques for removal of fractured rotary nickel-titanium instruments from root canals. J Endod 2017 jan; 43(1): 116-120.
23. Zayed Mohammadi, Sousan Shalavi, Luciano Giardino, Flavio Palazzie, Saeed Asgary. Impact of ultrasonic activation on the effectiveness of sodium hypochlorite: A Review. Iran Endod J 2015; 10(4): 216-220.
24. Chanail BL, Teplitsky PE: Orthograde Ultrasonic Retrieval of Root Canal Obstructions, J Endod., 1987; 13: 186-190.
25. Ruddle CJ: Microendodontic Nonsurgical Retreatment, In Microscopes In Endodontics, Dent Clin of North Am 41:3, 429-454.
26. Ruddle CJ: Nonsurgical Endodontic Retreatment. In Cohen S, Burns RC, editors: Pathways of the pulp, 9th edition, Mosby, St.Louis, pp.875-929, 2001.
27. Goon WW. Managing the obstructed root canal space: rationale and techniques. Ensuring the soundness of the remaining tooth structure. J Calif Dent Assoc 1991; 19(5): 51-60.
28. Machtou P, Safarati P, Cohen AG. Post removal Prior To Retreatment. J Endod 1989; 15(11): 552-4.
29. Ruddle CJ. Nonsurgical Endodontic Retreatment. J Calif Dent Assoc 2004; 32(6): 474-84.
30. Matthias Zehnder, Root Canal Irrigants JOE-Volume 32, Number 5, May 2006.
31. D.M.Z. Guerisoli, M.A.Marchesan, A.D.Walnsey, P.J.Lumley & J.D.Pecora. Evaluation of smear layer removal by EDTAC and sodium hypochlorite with ultrasonic irrigation. International Endodntic Journal, 2002; 35: 418-421.
32. Abbott PV, Heijkoop PS, Cardaci SC, Hume WR, Heithersay GS. An SEM study of the effects of different irrigation sequences and ultrasonics. International Endodontic Journal, 1991; 24: 308-16.
33. Cameron JA. The choice of irrigant during hand instrumentation and ultrasonic irrigation of the root canal: a scanning electron microscope study. Australian Dental Journal, 1995a; 40: 85-90.
34. Cameron JA. Factors affecting the clinical efficiency of ultrasonic endodontics – a scanning electron microscopy study. International Endodontic Journal, 1995b; 28: 47-53.
35. Cheng GS, Stock CJ. In vitro cleaning ability of root canal irrigants with and without endosonics. International Endodontic Journal, 1993; 26: 334-43.
36. Huque J, Kota K, Yamaga M, Iwaku M, Hoshino E. Bacterial eradication from root dentine by ultrasonic irrigation with sodium hypochlorite. International Endodontic Journal, 1998; 31: 242-50.
37. Martin H, Cunningham MJ, Morris JP, Cotton WR. Ultrasonic versus hand filing of dentine: a quantitative study. Oral Surgery, Oral Medicine and Oral Pathology, 1980; 49: 79-81.
38. S.J. Lee, M.K Wu & P.R. Wesselink. The efficacy of ultrasonic irrigation to remove artificially placed dentine debris from differentsized simulated plastic root canals. International Endodontic Journal, 2004; 37: 607-612.
39. Abbott PV, Heijkoop PS, Cardaci SC, Hume WR, Heithersay GS. An SEM study of the effect of different irrigation sequences and ultrasonics. International Endodontic Journal, 1991; 24: 308-16.
40. Ahmad M, Pitt Ford TR, Crum LA. Ultrasonic debridement of root canals: acoustic streaming and its possible role. Journal Of Endodntics, 1987; 14: 490-9.
41. Cunningham WT, Martin H. A scanning electron microscope evaluation of root canal debridement with the endosonic ultrasonic synergistic system. Oral Surgery Oral Medicine Oral Pathology, 1982b; 53: 527-31.
42. Weller RN, Brady JM, Bernier WE. Efficacy of ultrasonic cleaning. Journal Of Endodontics, 1980; 6: 740-3.
43. Stock CJR. Current status of the use of ultrasound in endodontics. International Dental Journal, 1991; 41: 175-82.
44. Lumley PJ, Walmsley AD, Walton RE, Rippin JW. Cleaning oval canals using ultrasonic or sonic instrumentation. Journal Of Endodontics, 1993; 19: 453-7.
45. Fors UGH, Berg JO. Endodontic treatment of root canals obstructed by foreign objects. Int Endod J 1986; 19: 2-10.
46. A review on ultrasonic methods in endodontics. Journal Of Endodontics February 2007; volume 33, number 2.
47. Ultrasonics in endodontics Clinical applications. Rev Esp Endodoncia. 1989 Jul-Sep; 7(3): 107-14.

48. Uses of ultrasonic instrumentation in endodontics. J Okla Dent Assoc. 2001 Fall; 92(2): 33-8.
49. Sonic instrumentation in endodontics. International Journal Of Endodontics, 20: 105-111.
50. Ward, P. Parashos, H. Messer. Evaluation of an Ultrasonic Technique to Remove Fractured Rotary Nickel-Titanium Endodontic Instruments from Root Canals: Clinical Cases. Journal Of \Endodontics, Volume 29, Issue 11, Pages 764-767.