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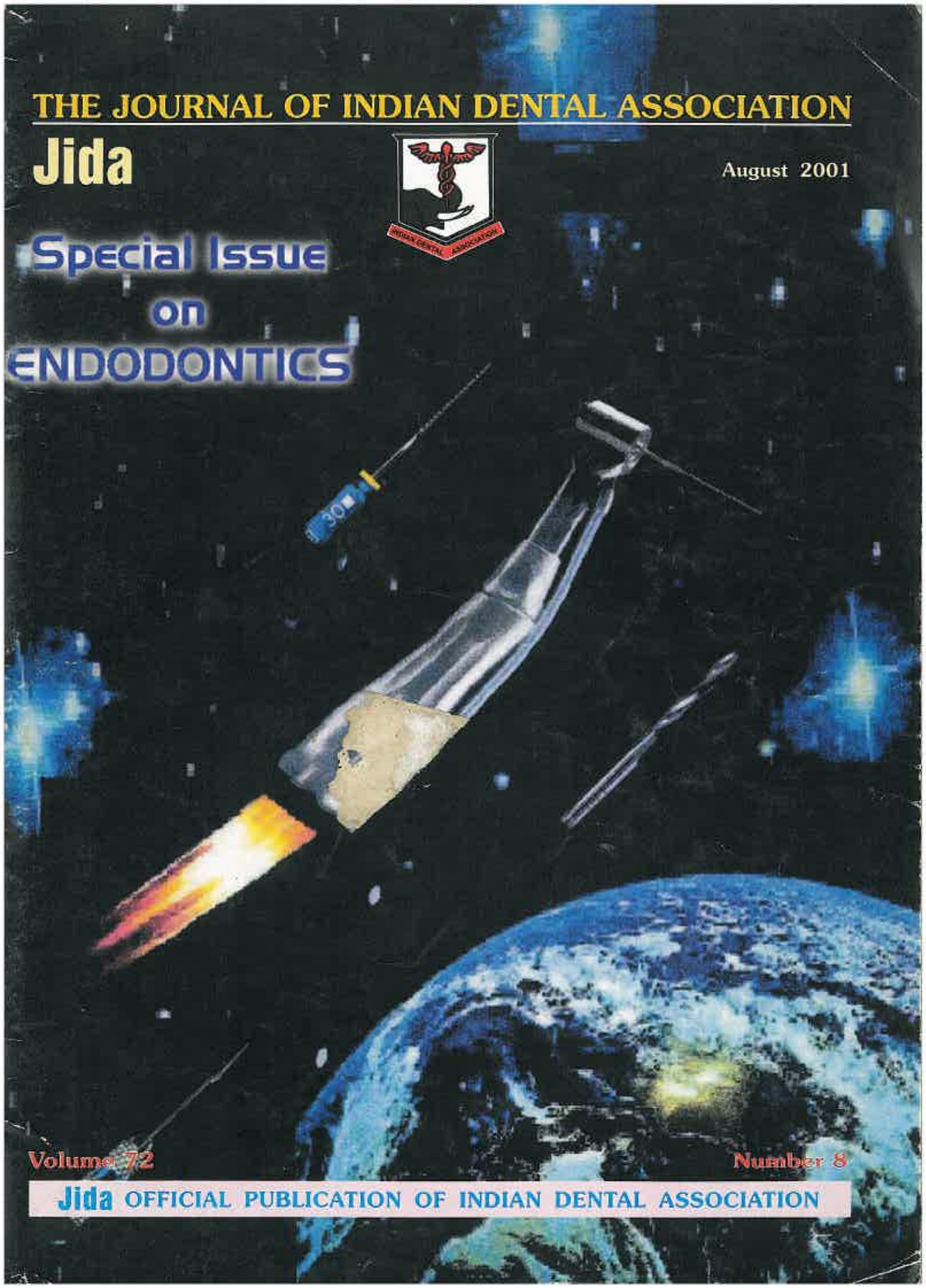

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EQUIPMENT AND INSTRUMENTS

SONICS VERSUS ULTRASONICS

PART-II: A PRACTITIONER'S PERSPECTIVE

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INTRODUCTION

Thorough debridement of the pulp space is regarded as essential for endodontic success. Dentists strive to remove all vital and nonvital tissue, as well as microbial contaminants from the root canal space. Research however, has shown this ideal to be far from obtainable. Haga[1] reported that hand instrumentation was inadequate in 80% of the teeth he examined. Root canal anatomy also serves to deter proper debridement, as shown by Guiterez and Garcia[2], who found cul-de-sacs, fins and irregularities in 78% of the teeth examined. In a landmark study in 1976, Walton[3] performed histological evaluation of different methods for enlarging the pulp canal space. Walton's research showed that only 62% of canal walls in curved canals are instrumented whereas only 72% of straight canal walls were instrumented. Although the percentage of walls planed may not determine the adequacy of debridement, instrumenting as many canal walls as possible is desirable to enhance adequate chemomechanical preparation. Chemical debridement of the root canal has been relied upon to help remove tissue not accessible to mechanical instrumentation. Yet, it has been shown that chemomechanical instrumentation is not very effective in removing debris from the apical one third of the canal. Research results have repeatedly revealed that root canal anatomy and the limitations of hand instrumentation restrict the chances of attaining complete chemomechanical debridement.

ULTRASONICS

Ultrasonic Endodontics is based on a system in which sound as a energy source (at 20 to 42 kHz), activates an endodontic file resulting in three dimensional activation of the file in the surrounding medium. The ultrasonic systems (Magnetostrictive and Piezo-electric) involve a power source to which an endodontic file is attached with a holder and an adapter. Ultrasonic handpieces use K-files as a canal instrument. Beginning at ISO size 15, they range up to size 40. Before a size 15 can fully function, however, the canal must be enlarged with hand instruments to a size 20. Martin also designed a stiff, non-end cutting diamond file to be used in the straight part of the canal[4]. The irrigants are emitted from cords on the power source and travel down the file into the canal to be energized by the vibrations.

SONICS

The only similarity between the ultrasonic and sonic instruments is in imparting vibrational type of movement for the root canal instrument, which they activate. The rest of the features such as the source of power, frequency of vibration, type of handpiece and root canal instruments used are all different. Further more, unlike ultrasonics, sonic system does not require special connections, as it involves only a hand piece. Sonic instruments use compressed air line at a pressure of 0.4 MPa, which is already available in the dental unit setup, as its source of power. There are two options for irrigating the root canal while using sonic handpieces. Either the water line of the dental units can be attached to the sonic handpiece, or the water can be cut off and the dental assistant can introduce sodium hypochlorite from a syringe. Sonic handpieces impart vibrations usually in the frequency of 1.5 - 3 kHz with provision for adjusting the frequency, in the form of a ring on the handpiece.

The root canal instruments which sonic handpieces use are specially designed and are unique. The three choices of files that are used with sonic handpieces are the Rispi sonic, Shaper sonic and the Helio sonic. The Rispi sonic file resembles a rat-tail file and was developed by Dr. Retano Spina. The Shaper sonic files were developed by Dr. J.M. Laurichesse and resemble a husky barbed broach. The Helio sonic file is otherwise known as Trio sonic or Triocut file and resembles a triple helix Hedstroem file. All these instruments have safe ended non-cutting tip 1.5-2.0 mm in length. The ISO sizes of these instruments range from 15 to 40. As the graduated size instruments have varying shaft sizes, the instrument must be tuned with the unit's tuning ring to an optimum tip amplitude of 0.5 mm.

A COMPARATIVE ANALYSIS

Shaping Of Root Canals:

High efficiency of ultrasonics in dentin removal with reduced operator fatigue, raised the hope that it would be an ideal power driven device for root canal preparation. However, the results achieved by the ultrasonic units have ranged from outstanding[5,6,7] to disappointing[8,9]. The explanation for such wide variance in results lies in the difficulty of controlling the exact position of the tip and also the vibration of the file inside the canal curtails its hope as a precise tool for root canal preparation, particularly the apical part.

One of the uncharted problems with the ultrasonic units is their choice of enlarging instrument – the K file. These files are made to function best in a push – pull, in and out motion. The action of the ultrasonic units, however, is an oscillating side to side, transverse motion. Walmsley and Williams[10] suggested that the devices would work much better if the transverse motion could be changed to an up and down, longitudinal oscillation. May be rather than

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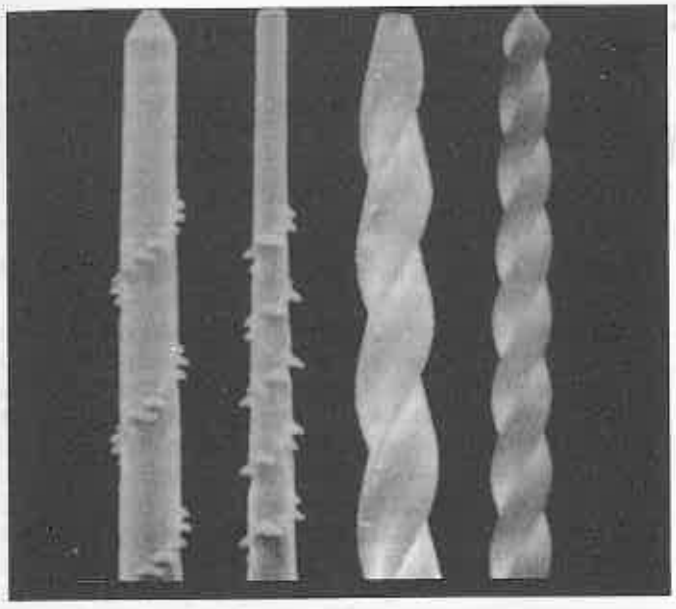


Fig.1. Files. Left - Shaper Sonic & Rispi Sonic Right - Ultrasonic K-Files

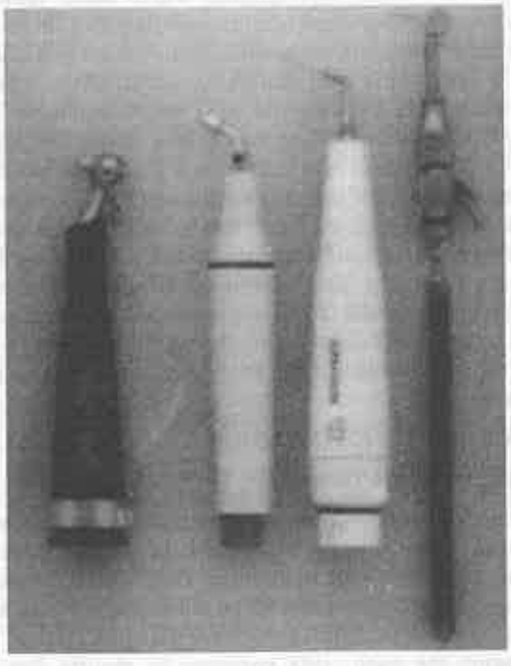


Fig. 2. Handpieces. Left - Sonic. Center - Piezo-electric. Right - Magnetostrictive

change the configuration of motion, the problem would be better solved by changing the canal instruments into a shape that functions better in an oscillating fashion. Ahmad[11] tried substituting K-Flex files for the regular K-Files and found the K-Flex files to be more efficient, but the fact remains that this still does not tackle the core problem of the direction of file oscillation.

Ultrasonics will be of use in root canal preparations if its limitations and characteristics are fully understood. Improper use of ultrasonics may cause straightening or excessive removal of the canal wall, ledging or perforation.

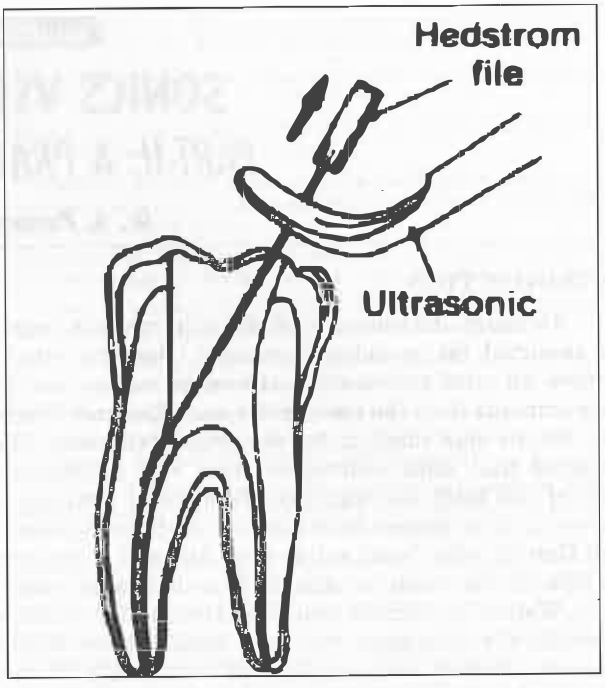


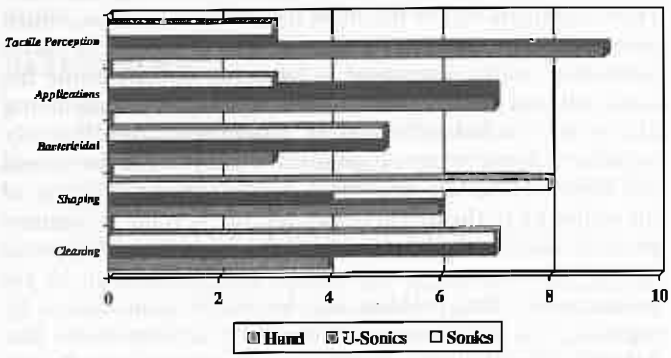
Fig. 3. Silver Point Removal using Ultrasonics.

In curved canals, only size 15 files can be used. Sizes 20 and above have been shown to cause straightening of the canal and apical transportation. In the mesial roots of molars proper care should be shown as ultrasonics may cause strip perforations. It has been reported that many factors such as power setting, the interfacial force between the file and dentin, direction of file oscillation, root canal geometry, type of irrigant and the super imposition of operator assisted movement of the file may affect the final shape of the preparation[12]. Hence, using exclusively ultrasonics for the preparation of root canal may not be a predictable procedure. However, if used judiciously along with hand instruments, ultrasonics may be a useful adjunct for root canal preparations.

The unique oscillatory pattern of sonic files (Refer Part I) has made them a powerful root canal shaping device. As with the ultrasonic canal preparations, these instruments must be free to oscillate in the canal, to rasp away at the walls and to remove necrotic debris and pulp remnants. To accommodate the smallest instrument, size 15, the canal must be first hand instrumented up to size 20. The sonic instruments, with their 1.5-2.0 mm safe tips, begin their rasping action this far removed from the CDJ. This is known as the *'Sonic Length'*. As the instrument becomes loose in the canal, the next size instrument is used thus developing a flaring preparation. The Rispi sonic and the Shaper sonic files are more effective in canal shaping than the Helio sonic[13]. Bolanos et al found that the Shaper files left the least debris in the apical third and the Rispi sonic the least in the middle and coronal thirds[14]. Hence, it is recommended that the Shaper sonic files be used first and that the remaining two thirds of the canal be finished with the Rispi sonic.

In comparing Sonics cutting efficacy with that of ultrasonics, Miserendino[15] noted that the Rispi sonic was

GRAPH I
A Practitioners Guide in comparing
Hand, Ultrasonic and Sonic Systems



GRAPH II
A Practitioners Guide in comparing
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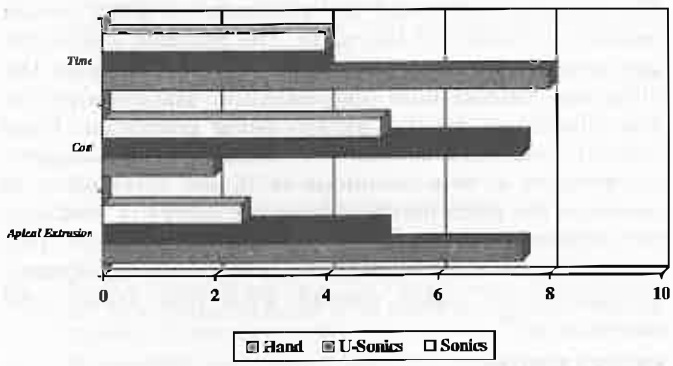

the most efficient followed by Shaper sonic and then the ultrasonic K-file. In straight canals however, the ultrasonic diamond file performed well. The Sonics also cause least amount of straightening of canals when compared with the ultrasonics[16]. The sonic technique also extrudes the least amount of apical debris when compared to hand instrumentation and ultrasonic technique. However, the ultrasonic group fared much better than the hand instrumentation group[17].

Canal Debridement:

Extensive experiments on ultrasonic instruments were carried on at Guy's hospital in London. They thoroughly studied the mechanisms involved and questioned the role cavitation and implosion played in the cleansing process (Refer Part I). They proposed a different physical phenomenon "Acoustic Streaming" to be responsible for the debridement[18]. They pointed out that acoustic cavitation depends on free displacement amplitude of the file and that the vibrating file is dampened in its action by the restraining walls of the canal. An important parameter to note is that the smaller files generate greater acoustic streaming and hence much cleaner canals. Hence, after canals are fully prepared by whatever means it is recommended returning with a fully oscillating No 15 file for 3 minutes with a free flow of 1 – 2.5% sodium hypochlorite. Others[19,20] including Martin have recommended that the No 15 file be used exclusively.

The role of irrigants in ultrasonic debridement was highlighted by Archer[21] who demonstrated an enormous difference in cleanliness between canals merely irrigated during preparation and those canals prepared and then followed by 3 minutes of ultrasonic instrumentation with a No15 file and 5.25% NaOCl. The antibacterial efficacy of irrigants in endosonics was further proved when the viable counts of bacteria dramatically reduced when water as an irrigant was replaced by NaOCl[22].

On comparing the soft tissue debridement scores between hand instrumentation, Sonics and Ultrasonics it was found that no statistically significant difference exists between these techniques when water is used as an irrigant[23]. This observation further reiterates the fact that the most important variable in canal debridement remains the irrigant employed. This is correlated by the excellent debris free fields seen when the canals are ultrasonically debrided using small K-files and half strength sodium hypochlorite (2.6%) for an extended time of 3 minutes[24].

Root end Preparation:

Although conventional endodontic therapy has been shown to be successful in 90% of cases[25], a surgical approach is frequently indicated when a treatment through the canal is not possible. Root end preparation and retrograde filling are commonly performed during endodontic therapy when the quality of the apical sealing is doubtful. Thus, root-end preparation is one of the most crucial factors in achieving success in surgical endodontics[26]. Recently, Ultrasonic retopreparation technique was devised to address the major shortcomings of conventional rotary bur type of preparations[27]. They are increasingly becoming popular and appear to have many advantages, such as more conservative preparations, less need for beveling the root tip (decreasing the chances of micro-leakage), and the ability to prepare the canal farther in a coronal direction from the apex with parallel walls for better retention[28]. The dentin walls are also cleaner with less debris and smear layer. These special retro tips are only ¼ mm in diameter, 3 mm in length, and about 1/10th the size of a conventional microhead handpiece. They are used by placing them in the long axis of the canal and then activating the ultrasonic unit. It vibrates in the range of 30-40 KHz, and a root-end cavity is prepared with parallel walls 2.5 to 3 mm in depth. Continuous irrigation cools the surface and maximizes cutting and debridement. Although ultrasonics have made retropreparation of root apex simpler, easier and more effective, long-term clinical studies are warranted.

Retroprep tips specially designed for periapical surgeries are also available for sonic handpieces. They are available in three standardized sizes (#35, #45, #55) and in two different lengths (2mm, 3mm). Although they are versatile in their angulations and can adapt to the various configurations of the root apex, they are not very effective when compared to the ultrasonic retroprep tips.

Endodontic Retreatment:

1. Intraradicular Post Removal:

Teeth that present with intraradicular posts and periapical infections can be difficult to retreat from a coronal approach. Atraumatic and efficient post removal is essential for optimal non-surgical clinical management. Many techniques have been devised to aid in removal of posts from root canal spaces of which ultrasonics are highly efficient as post removal can be achieved with minimal loss of tooth structure and decreased risk of other root damage[29]. Ultrasonic instrumentation for post removal typically involves removing coronal cement and buildup material from around the post, then activating the tip of the ultrasonic instrument against the metal post. The ultrasound energy transfers to the post and breaks down the surrounding cement until the post loosens and is easily removed. Sonic instruments are ineffective at removing cemented posts. It is possible that the frequency or amplitude of the vibrations play a key role in removing the posts. Regardless of the method of sonic vibration, these instruments cannot be recommended for removal of cemented posts clinically[30].

2. Silver Point Removal:

The tightly fitted, well-cemented silver cone that is flush with the canal orifice is a challenge to remove. In such cases, removal is enhanced through the use of ultrasonic devices. A conservative approach for removing defective silver points has been advocated by Krell[31]. In this technique, a fine Hedstrom file is placed down into the canal alongside the silver point. The file is then enervated by the ultrasonic tip and slowly withdrawn (Fig). A number of tries are usually necessary before the silver point is loosened and retrieved.

Ultrasonics mounted with a No15 file can be used to loosed obstructions and often float them out. Ultrasonics with copious water irrigation along with gentle up and down strokes is quite effective in not only removing silver points and broken files, but spreader and bur tips as well[32].

3. Gutta Percha Removal:

Many endodontists believe that endodontic success depends more on what is taken out of the canal (i.e. bacteria and necrotic tissue) than on what is put in it. The same is true for endodontic retreatment. It is important to remove as much sealer and gutta percha as possible in order to uncover remnants of necrotic tissue or bacteria, which may be responsible for the endodontic failure. Ultrasonic instrumentation alone or with a solvent are as effective as hand instrumentation in removing gutta percha from root canals[33,34] The ultrasonic-chloroform technique may produce residual slurry that may coat the canal wall. In contrast when halothane is employed it results in quick retrieval of the bulk of the filling material and leave minimal residual debris[35]. Although ultrasonic instrumentation requires less time than hand instrumentation to attain the working length, it uses significantly more solvent (chloroform or halothane) because the solvent not only acts as an irrigant but also gets volatilized.

Sealer Placement & Gutta Percha Obturation:

The significance of sealer consistency and placement has not been fully appreciated by the practicing clinician. They constitute one of the most important variables, which determine the success of Endodontic therapy. A novel method of sealer placement is by using an ultrasonic file – run without fluid coolant, of course. A recent study found ultrasonic endodontic sealer placement significantly superior to hand reamer placement[36]. They found the lateral and accessory canals well filled, with a proper coverage of the sealer up to the apical orifice but not beyond. A common problem encountered with this technique is the "whipping up" of the cement in the canal and causing it to set prematurely. This problem can be solved to an extent by replacing the ZnO-Eugenol sealer with a resin sealer like AH-26[37]. The Helio Sonic files are also equally useful for coating the canal wall with sealers and for placing calcium hydroxide pastes.

Moreno[38] first suggested the technique of plasticizing gutta percha in the canal with an ultrasonic instrument. His technique advocated the placement of gutta percha points to virtually fill the canal. The attached endodontic instrument is then inserted into the mass and the ultrasonic instrument is then activated. The gutta percha gets plasticized by the friction being generated. Final vertical compaction is done with hand or finger pluggers. A variation of this technique is in not attempting to plasticize the gutta percha. Ultrasonic energy is used only to condense the gutta percha mass with a spreader. This energized spreading technique leads to a more homogenous compaction of gutta percha with less stress and microleakage[39] .

CONCLUSION

The ultrasonics units, using small K-Files and 2.6% NaOCl for 3 minutes seem to debride the canal best. No technique without NaOCl kills bacteria, however. Ultrasonics also seem to have other potential applications in endodontics, including being an alternative to rotary burs for root end preparations, as an efficient intraradicular post, silver point and gutta percha remover and also for the placement of root canal sealer and as an alternative method of gutta percha obturation. However, these potential benefits need to be further clinically evaluated.

The sonic system enlarges the canal fastest when Rispi or Shaper files are used. They extrude the least amount of peri-apical debris when compared to hand and ultrasonic instrumentation. When combined with hand instrumentation it is a very efficient and fast technique for cleaning and shaping of the root canals consistently. They are also much more economical when compared to ultrasonics and can be easily incorporated into the existing dental unit.

It is apparent that no automated device will answer all needs in cleaning and shaping. Hand instrumentation is essential to prepare and cleanse the apical canal, no matter which device, sonic or ultrasonic is used later. Both ultrasonics and sonics will be a useful adjunct in Endodontics if their limitations and characteristics are fully understood. These devices when used judiciously go

a long way in increasing the speed with which quality endodontics can be practiced. In the end one must evaluate one's practice needs and decide which device suits one's needs.

REFERENCES

1. Haga C.S. Microscopic measurements of root canal preparations following instrumentation. J Br Endod Soc: 1968: 2: 41-46.
2. Gutierrez J.H and Garcia J. Microscopic and macroscopic investigations of results of mechanical preparation on root canals. Oral Surg Oral Med Oral Path: 1968: 21: 108-116.
3. Walton R. Histologic evaluation of different methods of enlarging the pulp canal space, J Endod: 1976: 2: 304-311.
4. Martin H, Cunningham W.T. and Norris J.P. A quantitative comparison of the ability of diamond and K-type files to remove dentin: Oral Surg. Oral Med. Oral Pathol: 1980: 50: 566
5. Walter T. Cunningham and Howard Martin. A scanning electron evaluation of root canal debridement with the endosonic ultrasonic synergistic system: Oral Surg. Oral Med. Oral Pathol: 1982: 53: 527-531.
6. Martin H. Ultrasonic disinfection of the root canal. Oral Surg. Oral Med. Oral Pathol: 1976: 54: 74-76.
7. Cunningham, W.T, Martin H et al. A comparison of antimicrobial effectivemness of Endosonic and hand root canal therapy: Oral Surg. Oral Med. Oral Pathol: 1982: 54: 238
8. Pedicord D et al. Hand versus ultrasonic instrumentation. Its effect on canal shape and instrumentation time: J Endodon: 1986: 12: 375.
9. Walsh C.L et al. The effect of varying the ultrasonic power setting on canal preparation: J Endodon: 1990: 16: 273.
10. Walmsley A.D and Williams. Effects of constraint on the oscillatory pattern of endosonic files: J Endodon: 1989:15:189-194.
11. Ahmad M. Shape of the root canal after ultrasonic instrumentation with K-Flex files: Endodont. Dent. Traumatol: 1990: 6: 104.
12. Roy R.A, Ahmad M and Crum L.A. Physical mechanisms governing the hydrodynamic response of an oscillating ultrasonic file: Int. Endodont. J: 1994: 27: 197-207
13. Dummer P.M.H et al. Shaping of simulated root canals in resin blocks using files activated by a sonic handpiece: Int. Endodon. J: 1989: 22: 211.
14. Bolanos O.R et al. A comparison of engine and air driven instrumentation methods with hand instrumentation: J Endodon: 1988: 14: 392.
15. Miserendino L.J et al. Cutting efficiency of endodontic instruments. Part III - Comparison of sonic and ultrasonic instrument systems: J. Endodon: 1988: 14: 24.
16. Yahya A. S and El Deeb M.E. Effect of sonic versus ultrasonic instrumentation on canal preparation: J Endodon: 1989: 15: 235.
17. Fairbourn D.R. The effect of four preparation techniques on the amount of apically extruded debris: J Endodon: 1987: 13: 102
18. Majina Ahmad, Thomas R. Pitt Ford and Lawrence A. Crum. Ultrasonic Debridement of Root Canals: Acoustic Streaming and its possible role: J Endodon: 1987: 13: 490- 499.
19. Chenail B and Teplitsky P.E. Performance of endosonics in curved root canals: J Endodon: 1985: 11: Abs#44.
20. Chenail B and Teplitsky P.E. Endosonics in curved root canals Part II: J Endodon: 1988: 14: 214.
21. Archer R et al. An in vivo evaluation of the efficacy of ultrasound after step back preparation in mandibular molars: J. Endodon: 1992: 18: 549.
22. Ahmad M et al. Effectiveness of ultrasonic files in the disruption of root canal bacteria: Oral Surg. Oral Med. Oral Pathol: 1990: 70: 328.
23. Walker T.L and del Rio C.E. Histological evaluation of ultrasonic and sonic instrumentation of curved root canals: J. Endodon: 1989: 15: 49.
24. Lev R et al. An in vitro comparison of the step back versus a step back/ultrasonic technique for 1 and 3 minutes: J Endodon: 1987: 11: 523.
25. Sjogren U, Hagglund B, Sundqvist G and Wing K. Factors affecting the long-term results of endodontic treatment: J Endodon: 1990: 16: 498-504.
26. Gartner A.H and Dorn S.O: Advance in Endodontic surgery. Dent Clin North Am: 1992: 36: 357-378
27. Carr G.B. Ultrasonic root end preparation: Dent Clin North Am: 1997: 541
28. Chun Pin Lin et al: The quality of ultrasonic root end preparation: A quantitative study: J Endodon: 1998: 24: 666-670.
29. Krell K.V, Jordan R.D, Madison S and Aquilino S: Using ultrasonic scalers to remove fractured root posts: J. Prosthet Dent: 1986: 55: 46-49.
30. Buoncristiani J, Bradley G. Seto and Angelo A. Caputo. Evaluation of ultrasonic and sonic instruments for intraradicular post removal: J Endodon: 1994: 20: 486-489.
31. Krell K.V et al. The conservative retrieval of silver cones in difficult cases: J Endodon: 1984: 10: 269.
32. Chenail B.L and Teplitsky P.E. Orthograde ultrasonic removal of root canal obstructions: J Endodon: 1987: 4: 186-190.
33. Stamos D. Endosonics: Clinical impressions: J.Endodon: 1985: 11: 181-187.
34. Meidinger D.L, Kabes B.J. Foreign object removal utilizing the Cavi-Endo ultrasonic instrument: J Endodon: 1985: 11: 301-304.
35. Ladley R.W, Campbell A.D, Hicks M.L and Shou-Hua Li. Effectiveness of halothane used with ultrasonic or hand instrumentation to remove gutta percha from the root canal: J Endodon: 1991: 17: 221-224.
36. Jeffrey I.W.M. An investigation into the movement of sealer during placement of gutta percha points: Int. Endodon. J: 1986: 19: 21
37. Hoen M.M et al. Ultrasonic endodontic sealer placement: J Endodon: 1988: 14: 169.
38. Moreno A. Thermomechanically softened gutta percha root canal filling. J Endodon: 1977: 3: 186.
39. Baumgardner K.R and Krell K.V. Ultrasonic condensation of gutta percha. An in vitro dye penetration and scanning electron microscope study: J Endodon: 1990: 16: 253.