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Comparative evaluation of various techniques of biomechanical preparation: A SEM study

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Abstract: *Proper debridement of contaminated system is paramount as a pre condition for successful treatment. This depends on meticulous removal of contaminates from within the anatomic irregularities of root canal. Considering the claim of the new various systems being marketed for effective biomechanical preparation, we carried out the study to evaluate the various techniques available for cleaning and shaping the root canals; viz. hand instrumentation, ultrasonic system and profile system with the help of SEM for proper debridement of canal and opening of dentinal tubules. Profile give maximum result followed by ultrasonic and hand instrumentation.*

Key Words: Hand instrumentation, Ultrasonic system, Profile system, SEM.

Introduction

Current instrumentation techniques are inadequate in completely cleaning the root canal system because of complex internal anatomy and deficiencies in instrument design. Significant alterations of canal morphology occur during the instrumentation of curved canals regardless of the type of enlarging instruments or techniques used. Larger sized files straighten within the canals and cut indiscriminately, creating undesirable alteration in the canals including ledges, strip perforations, zips and transportation. Various instrumentation techniques have been devised and minor changes in the design of files have been suggested to reduce some of these problems. Engine driven systems have also been developed to reduce time and fatigue in canal preparation, but previous studies comparing engine driven systems to hand instrumentation revealed significant problems including premature canal blockage, loss of tactile sensation, poor debridement, canal straightening and breakage. Therefore this study was done to evaluate the various techniques available for cleaning and shaping the root canals; viz. hand instrumentation, ultrasonic system and profile system with the help of scanning electron microscope.

Materials and Methods

Thirty freshly extracted human permanent anterior teeth were taken from 10% formalin and access opening was done just incisal to the cingulum with round bur using air rotor handpiece with air-water coolant spray after dividing the samples into 3 groups of 10 teeth each. The cleaning and shaping of root canals was done with three different systems:

Group 1: Hand instrumentation was done with K-File using crown-down technique.

Group 2: Ultrasonic system was used along with K-files without head using it in a circumferential manner.

Group 3: Profile system was used along with rotary Ni-Ti files using crown-down techniques.

K-File useful instrument in endodontic treatment for the removal of hard tissue during canal enlargement. File was developed by changing some of the principles of designs in an effort to make a more efficient instrument, one that would remove tooth structure faster. The kerr manufacturing company was the adopt k-file. The cross sectional area of the k-files greater than the reamers (Franklin S. Weine 5th edition Endodontic therapy 1996)

A representative instrument is the Enac (Osada electric Co., Inc. Los Angeles, CA). It is a multipurpose ultrasonic device designed to be used not only for root canal preparation but also to scale teeth and to remove cemented cast restoration The frictional heat generated by ultrasonic vibration, warms the NaCl solution which in turn significantly increases its tissue dissolving ability as well as making it a more effective bacterial agent.

The profile Ni-Ti endodontics instruments allow efficient preparation and cleaning of all sections of the root canals. They are designed for continuous rotation at 150-350 RPM in a contra angle, and are eminently suitable for use with the crown down technique. Profile instruments incorporate numerous innovations. They allow simple and quick preparations of root canals, closely respecting the original path of the canal and retaining the original position of the foramen that produces a conveniently tapered opening.

All the samples in the three groups were irrigated during the preparation by sodium hypochlorite and Glyde (EDTA+Carbamide peroxide) was used as lubricant. After the biomechanical preparation samples were cut from the CEJ with the help of carborundum disc. The remaining root was then grooved longitudinally from the buccolingual direction with the help of carborundum disc. The samples were split under liquid nitrogen using plier applying pressure along the buccolingual grooves. Then the samples were prepared for SEM analysis.

Samples were stored overnight in absolute alcohol in order to dehydrate.Then they were placed on blotting paper in order to remove the traces of alcohol. Cellophane paper was placed on the aluminium stubs in such a manner that the prepared root surface was on opposite side of the stub. A silver paint was applied between the sample and aluminium stub. The samples along with aluminium stub were than placed in the sputter coater machine.

Then they were placed in the specimen chamber of the SEM.The samples were then scanned as a whole initially for making the preliminary assessment and uninstrumented root canal surfaces. Representative photomicrographs were taken by focusing at 3000 magnification.

The photomicrographs taken with scanning electron microscope were coded and evaluated by different evaluator by value of percentage of cleaning efficacy, regarding the presence of debris and smear layer of all samples in the different groups. Statistical analyses of the grading was done.

Data analysis

The photomicrographs were qualitatively evaluated by counting the number of debris and calculating the debris value (%). For counting the number of debris a transparent paper of the same size as that of the photomicrographs was taken on transparent paper square of 1 cm^2 was marked with an indelible pencil, then the total number of square of 1 cm^2 each obtained were 70.The transparent paper was placed on each photomicrographs and different evaluator counted by number of debris obtained by three different evaluators.

The debris value (%) was obtained by the following formula:

Debris value (%) = 100×n/70

n= number of debris

The evaluated data provided by 3 different evaluators were taken into consideration for statistical analysis.

Results and Discussion

The data obtained from quantitative analysis of biomechanical preparation of different systems was subjected to statistical analysis using mean, standard deviation, student 't' test and level of significant 'p'. The photomicrographs were qualitatively evaluated by counting the number of debris and calculating the debris value (%).

On statistical analysis of debris value by the 3 different evaluators gives:

Group I was found to be 66.51, SD and SE of ±15.19 and 2.77 respectively.

In the second group the debris value was found to be 35.62, SD and SE of ±4.62 and 0.84 respectively.

In group III the debris value was found to be 9.98, SD and SE of ±3.76 and 0.69 respectively.

Since 'F' is highly significant, hence there is significant difference in debris value (%) of various groups.

The debris value (%) is maximum for hand instrumentation (K-file) then ultrasonic system then profile system.

Debris value (%) Hand Instrumentation (K-file) > Ultrasonic system > Profile system

Hence cleaning efficacy is maximum for the profile system and minimum for the hand instrumentation (K-file).

Cleaning efficacy [Profile system > Ultrasonic system > Hand Instrumentation (K-file)]

Debris values are significantly higher in hand instrumentation than ultrasonic system and profile system.

Table 1. Analysis of debris value (%) in different group.

	Group I Hand instrumentation (k-File)	Group II Ultrasonic system	Group III Profile system
No of samples	10	10	10
Debris value (%)	66.51	35.62	9.98
S.D.	15.19	4.62	3.76
S.E.	2.77	0.84	0.69

Table 2. ANOVA Table for Debris value (%) in different groups.

Source of Variation	D.F	Sum of Square	Mean Sum of Square	F Ratio
Between the groups	2	48062.041	24031.021	F = 270.468
Error	87	7729.935	88.850	P = 0
Total	89	55791.997		

Table 3. Comparison of debris value (%) in different groups.

Comparison	't'	P
Hand Instrumentation (K-file) Vs Ultrasonic System	10.6488	P < .001
Hand Instrumentation (K-file) Vs Profile System	19.7708	P < .001
Ultrasonic System Vs Profile system	23.5585	P < .001

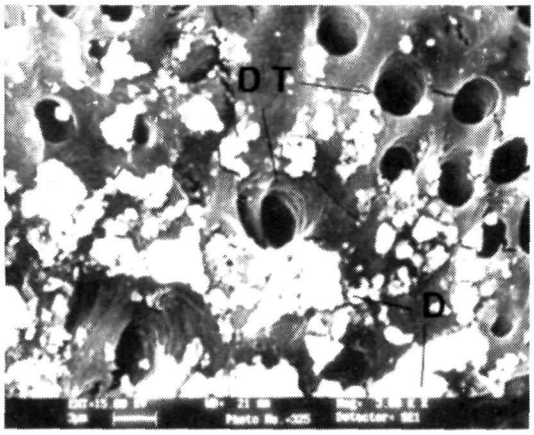

Fig. 1 SEM photomicrograph [x3000] of Hand instrumentation sample [DT-Dentinal Tubule, D-Dentinal Debris]

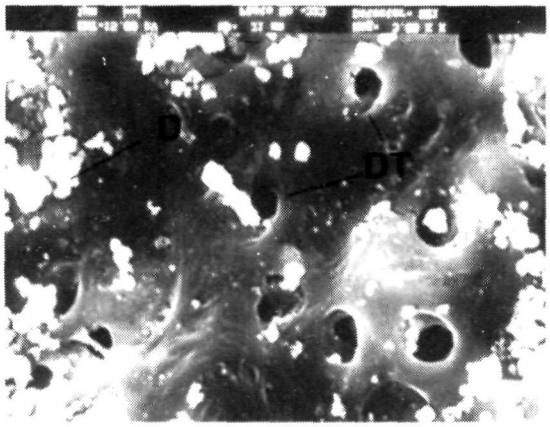

Fig. 2 SEM photomicrograph [x3000] of Ultrasonic system [DT-Dentinal Tubule,D-Dentinal Debris]

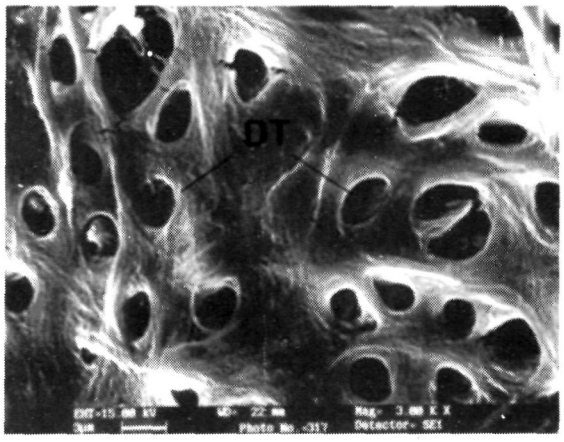

Fig. 3 SEM photomicrograph [x3000] of Profile system [DT-Dentinal Tubule]

Hence cleaning efficacy is higher in ultrasonic system and profile system then hand instrumentation (K-file).

Debris value is significant higher in ultrasonic system then profile system.

Hence cleaning efficacy is higher in profile system then the ultrasonic system.

The study was done on 30 freshly extracted human permanent anterior teeth. The extracted teeth were taken for this study so that root canal preparation can be done ideally in comparison to the previous studies which reported difficulties in canal preparation in patients.

The teeth selected were non-carious and had fully formed apices so that amount of debris should be less from the start. The teeth were cleaned for any calculus or periodontal remnants and placed in 10% formalin so that no anatomic or biological change could take place in the samples. Formalin is 40% of HCHO in aqueous solution. It is markedly bactericidal and sporicidal and also has lethal effect on viruses.The access opening was made just incisal to the cingulum with round bur using air-rotor handpiece at high speed with air-water coolant spray using crown-down technique.The use of ultrasound in relation to endodontics was first described by Richman.(1957). There were no other publications regarding the use of ultrasound in endodontics when Kasai. (1975), reported irrigation of root canals using ultrasonic. Martin (1976), reported ultrasonic disinfection of root canals. David *et al.*, (1986) reported that the instrumentation time is significantly decreased, canal is debrided better, bacteria are killed more readily and there is less post operative pain with this system.

In a study by Glosson *et al.* the light speed instrument overcame many of the pitfalls of previous dentin cause less canal transportation and remained centered in the canal better than K-Flex instruments using a quarter turn/pull

instrumentation techniques. Zmener and Banegas, (1996), compared three instrumentation techniques in the preparation of simulated curved canals. It was found that Rotary Instruments provided well centered and more tapered preparation. Conversely, use of Ultrasonically Energized K-files and Hand Instruments resulted frequent alteration of the original curvature, showing transportation at different level from the working length. Studied a new ultrasonic canal preparation system with electronic monitoring of file tip position. They evaluated the pre and postoperative shapes of the root canals and were using contact micro radiography. They found that using weak power and fine files, straightening, ledge formation and file breakage were minimal. It was concluded that this system minimized the danger of over instrumentation.

Walmsley *et al.,* (1996), studied breakage of ultrasonic root end preparation tips. To determine whether such tips are prone to breakage during use, it was found that fracture of the ultrasonic tips can occur and is related to the degree of bending. Bishop and Dummer (1997), compared the shaping ability of stainless steel Flexofiles and nickel-titanium NiTi Flex files during the preparation of simulated canals in resin blocks. They found the canal preparation using Ni-TiFlex files was significantly quicker ($P < 0.0001$) up to size 30. More instrument failures occurred with Flexofiles compared to Ni-Ti Flex files but there was no statistically significant difference between file type, instrument size or canal shape. Flexofiles created significantly more zips perforations and ledges; there were no differences in terms of danger zones. Overall, canal preparation with NiTi Flex files was more effective and produced more appropriate canal shaped than Flexofiles. Min *et al.,* (1997) investigated structural alterations in resected roots that had root end preparations made with a conventional microhead handpiece and ultrasonics as two intensity levels and by examining root ends were examined with fluorescence confocal microscopy. Root ends were prepared by ultrasonic microscopy. The result indicated that root ends were prepared by ultrasonic had a statisticaly greater number of fractures than both the control and conventionally prepared groups.

Roig-Cayon *et al.,* (1997) compared six different instruments (Flexofile, canal matter U, Heliapical, flexogate, Ultraflex, and Lightspeed). The best results were obtained with nickel-titanium, a short cutting blade and a rotary rather than a filing motion. The Canal master U, Flexogate, and Lightspeed instruments had significantly more round canals than the Flexofile, Heliapical and ultraflex instruments at all levels. Instrumentation time was also recorded, the canal master U and R flexogate was found to be significantly slower than the flexo or file, heliapical, ultraflex, and Light speed instruments. Chou *et al.,* (1997) compared the cleanliness of root end preparations made using ultrasonic instrumentation with that of those prepared in a traditional manner using a microhandpiece bur. The ultrasonic preparation had significantly less superficial debris and a thinner smear layer than the microhandpiece preparation ($pH < 0.05$). There was no significant differences between the canal and isthmus portions of the root end preparations within each group in either superficial debris or smear layer, indicating that cleaner surfaces for root end cavities are created using utrasonic retro tips than using microhandpiece burs. Siqueira Junior *et al.,* (1999) evaluated the reduction of the bacterial population in the root canal by the mechanical action of instrumentation and irrigation. The results of this study showed that the instrumentation and irrigation can mechanically remove more than 90% of bacterial cells from the root canal.

Conclusion

In the present study we evaluated the cleaning efficacy in three different systems and found that the cleaning efficacy is significantly better in profile system compared to ultrasonic system and hand instrumentation (K-File). The cleaning efficacy in the ultrasonic system is significantly better compared to hand instrumentation. The cleaning efficacy is least to Profile system and ultrasonic system. In the coronal one-third middle one-third and apical one-third of root canal respectively the cleaning efficacy of profile system was seen to be best, while that of hand instrumentation (K-file) was the least.

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