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ORIGINAL RESEARCH

An *in vitro* Study to Compare the Effectiveness of F-file with Ultrasonically Activated K-file to Remove Smear Layer by using a Scanning Electron Microscope

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ABSTRACT

Aim: The aim of this study was to compare the effectiveness of the F-file with an ultrasonically activated #15 K-file in removing the smear layer after biomechanical instrumentation along with irrigation of Saline, NaOCl and with or without a flush of EDTA.

Materials and methods: Sixty decoronated human premolar teeth with a single canal were instrumented with ProTaper using S1, S2 and F1 series to produce the smear layer and randomly divided into two groups. Group A used Ultrasonics and group B used F-file for activation of irrigants respectively. Each group was further divided in to three subgroups consisting of 10 teeth in each as I, II, III consisting of saline, NaOCl, NaOCl and EDTA as irrigants respectively. SEM micrographs were taken and amount of smear layer removal was analyzed by using Chi-square statistics tests.

Results: Most effective smear layer removal was seen only when EDTA was used. There was no statistically significant difference between the groups A and B in removal of smear layer.

Conclusion: There was no increase in smear layer between use of F-file when compared with the Ultrasonically activated K-file.

Clinical significance: The F-file although does not have a superior efficacy than the ultrasonics in removal of smear layer from root canals but when used along with EDTA, can be an effective alternative for the dentists who are unable to bear the initial setup cost of ultrasonics.

Keywords: F-file, Smear layer, Scanning electron microscope, Primary research.

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INTRODUCTION

Success in endodontic treatment depends on adequate preparation of the root canal space.[1] Related factors in achieving this success such as reduction in the number of organisms and obturation of the root canal system are dependent on thorough root canal debridement.[2] The smear layer which is formed during instrumentation has been shown to prevent the penetration of intracanal disinfectants and sealers into the dentinal tubules, which may result in compromised seal of the root filling.[3-5] Many studies have confirmed that the removal of the smear layer is said to enhance the success of endodontic treatment.[6]

Sodium hypochlorite (NaOCl) still remains the most effective endodontic irrigant[7,8] because of its ability to dissolve tissue, its broad antimicrobial spectrum and high efficacy against obligate and anaerobic facultative microorganisms.[9,10] Use of ultrasonics and sonics systems has shown to increase the efficacy of NaOCl in removing the canal debris due agitation of the irrigant.[11] However, it is also shown that traditional mechanical preparations in conjunction with needle irrigation with different concentrations of NaOCl still do not predictably render a root canal free of bacteria.[11-13] It has been shown by several authors that Ethylenediaminetetraacetic acid (EDTA) containing chelating agents may be partially responsible for effective cleaning of the canal walls after mechanical instrumentation with files.[14,15] But it has also been documented that some canal debris still persist after use of different types of endodontic file system even in conjunction with NaOCl and EDTA.[16]

F-file by Plastic Endo, a plastic rotary finishing file which is presterilized, single-use, plastic rotary file having a unique design with a diamond abrasive embedded into a nontoxic polymer. This file was designed to remove dentinal wall debris and agitate the sodium hypochlorite without further enlarging the canal. The file tip is equivalent to a size #20 K-file, and it has a taper 0.04. The F-file was designed to

be as effective as sonic and ultrasonic instrumentation and to be used as a replacement.[17] However, there is a need to investigate the F-file's effectiveness to remove the smear layer.

The objective of this study was to compare the effectiveness of the F-file with an ultrasonically activated #15 K-file in removing the smear layer after biomechanical instrumentation along with irrigation of Saline, NaOCl and with or without a flush of EDTA.

MATERIALS AND METHODS

Sixty extracted human premolar teeth with a single canal were used in this study. The presence of a single canal was verified with two digital radiographs in a mesiodistal and a buccolingual direction. The teeth were decoronated at the cementoenamel junction with a rotary diamond disk. Working length was determined by passively placing a #10 K-file (Dentsply Maillefer) in the canal until the tip of the instrument visibly penetrated and was adjusted to the apical foramen. The actual canal length was measured and the working length was calculated by subtracting 1 mm from this measurement. The canal were instrumented with ProTaper using S1, S2 and F1 series to a tip size of #20 to produce the smear layer. After canal preparation, the teeth were randomly divided into two groups consisting of thirty teeth each. Each group is further divided in to three subgroups consisting of ten teeth in each. The irrigants were introduced into the canal by needle syringe delivery.

- Group A – irrigating solutions were activated by using #15 K-file under ultrasonic vibration for 1 minute.
  - Subgroup I –10 ml saline was used as an irrigating solution
  - Subgroup II –10 ml of 5.25% NaOCl was used as an irrigating solution
  - Subgroup III –10 ml 5.25% NaOCl followed by a final flush of 10 ml 17% EDTA as an irrigating soultion
- Group B – irrigating solutions were activated by using F-file (PlasticEndo, Buffalo Grove, IL) for 30 seconds at 600 rpm in the electric slow speed rotary handpiece (Dentsply Tulsa Dental). A new F-file was used for each canal.
  - Subgroup I –10 ml saline was used as an irrigating solution
  - Subgroup II – 10 ml of 5.25% NaOCl was used as an irrigating solution
  - Subgroup III – 10 ml 5.25% NaOCl followed by a final flush of 10 ml 17% EDTA as an irrigating solution.

After preparation and irrigation, the specimens were fractured with a chisel and prepared for the scanning electron microscopy (SEM). The samples were then viewed in their entirety in a SEM. SEM micrographs were obtained at 1000 × magnification of the coronal, middle, and apical areas of each root canal using digital image analysis software. Each micrograph was scored blind for the amount of smear layer using a semiquantitative scale by two independent evaluators using a 4-step scale as follows:

0. All tubules visible
1. More than 50% of tubules visible
2. Less than 50% of tubules visible
3. No tubules visible.

The removal of smear layer from the root canals was analyzed by using Chi-square statistics tests.

RESULTS

There was no statistically significant difference between two groups in the efficacy of removal of smear layer (Figs 1 to 6).

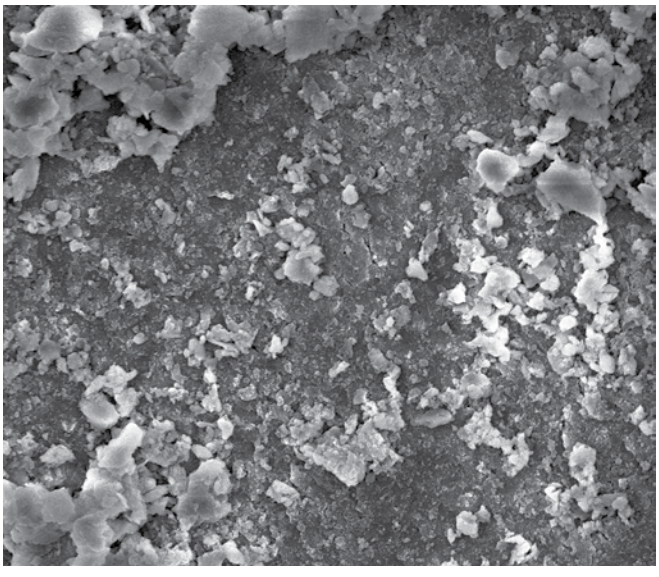


Fig. 1: Scanning electron micrographs of the middle aspect of root canals after using Ultrasonics with Saline

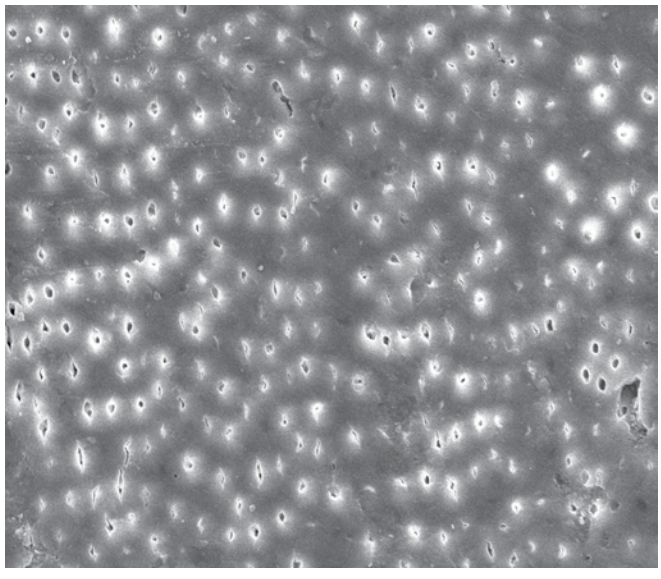


Fig. 2: Scanning electron micrographs of the middle aspect of root canals after using Ultrasonics with 5.25% NaOCl

However, there was a statistically significant difference between each subgroups in the same group (Figs 7 and 8). In both the groups the maximum amount of smear layer removal was found when EDTA was used as an irrigant ($p < 0.001$). In each subgroup around 80% of samples root canal was completely covered with smear layer when only saline was used as irrigant. When NaOCl was used around 26% samples had less than 50% of tubules visible. But when EDTA was used , around 26 to 31% samples showed complete canal opening in both the groups and around 50 to 60% samples had more than 50% tubules visible (Figs 7 and 8). There was also higher amount of smear layer removal seen in the coronal area than the apical area irrespective of the type of agitation method used in the groups (Figs 9 and 10).

DISCUSSION

There is around 50% reduction of bacterial count when only the mechanical instrumentation of root canal is done. In the remaining inaccessible areas, the irrigant have major role in achieving the enhanced disinfection of root canal. Although the NaOCl has been widely used but it has been documented that EDTA containing chelating agents are more efficient in removing smear layer than the other irrigants.[14] There are different irrigant agitation techniques proposed to increase the efficacy of these irrigant solutions which may include techniques like manual agitation with hand files, manual agitation with gutta-percha cones, sonic and ultrasonic agitation.[11]

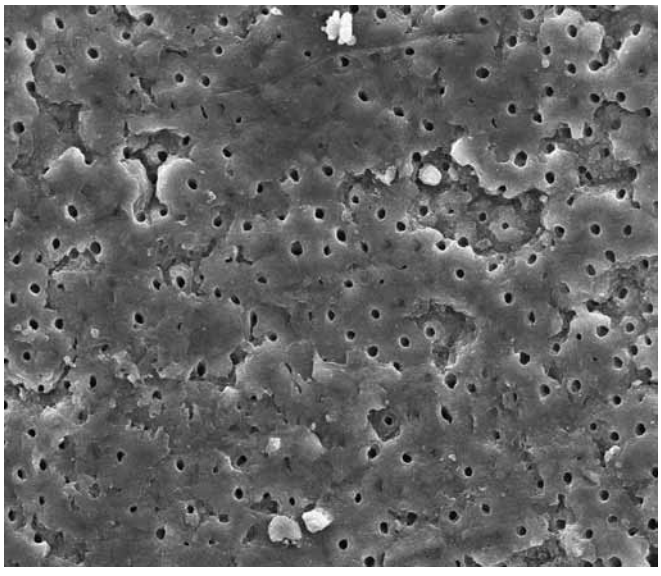


Fig. 3: Scanning electron micrographs of the middle aspect of root canals after using Ultrasonics with 5.25% NaOCl and 17% EDTA

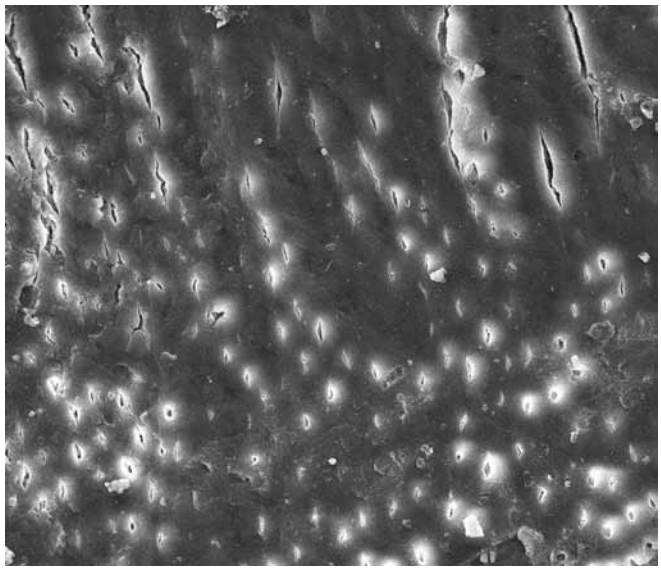


Fig. 5: Scanning electron micrographs of the middle aspect of root canals after using F file with 5.25% NaoCL

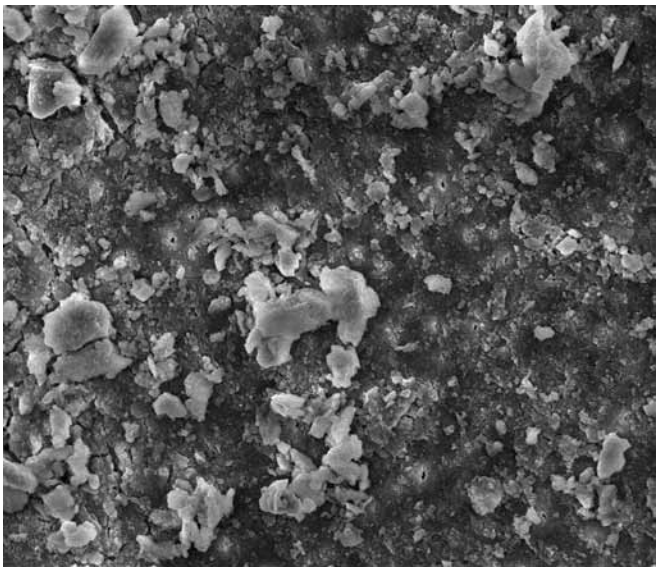


Fig. 4: Scanning electron micrographs of the middle aspect of root canals after using F file with Saline

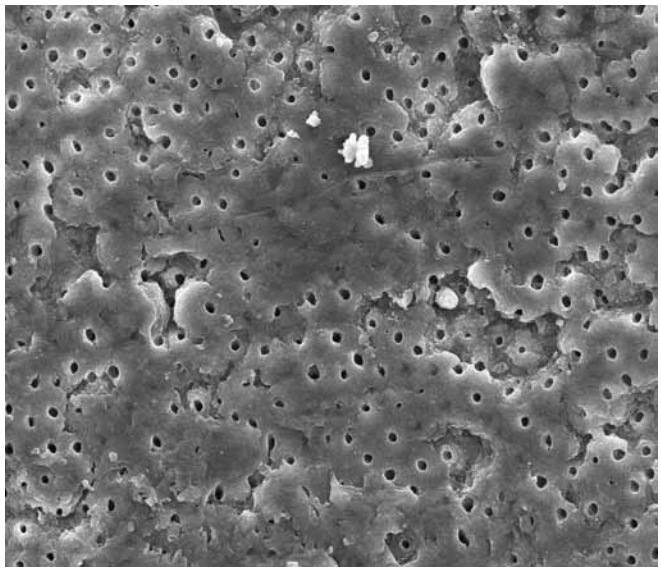


Fig. 6: Scanning electron micrographs of the middle aspect of root canals after using F file with 5.25% NaoCL and 17% EDTA

Plastic F-file (Fig. 11) chiefly works on mechanical agitation of these irrigants which increases the efficacy to remove smear layer. In the current study, it was found that, cleaner canals with greater numbers of visible dentinal tubules in SEM micrographs were obtained when final flush with 10 ml 17% EDTA was used (Subgroup III). This suggested that flushing the root canals with high volumes of EDTA had a greater potential to remove smear layer than ultrasonic activation and the F-file when used without EDTA. The 30 seconds difference between the use of F-file and ultrasonic K-file treatment between both the groups (Groups A and B) did not influence smear layer removal in the present study. A similar result was also found in a similar type of study done by Sonia Chopra, Peter E Murray and Kenneth N Namerow which concluded that smear layer removal appears to be mostly influenced by the introduction of an EDTA rinse.[18]

These observations are also in agreement with previous studies that have shown chelating agents, such as SmearClear (SybronEndo, Orange, CA), 17% EDTA, or 10% citric acid, are needed to remove the smear layer after NaOCl irrigation.[19]

A study by Cameron Townsend and James Maki found that Ultrasonic, EndoActivator, F-file, and sonic agitation are similar in their ability to remove bacteria in a plastic simulated canal.[20]

Another study by Raffaele Paragliola et al which used dentinal tubule dye penetration method with ultrasonically activated K-file, F-file, EndoActivator, Satelec, EMS was found that ultrasonic agitation has increased effectiveness in final rinse procedure in the apical third of the canal walls than other methods.[21]

The reason for less efficacy of F-file in removal of smear layer may be due to absence of cavitation and acoustic streaming mechanisms which may be responsible for higher efficacy of ultrasonics than the other method.[22]

Many studies[18,20,21] have already proven that the efficacy of the F-file in removing the smear layer is equal or inferior but not superior to ultrasonic activation of file. Also its

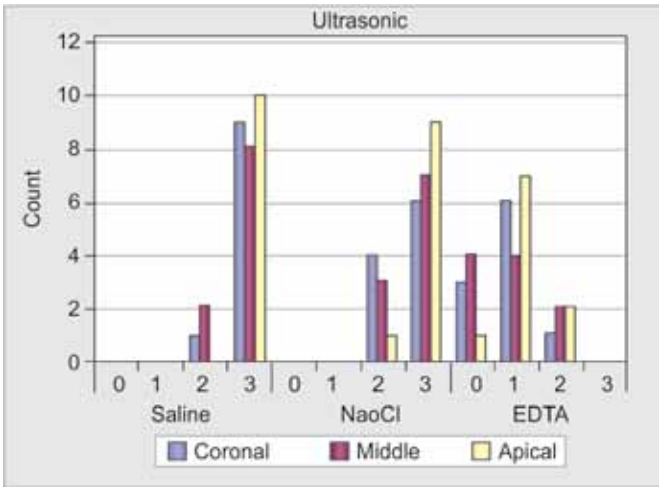


Fig. 7: Bar chart of smear layer removal from the apex, middle, and coronal aspects of root canals after F file activation of irrigants

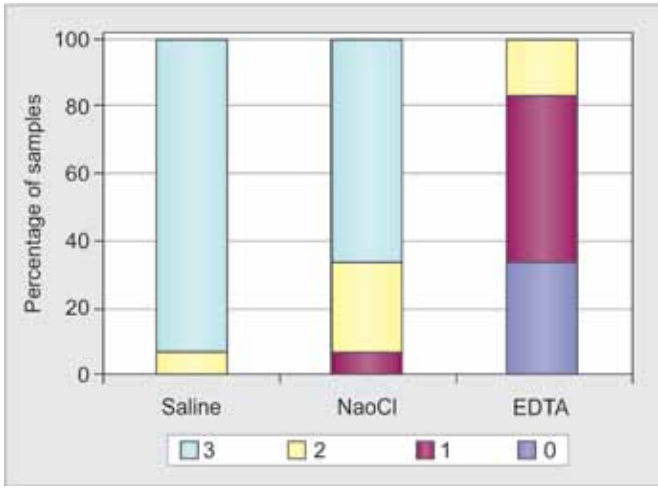
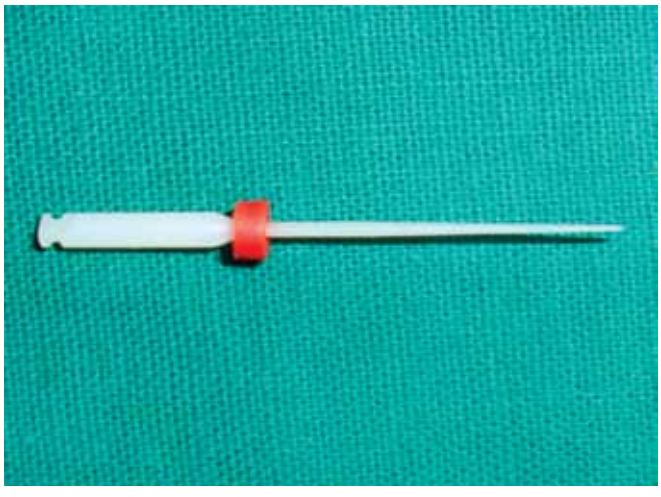


Fig. 9: Smear layer removal after root canal instrumentation with use of Ultrasonic for the activation of irrigants



Fiig. 8: F file, Plastic Endo, LLC

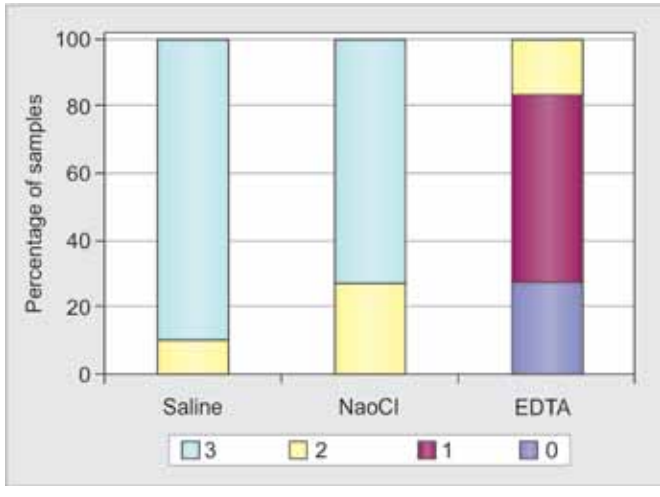


Fig. 10: Smear layer removal after root canal instrumentation with use of F file for the activation of irrigants

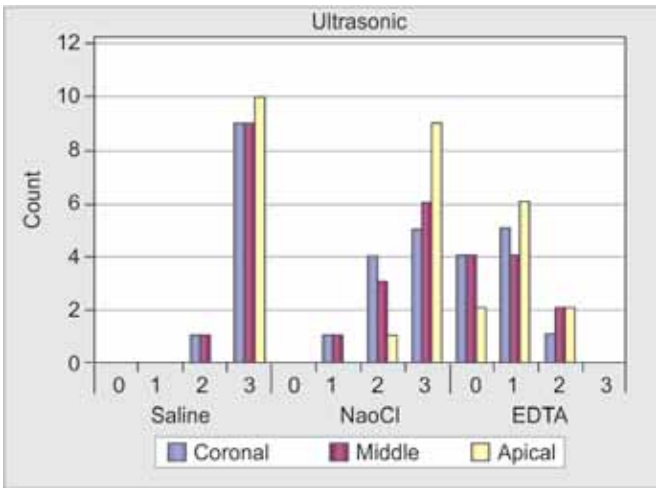


Fig. 11: Bar chart of smear layer removal from the apex, middle, and coronal aspects of root canals after ultrasonic activation of irrigants

efficacy in more curved and smaller size prepared canals needs to be further studies.

CONCLUSION

Hence the study concludes that there was no increase in smear layer removal by using the F-file when compared with the ultrasonically activated K-file. However, further research is needed to find its efficacy in complex root canal anatomy

CLINICAL SIGNIFICANCE

The F-file although does not have a superior efficacy than the ultrasonics in removal of smear layer from root canals but when used along with EDTA , can be an effective alternative for the dentists who are unable to bear the initial setup cost of ultrasonics.

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