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ORIGINAL ARTICLE

Efficacy of 17% Ethylenediaminetetraacetic acid with Shortened Irrigation Time on Smear Layer Removal after Rotary Canal Instrumentation: An *in vitro* Study

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ABSTRACT

Context: A search in the endodontic literature showed the absence of any reports regarding use of 17% ethylenediaminetetraacetic acid (EDTA) to remove smear layer at shortened irrigation time.

Aim: To determine the efficacy of 17% EDTA with shortened irrigation time on smear layer removal after ProTaper rotary canal instrumentation.

Materials and methods: Twenty single-rooted lower premolar teeth were randomly divided into two experimental groups. After decoronation of all the samples working length was determined and all the teeth were instrumented to master apical size #30 (F3), using ProTaper rotary files. Teeth were irrigated with 3% NaOCl during instrumentation.

Experimental groups I and II were irrigated with 1 mL final rinse using 17% EDTA for 1 minute and 30 seconds respectively, followed by rinse with 3 mL of 3% NaOCl. After irrigation, all root canals were dried with absorbent paper points.

The teeth were then sectioned longitudinally and prepared for a scanning electron microscopic (SEM) examination. The SEM photographs were evaluated using a standard scoring system developed by Rome et al.

Statistical analysis: Results were statistically analyzed using Mann–Whitney test.

Results: When intercomparison was made between groups I and II at the coronal and middle third, statistically significant difference was observed, with group I having significantly less smear layer than group II.

At the apical third, no statistically significant difference was observed between groups I and II, even though smear layer removal was more in group I than group II.

Conclusion: Effective smear layer removal was not possible with shortened irrigation time using 17% EDTA.

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Key messages: Depending on the canal master apical size, curvature, and taper, it appears the optimal regimen for effectively removing the smear layer in root canals is 1 mL of final rinse using 17% EDTA for 1 minute.

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INTRODUCTION

The success of root canal therapy (RCT) depends on the debridement of diseased tissue, elimination of bacteria present in the canals including dentinal tubules, and prevention of recontamination after treatment. These objectives are achieved by thoroughly cleaning, shaping, and disinfecting the root canal system followed by a three-dimensional (3D) obturation.[1]

Studies have shown that cleaning and shaping root canals produce a smear layer that covers the instrumented walls.[2] During canal preparation, dentin chips created by action of endodontic instruments add to the remnants of organic material, forming a smear layer that adheres to canal walls. This layer is made up of organic matter and dentin particles and can form two zones: The first, 1 to 2 µm thick layer on the surface of canal walls; the second, extending into dentinal tubules to a depth of 40 µm.[3]

An *in vitro* study showed the importance of removal of the smear layer and the presence of patent dentinal tubules for decreasing the time necessary to achieve the disinfecting effect of intracanal medications.[4] It has been shown that the presence of a smear layer can inhibit or significantly delay the penetration of antimicrobial agents, such as intracanal irrigants and medications into the dentinal tubules.[5] It has been substantiated that better adhesion of obturation materials to the canal walls occur after removal of the smear layer.[6] Recent systematic review and meta-analysis of leakage studies concluded that removal of smear layer improves the fluid tight seal of the root canal system.[7]

There are various methods to eliminate smear layer in clinical practice, which include chemical, mechanical, and by means of laser. Irrigation of root canal system is one of the chemical means to remove the smear layer and also a critical adjunct in debridement. Irrigation serves as a physical flush to remove debris and ideally should also act as bactericidal agent, tissue solvent, and lubricant. Alternating use of EDTA and NaOCl is an effective method for smear layer removal,[8] while EDTA removed the inorganic portion, the NaOCl effectively eliminated the organic part.

The contact time studied for removal of smear layer with 17% EDTA ranges from 1 to 10 minutes. 17% EDTA when irrigated for 2 minutes completely removed the smear layer, but intertubular and peritubular erosion was observed.[9] The purpose of this *in vitro* study on extracted tooth is to determine efficacy of 17% EDTA with shortened irrigation time on smear layer removal after ProTaper rotary canal instrumentation.

MATERIALS AND METHODS

Twenty single-rooted lower premolar human teeth extracted for periodontal reasons were used in this study.

The crowns of all 20 mandibular premolar teeth were severed at proximal cementoenamel junction. The canal patency was determined by passing no. 10 k-file into the root canal until the tip of the file was visible at the apical foramen. The teeth were randomly divided into two experimental groups of 20 teeth each. The working lengths was established by placing #10 file into the root canal until it was visible at the apical foramen, then 1 mm was subtracted from that length. The root canals were instrumented in a crown down technique using ProTaper rotary files (Dentsply, Maillefer, Switzerland) to master apical size #30 (F3), irrigating with 1 mL of 3% NaOCl.

Experimental groups I and II were irrigated with 1 mL final rinse using 17% EDTA for 1 minute and 30 seconds respectively. After irrigation, all root canals were dried with absorbent paper points.

The teeth were then sectioned vertically along the long axis. To ensure that the sectioning process did not damage the inside of the canal, the sectioning was done with water cooled diamond disk along the root, thereby creating a straight canal. A chisel was used to wedge and split the teeth.

One half of each tooth was selected randomly and placed in a 2% glutaraldehyde solution for 12 hours. Then using graded concentration of ethanol starting from 30 and then 50, 70, 90, and 100% the specimens were dehydrated. The specimens were fixed on an aluminum stub for gold ion sputtering. Then the specimens were viewed under scanning electron microscope (SEM) at 10 KV accelerating voltage. After a general survey of the entire canal wall, photomicrographs were taken at 1000× magnification of representative area of the coronal, middle, and apical third of canal. The photomicrographs of the cervical third, middle third, and apical third were taken and compared. The SEM photographs were evaluated using scoring system:[11]

0 = No smear layer, dentinal tubules open, free of debris.
1 = Moderate smear layer, outlines of dentinal tubules visible or partially filled with debris.
2 = Heavy smear layer, outlines of dentinal tubules obliterated.

The results were statistically analyzed using Mann–Whitney U test.

RESULTS

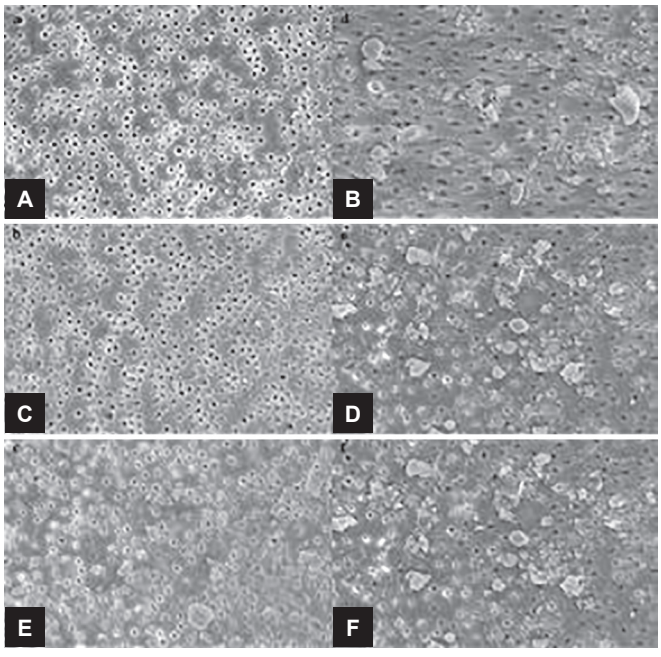
Scanning electron microscopic images of various regions of canals are shown in Figure 1. When comparing the smear layer removal in the cervical third, 80% of specimens in group I were free of smear layer and 20% with few areas covered with smear layer (Fig. 1A). In group II, 30% of the specimens were free of smear layer and 70% with few areas covered by smear layer (Fig. 1D). None of the samples had all or most of the area covered by smear layer. When comparison was made between groups 1 and 2 at the coronal third (Table 1), statistically significant difference ($p < 0.05$) was observed, with group I having significantly less smear layer than group II.

The smear layer removal at the middle third, 80% of specimen in group I was free of smear layer and 20% with few areas covered by smear layer (Fig. 1B). In group 2, 20% of the specimens were free of smear layer and 80% with few areas covered by smear layer (Fig. 1E). Comparison at the middle third showed that group I having significantly less smear layer than group 2 (Table 1).

In apical third, 90% of specimen in group I had few areas covered with smear layer and 10% of specimen had all the areas covered by smear layer (Fig. 1C). In group II, 80% of the specimens had few areas covered by smear layer and 20% with all the area covered by smear layer (Fig. 1F). No statistically significant difference ($p < 0.05$) was observed between the two groups; even though smear layer removal was more in group I than group II (Table 1).

DISCUSSION

Root canal system presents a unique site where soft and hard tissue of infected tooth needs to be debrided and rendered bacteria-free prior to obturation of the canals. Therefore, the removal of diseased tissue, elimination of bacteria present in the canals and dentinal tubules, and



Figs 1A to F: Scanning electron microscopic images: (A) Coronal third of specimen irrigated with 17% EDTA for 1 minute; (B) middle third of specimen irrigated with 17% EDTA for 1 minute; (C) apical third of specimen irrigated with 17% EDTA for 1 minute; (D) coronal third of specimen irrigated with 17% EDTA for 30 seconds; (E) middle third of specimen irrigated with 17% EDTA for 30 seconds; and (F) apical third of specimen irrigated with 17% EDTA for 30 seconds

Table 1: Results of Mann-Whitney test in various regions of canal

Comparison of treatment with 17% EDTA w.r.t. time in various regions of canal	*Mann–Whitney value*	*p-value*
Cervical region	25.000	0.028
Middle region	20.000	0.009
Apical region	45.000	0.542

prevention of recontamination after treatment are the objectives of endodontic therapy. These objectives are achieved by thoroughly cleaning, shaping, and disinfecting the root canal system. Although instrumentation of root canal is the primary method of canal debridement, irrigation is a critical adjunct. Irrigation serves as a physical flush to remove debris as well as serving as a bactericidal agent, tissue solvent, and lubricant. Furthermore, some irrigants are effective in eliminating the smear layer.[10] The present study was aimed to evaluate the efficacy of 17% EDTA with shortened irrigation time on smear layer removal.

CONCLUSION

Based on the results of the present study, it can be concluded that optimal regimen for effectively removing the smear layer in root canals is a final rinse with 1 mL of 17% EDTA for 1 minute followed by rinse with 3 mL of 3% NaOCl.

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