

Comparative Analysis of Efficacy of Different Final Irrigating Solutions on Smear Layer Removal in Apical Third Of Root Canal

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ABSTRACT

Background: The success of endodontic therapy relies on proper biomechanical preparation, disinfection and three-dimensional obturation of the root canal system. During cleaning and shaping of the root canal system, mechanical instrumentation leaves a smear layer covering the dentinal walls. Mechanical instrumentation, therefore, must be supplemented by irrigation to keep the canal wall lubricated, to remove/kill microorganisms, and to dissolve pulp remnants and infected predentin from root canals and ramification. Irrigation has a major influence on removal of smear layer as well. A number of chemicals have been investigated as irrigants to remove the smear layer, for example, sodium hypochlorite (NaOCl), ethylenediaminetetraacetic acid (EDTA), citric acid, etc.

Materials and methods: The present study was conducted in the Department of Endodontics of the dental institution. This study was conducted in-vitro. A total of 30 single rooted human maxillary central incisors were selected for the study, They were decoronated to get the stable reference point and to standardize the root canal length of 14 mm. Patency of the root canal is established by passing a stainless steel number 15 K-file just beyond the apex of all canals. Working lengths were determined by subtracting 1 mm from that length. Canals were prepared using ProTaper rotary system.

Results: In the present study, a total of 30 single rooted maxillary central incisors were used for evaluation of efficacy of saline, EDTA and MTAD as final irrigants for apical third of root canal. It was observed that the efficacy of saline was lowest as it was not able to remove smear layer. The most efficacious irrigating solution was MTAD. The results on comparison were statistically significant.

Conclusion: Within the limitations of the present study, it can be concluded that MTAD was more effective in smear layer removal than EDTA and saline in the apical third.

Keywords: Smear removal, endodontic treatment, root canal, EDTA.

INTRODUCTION

The success of endodontic therapy relies on proper biomechanical preparation, disinfection and three-

dimensional obturation of the root canal system. During cleaning and shaping of the root canal

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system, mechanical instrumentation leaves a smear layer covering the dentinal walls.^{1,2,3} The first researchers to describe the smear layer on the surface of instrumented root canals were McComb and Smith.¹ They suggested that the smear layer consisted not only of dentin, as in the coronal smear layer, but also the remnants of odontoblastic processes, pulp tissue and bacteria. Mader et al. reported that the smear layer thickness was generally 1-2 μm .³ During cleaning and shaping procedure, mechanical instrumentation leads to the formation of an amorphous, granular, and irregular layer covering root dentin and occluding the orifices of dentinal tubules known as "smear layer" that contains organic and inorganic material.¹ The smear layer prevents the penetrations of intracanal medicament and sealers into the dentinal tubules. Hence, removal of smear layer improves the fluid-tight seal during obturation of the root canal systems.⁴ Mechanical instrumentation, therefore, must be supplemented by irrigation to keep the canal wall lubricated, to remove/kill microorganisms, and to dissolve pulp remnants and infected predentin from root canals and ramification.⁵ Irrigation has a major influence on removal of smear layer as well.⁵ A number of chemicals have been investigated as irrigants to remove the smear layer, for example, sodium hypochlorite (NaOCl), ethylenediaminetetraacetic acid (EDTA), citric acid, etc. Hence, the present study was conducted to compare efficacy of different final irrigating solutions on smear layer removal in apical third of root canal.

MATERIALS AND METHODS

The present study was conducted in the Department of Endodontics of the dental institution. The ethical clearance for the study was approved from the ethical committee of the hospital. This study was conducted in-vitro. A total of 30 single rooted human maxillary central incisors were selected for the study, They were decoronated to get the stable reference point and to standardize the root canal length of 14 mm. All specimen teeth were randomly divided into four groups with 10 teeth in each group as follows:

- Group 1: Saline.
- Group 2: EDTA.
- Group 3: BioPure MTAD.

Patency of the root canal is established by passing a stainless steel number 15 K-file just beyond the apex of all canals. Working lengths were determined by subtracting 1 mm from that length. Canals were prepared using ProTaper rotary system. Each canal was prepared up to an apical preparation of #F3. Three percent NaOCl irrigant was used between each subsequent file size in all experimental groups while saline was the sole irrigant in Group 1. To determine the effects of final irrigating solutions on the surface of root canals after instrumentation, the canals were treated with 5 ml of the respective irrigant for 3 min. The irrigating solution was delivered using a 30-gauge side-vented needle passively placed to within the apical third of the root canals. The canals were then dried with paper points. Nonpenetrating grooves were made in all specimen teeth at the cement-enamel junction (CEJ) and longitudinally on the buccal and lingual aspects. The teeth were then longitudinally split into two halves using chisel and mallet and the half containing the greater part of the apex was selected as the representative sample for each group and they were evaluated under high power microscope. The amount of smear layer remaining on the surface of the root canal and dentinal tubules was scored according to a three score system developed by Torabinejad et al.

- Score 1: No smear layer — No smear layer was detected on the surface of the root canal, and all tubules were open.
- Score 2: Moderate smear layer — No smear layer on root canal walls but tubules contained debris.
- Score 3: Heavy smear layer — Smear layer covered the root canal wall surface and the tubules.

The statistical analysis of the data was done using SPSS version 11.0 for windows. Chi-square and Student's t-test were used for checking the significance of the data. A p-value of 0.05 and lesser was defined to be statistically significant.

Results:

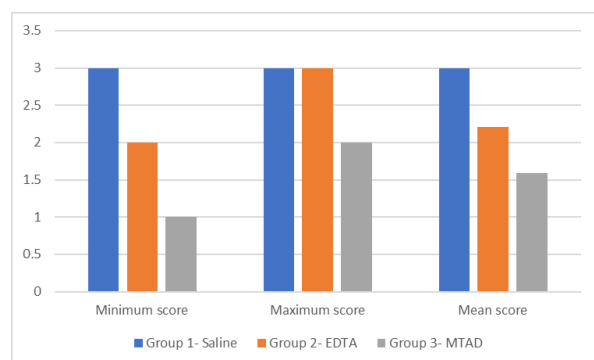
In the present study, a total of 30 single rooted maxillary central incisors were used for evaluation of efficacy of saline, EDTA and MTAD as final

irrigants for apical third of root canal. It was observed that the efficacy of saline was lowest as it was not able to remove smear layer. The most efficacious irrigating solution was MTAD. The results on comparison were statistically significant. ($p < 0.05$) [Fig 1]

Table 1: Comparison of smear layer scores between Group 1, 2 and 3.

Group	Minimum score	Maximum score	Mean score	p-value
Group 1- Saline	3	3	3.00	0.02
Group 2- EDTA	2	3	2.21	
Group 3- MTAD	1	2	1.59	

Fig 1: Comparison of smear layer scores between Group 1, 2 and 3.



DISCUSSION

In the present study, we observed that MTAD is the most efficacious final irrigant solution when compared with EDTA and saline. MTAD group had lowest mean score for smear layer. EDTA was also fairly efficacious in removal of smear layer. The saline was least efficacious. On comparison, the results were found to be statistically significant. The results were compared with previous studies and were found to be consistent. Purakkal AT et al ⁷ compared the smear layer removal efficacy of different final irrigants from the coronal, middle, and apical third of the root canals of primary teeth using field-emission scanning electron microscopy. Sixty therapeutically extracted human single-rooted primary teeth were prepared by step-back technique. Prepared teeth were randomly divided into six groups ($n = 10$): MTAD (Group I),

TetraClean (Group II), QMix (Group III), 0.9% normal saline (Group IV), coconut water (Group V), and 5.25% NaOCl (Group VI). Among the six irrigants QMix 2 in 1 showed the best smear layer removal efficacy, followed by 5.25% NaOCl, TetraClean, MTAD, coconut water, and the least efficacy was for normal saline. Patil PH et al ⁸ compared the smear layer removal efficacy of etidronic acid-based irrigating solution with others in the apical third of the root canal. Forty human single-rooted mandibular premolar teeth were taken and decoronated to standardize the canal length. After biomechanical preparation, teeth were randomly divided into four groups ($n = 10$) and the final irrigation was carried out with tested irrigants. Group I: normal saline (negative control); Group II: 5.25% sodium hypochlorite (NaOCl) with surfactant and 17% ethylenediaminetetraacetic acid (EDTA) with surfactant; Group III: freshly mixed BioPure MTAD; and Group IV: freshly mixed Chloroquick solution. Group II (5.25% NaOCl with surfactant followed by 17% EDTA with surfactant) showed least smear layer scores (1.1 ± 0.3162). This was followed by Group III (MTAD) (2.2 ± 0.4216) and then Group IV (Chloroquick) (2.4 ± 0.5164). they concluded that sequential use of 5.25% NaOCl with surfactant and 17% EDTA with surfactant was found to be the most efficient than MTAD and Chloroquick in the removal of smear layer in the apical third of root canal.

Vemuri S et al ⁹ compared the smear layer removal efficacy of different irrigating solutions at the apical third of the root canal. Forty human single-rooted mandibular premolar teeth were taken and decoronated to standardize the canal length to 14 mm. They were prepared by ProTaper rotary system to an apical preparation of file size F3. Prepared teeth were randomly divided into four groups ($n = 10$); saline (Group 1; negative control), ethylenediaminetetraacetic acid (Group 2), BioPure MTAD (Group 3), and QMix 2 in 1 (Group 4). Intergroup comparison of groups showed statistically significant difference in the smear layer removal efficacy of irrigants tested. QMix 2 in 1 is most effective in removal of smear layer when compared to other tested irrigants. Shenoy A et al ¹⁰ evaluated the effect of final rinsing solution on smear layer removal through penetrability of the root canal sealer. The teeth were divided into three groups of 10 teeth each. Group-I was irrigated with

17% EDTA, Group-II with TUBLICID plus, and Group-III with Biopure MTAD®. ISO 30 size gutta-percha points were selected as master cones. The Acroseal sealer was mixed with approximated concentration 0.1% fluorescent rhodamine B isothiocyanate dye. Obturation was done and after 48 hours, the roots were sectioned and subjected to confocal laser scanning microscopy. Comparisons among the three groups were done by two-way analysis of variance (ANOVA) and Newman-Keuls multiple post-hoc procedures. The two-way ANOVA showed statistically highly significant results. The maximum depth of sealer penetration was observed in Group II followed by Group III and Group I. Zhou H et al ¹¹ compared the efficacy of chitosan and MTAD for the smear layer removal from the root canal through a scanning electron microscope (SEM). Thirty teeth were randomly divided into three groups according to the final irrigants: 0.2% chitosan, MTAD, saline (control group). After the mechanical preparation, the samples were irrigated with saline (control group), 0.2% chitosan and MTDA respectively. The difference between chitosan and MTDA was statistically significant in the apical region, no significant difference was obtained in the coronal and middle regions in these two experiment groups. The control group exhibited the lowest efficacy in smear layer removal in all regions.

CONCLUSION

Within the limitations of the present study, it can be concluded that MTAD was more effective in smear layer removal than EDTA and saline in the apical third.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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