

Original Research

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 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. **Aim of the study:** 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 Dentistry of Sapthagiri Institute of Medical Sciences & Research Institute, Bengaluru, Karnataka. This study was conducted in-vitro. A total of 60 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. 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. **Results:** 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 is the most efficacious for smear removal in apical third of root canal.

Keywords: smear layer, irrigating solution.

Received: 15, January 2021

Accepted: 17 February, 2021

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This article may be cited as: Kumar K, Shushma G, Doni BR. Comparative analysis of efficacy of different final irrigating solutions on smear layer removal in apical third of root canal. J Adv Med Dent Scie Res 2021;9(3):120-123.

INTRODUCTION

Root canal treatment is an element of routine dental practice, which aims to preserve teeth in a healthy and functional condition by removing diseased pulp tissue, managing internal infection, and preventing its recurrence. Treatment should balance the need to eliminate microorganism and organic matter from the pulp space, with the imperative to minimize harm to the host and the dental hard tissues. 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.² 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.³ Irrigation has a major influence on removal of smear layer as well.⁴ 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. BioPure MTAD disinfects as well as effectively removes smear layer after biomechanical preparation.⁵ Etidronic acid or etidronate (1-hydroxyethylidene-1, 1-bisphosphonate) has been suggested as a possible alternative to EDTA or citric acid.⁶

Hence, the present study was conducted to compare efficacy of different final irrigating solutions on smear layer removal in apical third of root canal.

MATERIAL & METHODS

The present study was conducted in the Department of Dentistry of Sathagiri Institute of Medical Sciences & Research Institute, Bengaluru, Karnataka. The ethical clearance for the study was approved from the ethical committee of the hospital. This study was conducted in-vitro. A total of 60 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 20 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.

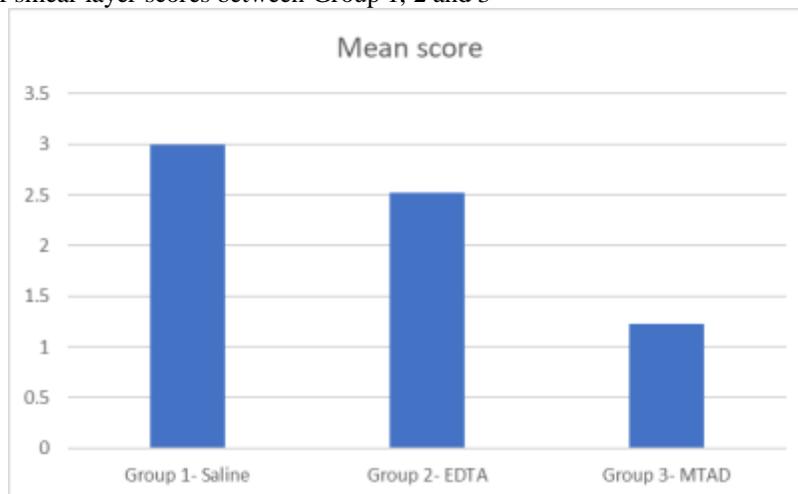
RESULTS

In the present study, a total of 60 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 I 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	0.01
Group 2- EDTA	2	3	2.52	
Group 3- MTAD	1	2	1.23	

Graph I Comparison of smear layer scores between Group 1, 2 and 3



DISCUSSION

In the present study, we performed a study on 60 teeth. These teeth were grouped into 3 groups with 20 teeth in each group. After the study results, it was observed that MTAD as final irrigant for apical third of root canal is the most efficacious. Saline was least effective. The results were compared with previous studies from the literature. Vemuri S et al ⁷ 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). After final irrigation with tested irrigants, the teeth were split into two halves longitudinally and observed under a scanning electron microscope (SEM) for the removal of smear layer. The SEM images were then analyzed for the amount of smear layer present using a three score system. 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. They concluded that QMix 2 in 1 is the most effective final irrigating solution for smear layer removal. Andrabi SM et al ⁸ compared the smear layer removal efficacies of 3% sodium hypochlorite (NaOCl), 17% Ethylenediaminetetraacetic acid (EDTA), SmearClear and BioPure MTAD using a common irrigation protocol. Fifty freshly extracted human single rooted maxillary and mandibular teeth were prepared by a ProTaper rotary system up to an apical preparation file size F3. Prepared teeth were randomly divided into five groups (n=10); distilled water (Group A; negative control), EDTA (Group B), SmearClear (Group C), BioPure MTAD (Group D) and NaOCl (Group E). After final irrigation with tested irrigants the teeth were decoronated, split into two halves longitudinally and observed under a scanning electron microscope (SEM) for removal of the smear layer. The SEM images were then analyzed for the amount of smear layer present using a three score system. Data were analyzed using the Kruskal-Wallis test and Mann-Whitney U test. Intergroup comparison of groups B, C, and D showed no statistical significant differences in the coronal and middle thirds, however, in the apical third the canal surfaces were cleaner in samples from group D. They concluded BioPure MTAD was the most effective agent for the purpose of smear layer removal in the apical third of the root canals.

Patil PH et al ⁹ 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. The teeth were split into two halves and observed under a scanning electron microscope to analyze the amount of smear layer present. 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. Ahir B et al ¹⁰ compared cleaning efficacy of smear layer removal by different irrigating solutions such as 2.5% sodium hypochlorite (NaOCl), 17% ethylenediaminetetraacetic acid (EDTA) with 2.5% NaOCl, 10% citric acid with 2.5% NaOCl and 1% tetracycline Hydrochloride (HCl) with 2.5% NaOCl for smear layer removal in the apical third of root canal. Seventy-five single rooted permanent maxillary central incisor teeth were subjected to standardized root canal instrumentation (crown down technique). The teeth were randomly divided into five groups with 15 teeth in each groups: (1) Normal saline (n = 15) (2) 2.5% NaOCl (n = 15) (3) 17% EDTA + 2.5% NaOCl (n = 15) (4) 10% citric acid + 2.5% NaOCl (n = 15) (5) 1.0% tetracycline HCL + 2.5% NaOCl (n = 15). After final irrigation, the teeth were prepared for scanning electron microscope analysis to evaluate the cleaning of apical third of radicular dentine to determine the presence or absence of smear layer. There was no significant statistical difference in the efficacy of smear layer removal when 2.5% NaOCl was compared with 17% EDTA with 2.5% NaOCl, 10% citric acid with 2.5% NaOCl and 1% tetracycline HCl with 2.5% NaOCl in apical third of root canals. Their study suggests that irrigating agents, citric acid and tetracycline HCl can be used as an alternative to EDTA for the removal of smear layer in endodontics.

CONCLUSION

Within the limitations of the present study, it can be concluded that MTAD is the most efficacious for smear removal in apical third of root canal.

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