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Research Article

Comparative evaluation of the efficacy of smear layer removal by ethylenediaminetetraacetic acid, *Triphala,* and *German chamomile* as irrigants - A scanning electron microscopy study

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ABSTRACT

The desired outcome of endodontic treatment is to get rid of bacteria in the root canal and to provide a very good seal of root canal filling materials. It has been exhibited that smear layer was found covering the root canal walls after instrumentation of the root canal. The use of herbal alternatives as a root canal irrigant is advantageous as it eliminates the undesirable characteristics of chemical irrigants. Alternative irrigants are proven to be safe and contain active constituents that have beneficial physiologic effect and curative property such as antioxidant, anti-inflammatory, and radical scavenging activity. The aim of this study is to compare the efficacy of ethylenediaminetetraacetic acid, *Triphala*, and *German chamomile* on smear layer removal of prepared root canal walls by scanning electron microscopy.

Keywords: Smear layer removal, ethylenediaminetetraacetic acid, *Triphala*, *German chamomile*, scanning electron microscopy

Introduction

Main goal of root canal treatment is three-dimensional cleaning, shaping, and proper obturation with the adequate seal of the root canal system as complete debridement with smear layer removal is essential to achieve a successful outcome.[1] Root canal instrumentation is known to produce a smear layer that covers the surfaces of root canal walls. The superficial smear layer of 1-2 μm thickness, and the deeper smear plug having thickness up to 40 μm.[2-4] Smear layer contains both inorganic and organic components, and it has been recommended to remove it as it may be having a mixture of bacteria and their byproducts.[5,6] It also prevents the penetration of irrigants and intracanal medicaments into the dentinal tubules and interferes with the adherence and adaptation of the sealer to the walls.[7-9]

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Ethylenediaminetetraacetic acid (EDTA) is the frequently used chelator in endodontics.[10] Studies have concluded that the use of a combination of 2.5–5% sodium hypochlorite and 10–17% EDTA is effective in the removal of organic and inorganic debris.[11,12] EDTA is a calcium ion chelating agent and can remove the smear layer. Final flush of EDTA can open the dentinal tubules, and increases the number of lateral canals to be filled.[13]

Triphala is an Indian Ayurvedic herbal formulation consisting of dried and powdered fruits of three medicinal plants *Terminalia chebula*, *Terminalia bellerica*, and *Emblica officinalis*.[14]

The *German chamomile* has been used for centuries as a medicinal plant mostly for its analgesic, anti-inflammatory, antispasmodic, antimicrobial, and sedative properties. Chamomile has been proven to be effective when used as a mouthwash to treat irritations and minor infections of the mouth and gingivae and is also used in some toothpaste.[15]

The use of herbal alternatives as a root canal irrigant is advantageous as it eliminates the undesirable characteristics of chemical irrigants. Alternative irrigants are proven to be safe and contain active constituents that have beneficial physiologic effect and curative property such as antioxidant, anti-inflammatory, and radical scavenging activity.[16]

The aim of this study is to compare the efficacy of EDTA, *Triphala*, and *G. chamomile* on smear layer removal of prepared root canal walls by scanning electron microscopy.

Materials and Methods

In this experimental *in vitro* study, 30 single-rooted human teeth were selected. The teeth had been recently extracted from patients because of periodontal diseases and prosthetic reasons. The teeth were radiographed to ensure that the teeth had a single canal. The teeth were immersed in isotonic saline solution after cleaning. The samples were then autoclaved. The teeth were decoronated with diamond disc (D & Z, Darmstadt, Germany). The remaining roots lengths were almost 15mm.

The root canals were accessed and the coronal preparation was done initially with Gates-Glidden drills (Dentsply Maillefer, Ballaigues, Switzerland) up to number size 3. The teeth were instrumented with K-files and Protaper Universal rotary files with 2.5% NaOCl irrigation (Novo Dental Product, India) between each file, followed by irrigation with 5 ml of saline. The teeth were instrumented till size F5. They were randomly divided into three groups according to the final irrigation solutions.

Group 1: EDTA,
Group 2: 1:1 ratio of *Triphala* powder (Impcops, Chennai) and dimethyl sulfoxide,
Group 3: *G. chamomile*.

Then, samples were irrigated with 5 ml of each irrigant for 1 min. The herbal irrigants were freshly prepared and standardized. The irrigants were delivered with a side vented endodontic irrigating needle (RC Twents, Prime Dental Products, Mumbai, India) until the working length using manual technique into the root canal. Final irrigation was done with 5 ml of distilled water for each sample. The canals were dried with sterile paper points after instrumentation. Each dried specimen was split into two with chisel and mallet along the prepared groove on the buccal and palatal aspect. A half of each specimen was discarded; the other half was prepared for scanning electron microscopic (SEM) examination.[17,18]

The split halves were stored in a 2.5% glutaraldehyde solution. After fixation, the samples were dehydrated in ethanol series (70%, 90%, 95%, and twice at 100%), and then, critical point dried using the dry ice method (BAL-TEC AG, Balzers, Lichtenstein). Each specimen was mounted on an aluminum stub and sputter coated with approximately 20 nm layer of gold, to render a conductive surface. The specimens were examined using a SEM JEOL 6400 (JEOL, Tokyo, Japan) and Cambridge S360 (Cambridge, UK) SEM at a magnification of 2000. The specimens were blind coded. Analysis of the SEM images was accomplished by two investigators who scored the presence of smear layer on the surface of the root canal in the coronal, middle, and apical portion of each canal based on the criteria described by Hulsmann *et al.* (2002) outlined below:

Score 1: Dentinal tubules completely opened;
Score 2: More than 50% of dentinal tubules opened;
Score 3: <50% of dentinal tubules opened; and
Score 4: Nearly, all of the dentinal tubules covered with smear layer.

Statistical analysis

The normality tests Kolmogorov–Smirnov and Shapiro–Wilks tests result reveal that the variable does not follow normal distribution. Therefore, to analyze the data nonparametric methods are applied. To compare between groups, Kruskal–Wallis is applied followed by Bonferroni adjusted Mann–Whitney *post hoc* tests for multiple pairwise comparisons (Table 1). To compare between sides (Apical Coronal and Middle), Friedman repeated measures ANOVA is applied followed by Bonferroni adjusted *post hoc* tests for multiple pairwise comparisons (Table 2). SPSS version 22.0 is used to analyze the data. Significance level is fixed as 5% ($\alpha = 0.05$).

Results

A moderate smear layer was seen in specimens treated with *Triphala*, especially in the middle and coronal sections [Figures 1 and 2]. In the apical section, there was heavy smear layer [Figure 3]. *G. chamomile* had substantial smear layer in all sections [Figures 4-6]. No smear layer was noted on the surface of the samples irrigated with EDTA [Figures 7-9].

Triphala was found to be significantly more effective at smear layer removal than *G. chamomile* ($P < 0.005$). Statistical analysis revealed that

Table 1: Nonparametric Kruskal–Wallis test to compare between groups in each side

Section	Group	*n*	Mean rank	*P*
Coronal	EDTA	10	8.00	<0.001
	Triphala	10	15.00	
	G. chamomile	10	23.50	
Middle	EDTA	10	8.30	<0.001
	Triphala	10	13.60	
	G. chamomile	10	24.60	
Apical	EDTA	10	7.90	<0.001
	Triphala	10	15.10	
	G. chamomile	10	23.50	

EDTA: Ethylenediaminetetraacetic acid, *G. chamomile: German chamomile*

Table 2: Nonparametric Friedman test to compare between sides in each group

Group	Side	Mean Rank	*P*
EDTA	Coronal	1.10	<0.001
	Middle	2.00	
	Apical	2.90	
Triphala	Coronal	1.15	<0.001
	Middle	1.90	
	Apical	2.95	
G. chamomile	Coronal	1.05	<0.001
	Middle	2.15	
	Apical	2.80	

EDTA: Ethylenediaminetetraacetic acid, *G. chamomile: German chamomile*

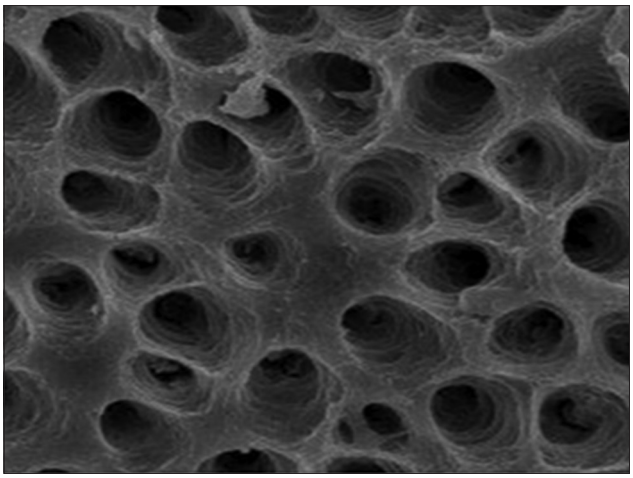

Figure 1: Group II: *Triphala* – coronal portion

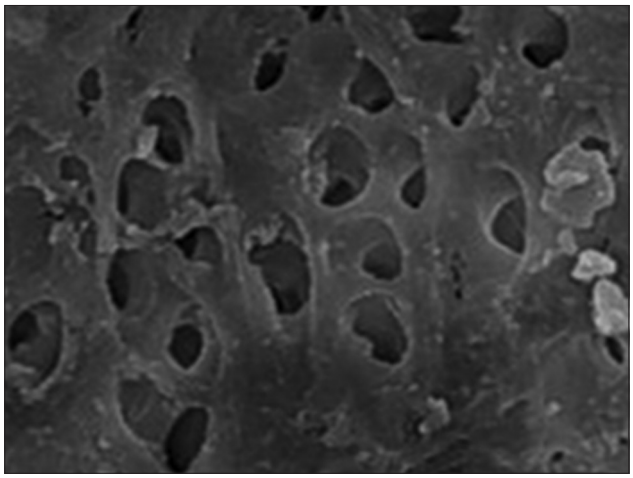

Figure 2: Group II: *Triphala* – middle portion

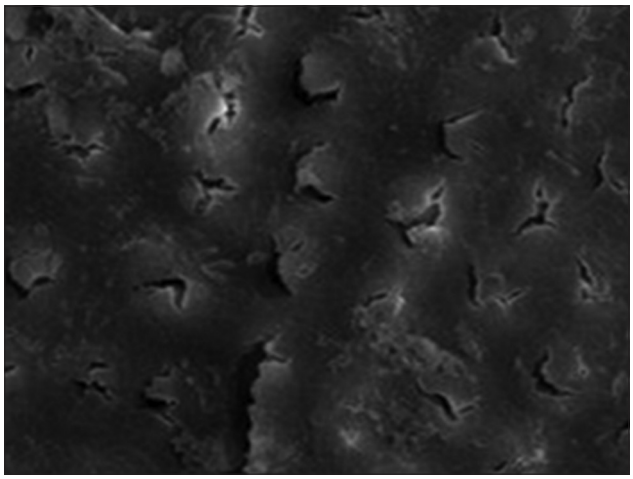

Figure 3: Group II: *Triphala* – apical portion

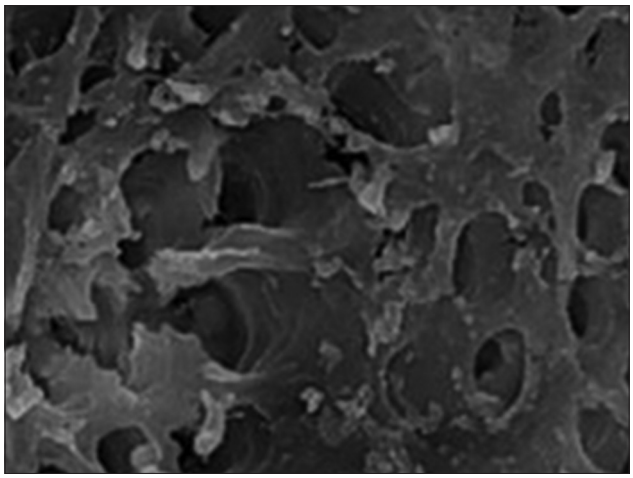

Figure 4: Group III: *German chamomile* – apical portion

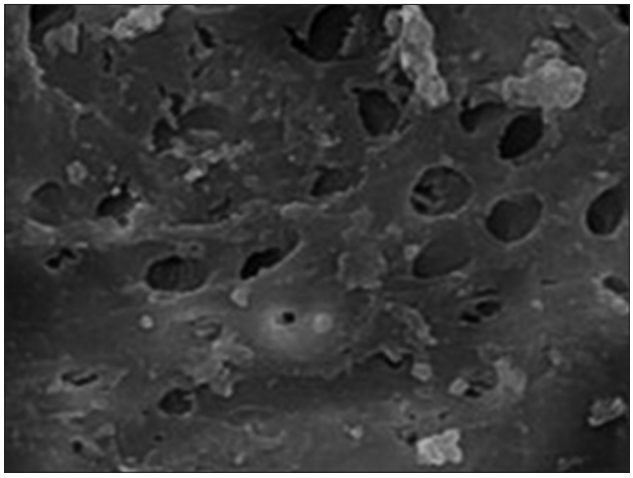

Figure 5: Group III: *German chamomile* – middle portion

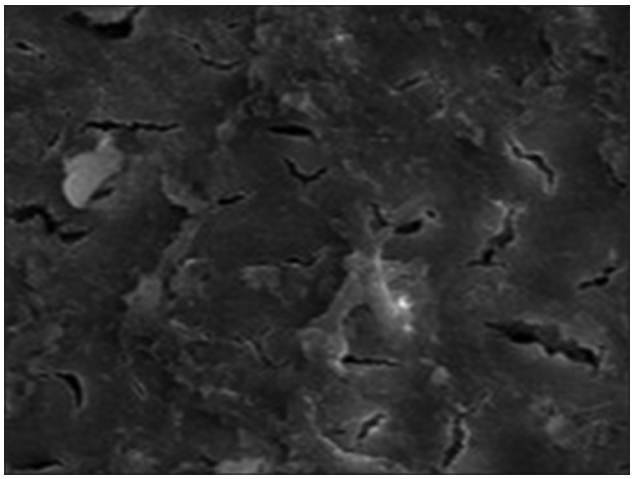

Figure 6: Group III: *German chamomile* – apical portion

Triphala and *G. chamomile* were not effective in removing the smear layer in comparison with EDTA. There was a significant difference between the EDTA and the other groups at different levels of the root ($P < 0.005$).

Discussion

Straight single-rooted was selected with root length of approximately 20-22 mm and curvature <5° according to Schneider to maintain

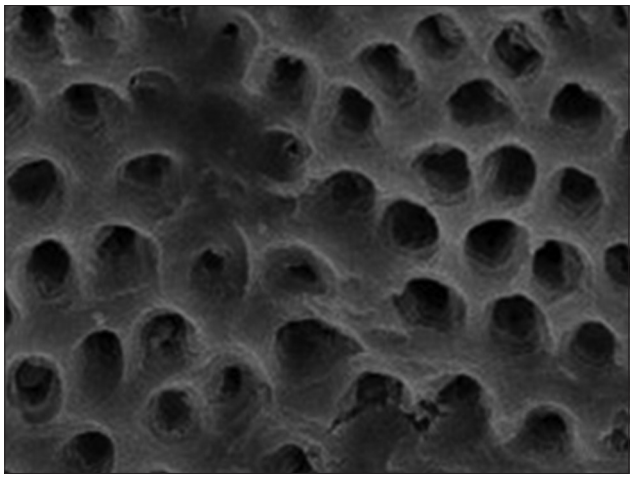

Figure 7: Group I: Ethylenediaminetetraacetic acid – coronal portion

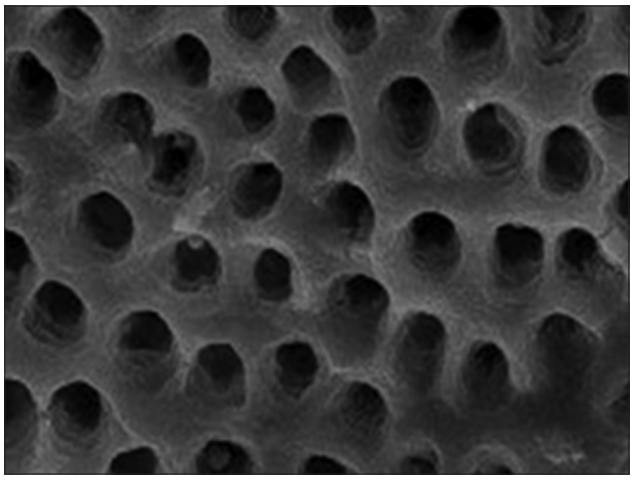

Figure 8: Group I: Ethylenediaminetetraacetic acid – middle portion

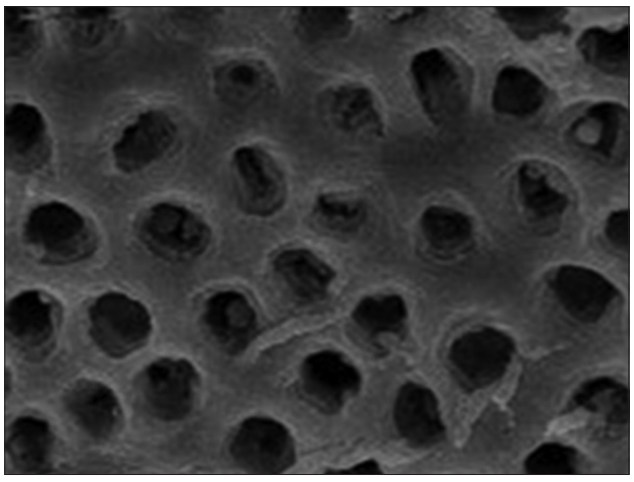

Figure 9: Group I: Ethylenediaminetetraacetic acid – apical portion

standardization and avoid anatomic variation which was confirmed using radiograph.[19]

The smear layer removal action of EDTA can be attributed to its chelation action on the root canal. The moderate smear removal was observed due to incomplete penetration of EDTA in the apical area of the root canal.[20]

Triphala demonstrated better smear layer removal in the coronal and middle third portion when compared with *G. chamomile*. *Triphala* is a traditional Ayurvedic herbal formulation consisting of the dried and powdered fruits of three medicinal plants *Phyllanthus emblica*, *T. chebula*, and *T. bellerica* in equal proportions. *P. emblica* contains a range of tannins and other phenolic compounds. It also contains ascorbic acid and flavonoids.[14] The smear layer removal efficacy may be attributed to these acid components.

In contrast, it was stated that *G. chamomile* extracts demonstrated better cleaning in the coronal and middle third portion.[21] The chemical analysis of *G. chamomile* has revealed its compounds to chamazolene, alpha-bisabolol, and acids such as capric acid, caprylic acid, chlorogenic acid, o-coumaric acid, p-coumaric-acid, dihydroxybenzoic acid, and other components.[22] The cleaning effect of chamomile might be related to these acid components.[21]

The contrast in results can be attributed to the suspension of *G. chamomile* used in this study. Oil form of *G. chamomile* would have made it difficult for the smear layer removal.

Conclusion

Within the limitations of this study, it could be concluded that *Triphala* showed good cleaning efficacy than *G. chamomile* used in this study. The most effective removal of smear layer occurred with the use 17% EDTA as a final rinse followed by the use of *Triphala*. *G. chamomile* did not produce satisfactory results. In future, further investigations are recommended to evaluate the potential use of *Triphala* as a root canal irrigant.

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