

Effect of Endodontic Irrigants in Removing Smear Layer from Root Canals: An in Vitro Study

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Abstract

Original Research Article

Aim: To evaluate the effectiveness of 5.25% sodium hypochlorite associated with 17% Ethylenediaminetetraacetic acid (NaOCl-EDTA), with that of 1% peracetic acid (PA), in removing the smear layer. **Methods and Materials:** Seventy five extracted mandibular premolars extracted due to orthodontic reasons were divided into three groups (NaOCl+EDTA, PA and saline). The teeth were instrumented using hand files and the ProTaper Next system for a standardized time of 7 min. A total of 20 mL of NaOCl followed by 5 mL of EDTA were applied during instrumentation in the NaOCl-EDTA group, whereas 20 mL of PA in the PA groups and 20 ml of normal saline in control group, respectively. An additional 5 mL of saline was applied in all the groups to neutralize the environment. A scoring system was used to conduct the SEM assessment. The results were submitted to the Kruskal-Wallis test, complemented by Dunn's test (SEM analysis) ($P<0.05$). **Results:** In the PA group, the presence of a smear layer in the apical third was significantly greater than in the cervical third ($P<0.05$); no significant differences were observed between the middle and cervical thirds, or between the middle and apical thirds ($P>0.05$). **Conclusion:** This study showed that there was no significant difference between PA and NaOCl-EDTA irrigation regimens regarding removal of the smear layer, except for greater removal in the middle third by the NaOCl-EDTA group.

Keywords: Peracetic Acid, Sodium Hypochlorite, smear layer.

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INTRODUCTION

Root canal instrumentation, can lead to formation of organic and inorganic remnants of dentinal tissue. These are deposited on the canal walls [1, 2]. This debris contributes to the formation of a smear layer [3]. The debris to the instrument and are compacted against the canal walls, obliterating the dentinal tubule entrances [4]. The presence of a smear layer may lead to treatment failure and its removal increases dentinal permeability and contributes to increasing the interface between the dentin and the materials applied inside the root canal during endodontic procedures [5]. Several irrigating substances have been tested to improve disinfection and removal of the smear layer in the root canal system, [6-9]. Sodium hypochlorite (NaOCl) solution is the most widely used in root canal cleansing, because of its ability to promote tissue dilution and to exert strong bactericidal action. Ethylenediaminetetraacetic acid (EDTA), is a chelating agent that promotes the removal of the inorganic components of the smear layer, acting as an adjunct to irrigation [10, 11]. Another irrigant that has been tested

is peracetic acid (PA). According to Arias-Moliz *et al.* [12], it is not only able to remove the smear layer, but also contributes toward disinfecting the root canal system. The use of PA instead of EDTA may be clinically interesting, because of its potential to improve disinfection of root canals [13, 14]. Therefore the aim of the study was to compare the effectiveness of 5.25% NaOCl with 17% EDTA with that of 1% PA, in terms of smear layer removal.

MATERIALS AND METHODS

Fifty permanent human mandibular premolars extracted due to orthodontic and periodontic reasons were obtained. The teeth were divided into two groups. Group 1: irrigation performed with 1% PA; Group 2: irrigation performed with 5.25% NaOCl associated to 17% EDTA; Group 3: irrigation performed with 0.9% saline solution.

Specimen preparation

After extraction, the teeth were cleaned with ultrasound and stored in 0.1% thymol until the time of the experiment. The roots were washed in running water for one h, and then dried with an air jet and gauze. The teeth were then selected based on radiographs performed in the buccolingual and mesiodistal directions. Inclusion criteria were teeth with straight, single fully formed roots, and with a single, oval-shaped canal [15]. Teeth with fractures, calcifications, dilacerations, or previous endodontic treatment were excluded from the study. The crowns of the teeth were sectioned at the cemento-enamel junction by a diamond disc to produce specimens with a standard length of 16 mm. The working length (WL) was determined by inserting a #10 K type file until it was visible at the apical end. The canal was enlarged to a diameter corresponding to a #20 Flexofile instrument (Dentsply-Maillefer, Ballaigues, Switzerland). The teeth were instrumented using the ProTaper next rotary system (Dentsply Sirona, Ballaigues, Switzerland) and the X-Smart electric motor (Dentsply Sirona, Ballaigues, Switzerland). A hybrid instrumentation technique was applied for a standardized time of 7 min. Irrigation was performed at each instrument change with a disposable 5-mL plastic syringe coupled to a Navitip 31-G needle, introduced to a level 2 mm short of the WL [16]. A total of 20 mL of 5.25% NaOCl followed by 5 mL of 17% EDTA were applied during instrumentation in the NaOCl-EDTA group, whereas 20 mL of 1% PA and 20 mL of 0.9% saline were applied in the PA and control groups, respectively. The EDTA was agitated with a hand file for 3 min in the NaOCl-EDTA group, and an additional 5 mL of saline was applied in all the groups to neutralize the environment.

Scanning electron microscopy (SEM) evaluation

Two longitudinal grooves were then made on the buccal and lingual surfaces of the roots with a diamond disc (KG Sorensen, Cotia, SP, and Brazil) [13, 17]. One-half of each root was selected depicting the entire root canal length and prepared for SEM examination. The selected samples were progressively dehydrated using graded concentrations of aqueous ethanol (70%, 80%, 90%, and 100%) for 24 h at each

concentration. After dehydration, samples were placed in a vacuum chamber and sputter coated with a 30 nm gold layer. The dentinal wall of the root canals was examined at coronal, middle, and apical thirds at a magnification of ×1000 for the presence or absence of smear layer and patency of dentinal tubules. , the examiners received a second presentation comprising four SEM images in descending order of cleanliness to serve as a reference for attributing scores of 0 to 4 to the study images, as follows: Score 0, completely clean surface with all the dentinal tubules clean or with the rare presence of a smear layer; 100% clean walls; Score 1, Surface with less than 50% of dentinal tubules exposed; Score 2, Surface covered by a thin smear layer, with half of the dentinal tubules exposed; 50% clean walls; Score 3, Surface with more than 50% of the walls with dentinal tubules exposed; and Score 4, Surface completely covered by a thick smear layer, with no visible dentinal tubules; 100% dirty walls.

Statistical analysis

The results were analyzed using the Kruskal-Wallis test complemented by Dunn's test. SPSS 21 was used in the analyses. The level of significance was set at 0.05.

RESULTS

The scores in the apical third were significantly higher than in the cervical third ($P < 0.05$) for the PA group, there was no significant difference between the middle and cervical thirds, nor between the middle and apical thirds ($P > 0.05$). In the NaOCl-EDTA group, scores were significantly higher in the apical third than in the cervical and middle thirds ($P < 0.05$) (Table 1) The inter-group analysis revealed that, in the cervical third, the scores observed in the control Group were significantly higher than in the PA and NaOCl-EDTA groups ($P < 0.05$). In the middle third, the highest scores occurred in the control group, which were significantly higher than in the NaOCl-EDTA group ($P < 0.05$). In the apical third, there was no significant difference between the groups ($P > 0.05$), and the worst results were observed in this region (Table 2).

Table-1: Intra-group comparison of the frequency distribution (n, %) and mean values for the smear layer scores

		SCORE 0(%)	SCORE 1(%)	SCORE 2(%)	SCORE 3(%)	p- VALUE
GROUP 1(NAOCL-EDTA)	CERVICAL	8.3	8.2	9.4	0.0	0.01
	MIDDLE	3	7.2	11.5	5.2	
	APICAL	0	0	7.2	18.8	
GROUP 2(PA)	CERVICAL	5.2	6.2	8.4	6.2	
	MIDDLE	1.5	4.1	10.3	10.3	
	APICAL	1.4	2.8	7.3	15.5	

Table-2: Inter-group comparison of the frequency distribution (n, %) and mean values for the smear layer scores

	CERVICAL (%)			MIDDLE (%)			APICAL (%)		
	GROUP 1	GROUP 2	GROUP 3	GROUP 1	GROUP 2	GROUP 3	GROUP 1	GROUP 2	GROUP 3
SCORE 0	8.3	5.2	0.0	2.8	1.4	0.0	0.0	1.4	0.0
SCORE 1	8.3	6.2	0.0	7.2	4.0	0.0	0.0	2.8	0.0
SCORE 2	9.3	8.2	0.0	11.4	10.1	0.0	7.2	7.2	0.0
SCORE 3	0.0	6.2	25	5.2	10.1	25	18.5	15.5	25
p-VALUE	0.001			0.006			0.15		

DISCUSSION

Results from the present study show that the smear layer observed in the apical third was significantly higher than in the cervical and middle thirds in the NaOCl-EDTA group. This could be related to the surface tension of these irrigants, which would hamper their action in the apical third. This interpretation could also explain the less effective removal of smear layer in the PA group, considering that PA has a greater surface tension than NaOCl and EDTA. There was no significant difference between root thirds in the control group, confirming the results found by Mello *et al.* [18]. The greater presence of dentin mud in the apical third also confirms the findings of Yang *et al.* [19], Rocha *et al.* [20], Haapasalo *et al.* [21], and Baldasso *et al.* [22]. These authors stated that the apical third is the most critical, because irrigation solutions display poorer cleaning action in this area. De-Deus *et al.* [23], concluded that, after 60 sec, removal of the smear layer promoted by 0.5% and 2.25% PA was significantly greater than that promoted by 17% Tartari *et al.* [24] observed that PA is capable of promoting tissue dilution, but to a lesser degree than that promoted by sodium hypochlorite. In the present study, PA was used alone in order to establish its isolated antibacterial and smear layer removal capacity. Nevertheless, new studies are warranted to assess new PA associations as well as its tissue dilution power. Hartmann *et al.* [14] observed that passive ultrasonic irrigation contributed to a higher bactericidal efficiency of the irrigating solution. Thus, new protocols using sonic or ultrasonic agitation of PA in order to increase the tissue dissolving power of this solution should also be investigated. According to Shahravan *et al.* [5], removal of the smear layer improved endodontic sealing, whereas other factors such as obturation technique or cement type had no significant effect on sealing. Carvalho *et al.* [25] found that the use of different chelating agents did not influence the adhesion strength of endodontic sealers. Their study, however, was also performed on dentin discs from the middle root third of the extracted teeth. This may have interfered in the results, owing to its far-removal from clinical reality. Kuga *et al.* [26] agreed with Carvalho *et al.* [25] and conclude that the association of NaOCl to acid solutions does not increase the penetration depth of the solution in root dentin.

CONCLUSION

Within the limitations of the present study the irrigations performed with 1% peracetic acid and with 5.25% NaOCl associated to 17% EDTA showed similar smear layer removal results, except regarding the middle third of the root canal, where the NaOCl plus EDTA association was superior to PA

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