Original Article

Comparison of XP-endo Finisher, self-adjusting file, and Canal Brush systems on the removal of calcium hydroxide paste from root canals

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Abstract

Introduction: This study aimed to compare the effectiveness of XP-endo Finisher (XPF), self-adjusting files (SAF), and Canal Brush (CB) systems in removing calcium hydroxide (CH) from an artificial standardized groove (ASG) created in the apical root area.

Methods: Fifty-five mandibular premolar teeth were prepared to size Reciproc R40 and were split longitudinally. An ASG was prepared in the apical third of the root and filled with CH. The root halves were reassembled, and the samples were divided into two control groups [positive control and negative control (n=5)] and three experimental groups [XPF, SAF, and CB, (n=15)]. The results were evaluated according to a four-grade scoring system to assess the remained CH in ASGs. The statistical difference between the groups was analyzed using the Kruskal-Wallis test.

Results: There was no statistically significant difference between the experimental groups in the ability to remove CH from the apical root thirds (P>0.05).

Conclusion: None of the finishing techniques could completely clean CH. The SAF, XPF, and CB systems showed comparable efficacy in removing CH from the roots. (J Dent Mater Tech 2023;12(1): 28-34)

Keywords: *Calcium hydroxide, Root canal medicament, Root canal therapy*

Introduction

The successful root can therapy mandates eliminating, or at least reducing microorganisms that cause pulpal and periapical infections (1). Although mechanical shaping and different irrigation methods are applied during root canal treatment, complete sterilization is often not achieved due to the complex root canal system (2).

The use of intracanal medicaments has been recommended to ensure antimicrobial efficacy (3). Despite the benefits of intracanal medicaments, their potential disadvantages are a matter of concern.

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Inadequate removal of root canal medicaments can negatively affect sealer penetration into the dentinal tubules, and thus may jeopardize the ultimate success of endodontic treatment (4).

In endodontics, the most commonly used intracanal medicament is calcium hydroxide (CH). The CH remnants create a physical barrier between the filling material and the dentinal wall during permanent root filling, afflicting the adhesion of the root canal filling materials (5). To remove CH from the root canal, NaOCl, Ethylenediaminetetraacetic acid (EDTA), and distilled water (6), alongside irrigation activation techniques such as manual, sonic, and ultrasonic methods, are widely used (7). Irrigation agents need to be activated by various methods to reach the accessory and lateral canals, which have an irregular structure and cannot be accessed during routine mechanical shaping procedures (8). It is stated that the cleaning efficiency significantly increases when sonic and ultrasonic vibrations are applied to the irrigation solutions (9). However, the pertaining literature suggests that none of these methods can completely remove intracanal medicaments from root canals (10-12).

The self-adjusting file (SAF; ReDent Nova, Israel) is a coreless, compressible, and adaptable nickel-titanium (NiTi) file, designed to support the cleaning and shaping of root canals. (13). The XP-endo Finisher (XPF; FKG Dentaire SA, Switzerland) is a finishing file that transforms its shape into an austenite phase when exposed to body temperature. Access to the entire root canal and hard-to-reach areas is provided using a special alloy used for making this file (Martensite-Austenite Electropolish-Flex) (14). Canal Brush (CB; Roeko Canal Brush, Germany) is a flexible endodontic micro brush that can be used manually and in rotary motion. The CB has been reported to be more effective in smear removal compared to using irrigation alone (15).

Few studies evaluated the effectiveness of CB in removing CH. Therefore, the present study aimed to compare the effectiveness of SAF, XPF, and CB files to remove CH paste from artificial standardized grooves (ASGs) in the root canals by evaluating them under a stereo microscope. The null hypothesis of this study was that there would be no significant difference in the effectiveness of the three activation methods on the removal of CH from ASGs.

Materials and methods

The local ethics committee approved the protocol of this study (Research Ethics Committee of Dicle University, Faculty of Dentistry, Diyarbakır, Turkey, no: 2021-47).

Sample size calculation

The sample size was calculated using the G*Power software (version 3.1.9.2). Using the effect size of $f=0.577$, $\alpha=0.05$, and $\beta=0.80$, a minimum of 33 teeth was required. To account for a possible dropout rate, the sample size in the experimental groups increased to 45 teeth (15 teeth per group) (16).

Sample Selection

Fifty-five human mandibular premolars were included in this study. Soft tissues and calculus on the teeth were removed with a scaler and the samples were kept in distilled water. The teeth were sectioned from the cementoenamel junction using a diamond disk. The working length was determined by subtracting 1 mm from the length of the #15K file (VDW, Munich, Germany) seen through the major apical foramen. Teeth with an apical diameter larger than 0.25 mm were not included in this study.

Sample Preparation

Reciproc R40 files (VDW, Munich, Germany) were used under the rpm speed and torque setting determined by the manufacturer via an endodontic motor (X-Smart, Dentsply, Maillefer, Ballaigues, Switzerland). Irrigation was performed with a 30 G Irriflex needle (Produits Dentaires SA, Switzerland) using 20 mL of 2.5% NaOCl per tooth. Five ml of 17% EDTA (Wizard, Lider Chemical Industry, Istanbul, Turkey) and 5 mL of distilled water were used in the final irrigation step. Then, the root canals were dried with paper points, and the teeth were embedded and fixed in polyvinyl siloxane impression material (Zetaplus, Zhermack Spa, Italy) in 2 ml Eppendorf tubes. The samples were placed in such a way that 2 mm of roots were outside the impression material. The specimens were then removed from the impression material and buccolingual notches were drilled with a diamond disk under water cooling. Then, the roots were divided into two longitudinal parts with a fine cement spatula. An ASG, with a width of 0.2 mm, depth of 0.5 mm, and length of 3 mm, was prepared in the canal dentin of one root half more than 2 mm coronal to the apex. The debris accumulated in the ASGs was cleaned with a toothbrush. All ASGs were sealed with CH paste (UltraCal; Ultradent Products, Inc., South Jordan, UT, USA) using a 29 G needle tip (Navitip; Ultradent, South Jordan, UT, USA). By creating these ASGs, the condition in which the CH remained in natural canal extensions after instrumentation was mimicked.

The root halves were combined with cyanoacrylate glue (Pattex Professional Rapid Adhesive, Henkel, Germany) and remounted in silicone. Following placement, the root canals were filled with CH paste. The access cavities were sealed with a temporary filling material. The specimens were stored for one week at 37°C in relative humidity equal to 100% to simulate the clinical situation when CH is used as an intermediate root filling between two treatment visits.

Then, the teeth were divided into three experimental groups (n=15) and two control groups (n=5) (Table 1).

Samples were washed with 10 mL of 2.5% NaOCl at a flow rate of approximately 5 ml/min using a syringe and a 30 G needle positioned 1 mm from the apical surface. All file stoppers were fixed at the working length with a composite resin (3M ESPE, St. Paul, MN, USA). The irrigation activation protocol applied to the groups is presented in Table 1.

Table 1. The description of the irrigation protocol applied in the experimental groups

Group	n	Company	Irrigation protocol
XPF	15	FKG Dentaire SA, Switzerland	The XP file was used with an endodontic motor at 800 rpm and 1 Ncm. The cavity was filled with irrigant, and the file was operated for 60 seconds with 7-8 mm long in-and-out movements.
CB	15	Roeko Canal Brush, Germany	The samples were brushed with #30 CB. The brush was advanced to the working length with a rotational motion of 450 rpm and an in-and-out motion of 2 to 3 mm for 60 seconds
SAF	15	ReDent Nova, Israel	It was passively inserted into the canal and activated for 4 minutes at an in-and-out vibration with an input frequency of 5,000 Hz and amplitude of 0.4 mm using an RDT3 (Re-Dent-Nova, Ra'anana, Israel) handpiece head. The operator applied pecking movements along the working length.
Negative Control	5		The control group in which CH was not applied.
Positive Control	5		The control group in which CH was applied but not subsequently removed.

Final irrigation was performed with 20 mL of 2.5% NaOCl at a flow rate of approximately 5 mL/min for groups 1 and 2. A total of 20 mL of 2.5% NaOCl was continuously irrigated by a VATEA peristaltic pump (ReDent-Nova, Ra’anana, Israel) at a rate of 5 mL/min for group 3. NaOCl was used at 37°C in all groups to ensure standardization.

The root canals were dried with paper points. The samples were then removed from the impression material and photographed after being separated. The amount of CH in the ASGs was independently graded by two calibrated researchers under a stereo microscope at 40X magnification. A four-grade scoring system described by Lee et al. (17) was used for scoring the remained CH (Table 2).

Statistical Analysis

The Kruskal Wallis test was used to detect significant differences in remaining CH between the groups (SPSS 20.0 software, IBM Corp., Armonk, NY, USA). The significance level was set at 0.05. Inter-observer agreement was calculated using Cohen's kappa analysis.

Results

The mean, standard deviation (SD), median, minimum, and maximum scores of the remained CH are presented in Table 3. The inter-observer kappa value indicated a high agreement rate (kappa value=0.881). Mean CH scores in XPF, CB, and SAF groups were 1.33, 1.67, and 1.47, respectively. No statistically significant difference was observed between the groups (P>0.05; Table 3).

Figure 1 illustrates representative samples of different CH scores in the study groups. Grade 0 was observed in four samples of the XPF and SAF groups and three samples of the CB group. Grade 1 was observed in five samples of the XPF group and four samples of the SAF and CB groups. Grade 2 was found in three samples of all groups. Grade 3 was observed in three samples of the XPF group, four samples of the SAF group, and 5 samples of the CB group (Fig 2).

Table 2. The four-grade scoring system to assess the remained CH

Grade	Description
0	The ASG is empty
1	$Ca(OH)_2$ is present in less than half of the ASG area
2	$Ca(OH)_2$ covers more than half of the ASG area
3	The ASG is completely covered with $Ca(OH)_2$

ASG: Artificial standardized groove; CH: Calcium hydroxide

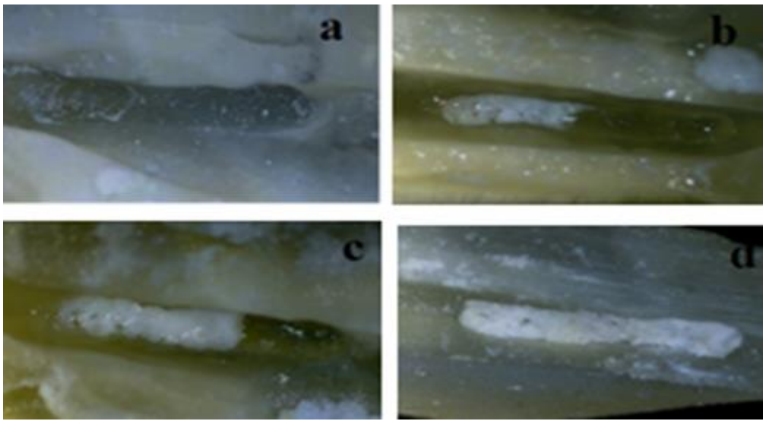

Figure 1. Samples of different groups from which CH has been removed: Grade 0 (a), Grade 1 (b), Grade 2 (c), and Grade 3 (d)

Discussion

The remaining CH in the dentinal walls can predispose an endodontically treated tooth to apical leakage by affecting the penetration of root canal sealers to dentinal tubules. The removal of CH, especially from the apical region of the tooth, is an important issue for the success of treatment (18). Although CH medicament is used as an intracanal drug between treatment sessions, it should be removed entirely before obturation to prevent post-operative leakage. However, numerous studies have shown that no irrigation activation method can thoroughly accomplish this procedure (10, 19, 20). To the best of our knowledge, no study has yet compared XPF, CB, and SAF. Therefore, in the present study, these three systems were compared in terms of their efficacy in removing CH from ASGs created in the apical third of prepared root canals.

Çalt et al. (21) reported that CH could not be completely removed by irrigation with NaOCl alone. However, using EDTA in combination with NaOCl resulted in the complete removal of the particles from the root canal walls (21). In the present study, only 2.5% NaOCl solution was selected as the irrigation agent to better evaluate the efficiency of irrigation activation systems in removing CH.

The findings of this study demonstrated no significant difference between the three activation systems applied for removing CH from the ASGs in the apical root thirds. Thus, the null hypothesis was accepted. Similar to our study, Aziz et al. (22) reported no difference between the CB and XPF irrigation systems in the removal of the intracanal medicament. Kfir et al. (23) compared the efficacy of SAF, XPF, and passive ultrasonic irrigation (PUI) techniques in the removal of CH from ASGs and found no significant difference between these three methods, although they were significantly better than the traditional needle irrigation. In addition, Göktürk et al. (24) reported no significant difference between the CH removal efficiency of XPF and CB from the ASGs in the apical root thirds.

Table 3. Descriptive statistics including mean, standard deviation (SD), median, minimum (min), and maximum (max) scores of remaining calcium hydroxide in the study groups

Groups	Mean ± SD	Median (Min-Max)	p-value
XPF	1.33 ± 1.11	1 (0 - 3)	
SAF	1.47 ± 1.19	1 (0 - 3)	0.728
CB	1.67 ± 1.18	2 (0 - 3)	

XPF: XP-endo Finisher, SAF: Self-adjusting file, CB: Canal Brush

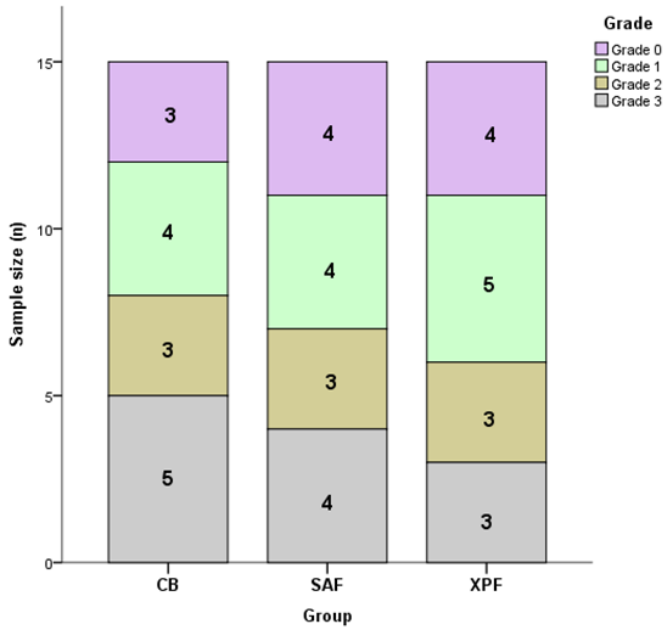

Figure 2. Distribution of remaining calcium hydroxide scores in the study groups (XPF: XP-endo Finisher, SAF: Self-adjusting file, CB: Canal Brush)

In contrast to the findings of this study, Türker et al. (25) used CB for 30 s and found that SAF performed significantly better than CB in removing CH from the apical third of the root canals. In our study, using CB for 1 min may explain the comparable performance between CB and SAF in CH removal.

Although there was no difference between the groups in terms of removing CH from the ASGs, XPF showed more grade 0 and grade 1 scores than the other two groups, implying a negligible better cleaning activity. The XPF with MaxWire alloy was developed to increase efficiency when removing the smear layer with irrigation activation. The file transforms from the M phase to the A phase at body temperature and takes the shape of a spoon with a length of 10 mm and a depth of 1.5 mm from the tip of the file (26). Although NaOCl was heated to 37°C

In our study, standardized root canal enlargement was performed with the R40 file; the file may not completely remove CH and make insufficient contact with the ASGs

in our study, the fact that each tooth has a different dentin and cementum thickness may have changed the heat absorption and could affect the effectiveness of XPF in this study. The manufacturer recommends using XPF for 1 min longitudinally, slowly and smoothly, with 7-8 mm back-and-forth motion (27). To determine whether XPF will perform better, testing it with longer run times and a more frequent back-and-forth motion may be beneficial. This may allow the XPF in the austenitic phase to make better cleaning of the ASGs.

The SAF is a hollow compressible file designed with thin walls. It is in the form of a pointed cylinder with a diameter of 1.5 or 2.0 mm, consisting of a nickel-titanium cage with a thickness of 120 micrometers. A 1.5 mm file is used with a #20 K file; the 2.0 mm file is easily compressed into a canal prepared with a #30 K file (13).

in the apical third. The SAF works by removing the dentin layer with a vibrational, grinding action combined with close contact along the entire circumference and length of the canal (13). The findings of this study suggest that CH cannot be completely removed by vibration alone at the 0.5 mm depth in the apical third of the ASGs.

The samples in the CB group showed slightly greater scores of remaining CH in ASGs compared to the XPF and SAF groups, but the difference was not significant. In other studies, bristle deformation was observed in all CBs after using CB in the canal (15, 28). This pattern was also observed in our study, suggesting that there is a reason why CH could not be removed entirely from the ASGs.

In the present study, we created ASG in the root canal walls to standardize the CH volume in all groups and facilitate scoring. However, it should be noted that this ASG design does not represent the complexity of root canal anatomy (10, 11). As none of the employed techniques were efficient in completely removing CH from the ASGs, further studies are suggested to find more efficient irrigation techniques for root canal cleaning.

Conclusion

None of the finishing tested methods could effectively remove all CH from the ASGs in the apical third of the root canals. The ability of SAF, XPF, and CB to clear CH from the ASGs was not different from each other.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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