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ORIGINAL RESEARCH

Efficacy of XP-endo finisher and TRUShape 3D conforming file compared to conventional and ultrasonic irrigation in removing calcium hydroxide

Ahmet Demirhan Uygun, DDs, PhD[1,*]; Eyüp Candaş Gündoğdu, DDs[2]; Hakan Arslan, DDs, PhD[2]; and İbrahim Ersoy, DDs, PhD[3]

1 Department of Endodontics, Faculty of Dentistry, Recep Tayyip Erdogan University, Rize, Turkey
2 Department of Endodontics, Faculty of Dentistry, Ataturk University, Erzurum, Turkey
3 Department of Endodontics, Faculty of Dentistry, Şifa University, İzmir, Turkey

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Correspondence
Ahmet Demirhan Uygun, Department of Endodontics, Faculty of Dentistry, Recep Tayyip Erdoğan University, Rize, 53100, Turkey.
Email: ademirhan100@hotmail.com

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Abstract

The aim of this study was to compare the efficacy of the XP-endo Finisher and TRUShape 3D Conforming File to conventional and ultrasonic irrigation techniques for removing calcium hydroxide from artificially created grooves on root canals. The study used 32 human mandibular premolar teeth, which were decoronated and instrumented up to ProTaper Universal F5 (Dentsply Maillefer; Ballagiues, Switzerland). The teeth were split longitudinally, two standardised grooves were prepared in the apical and coronal portions and filled with calcium hydroxide. Each tooth was reassembled with wax. The samples were stored at 100% humidity at 37°C for 1 week, after which the specimens were grouped and irrigated using needle irrigation, ultrasonic irrigation, XP-endo Finisher via continuous irrigation or TRUShape 3D Conforming File via continuous irrigation. Two calibrated observers scored the amount of calcium hydroxide remaining, and the data were statistically analysed using the Kruskal–Wallis and Mann–Whitney *U*-tests, ($P < 0.05$). Needle irrigation had the poorest scores ($P < .001$), while the XP-endo Finisher, TRUShape 3D Conforming File via continuous irrigation and ultrasonic irrigation groups had similar results in removing calcium hydroxide.

Introduction

The aims of endodontic treatment on a tooth with an infected root-canal system are the removal of bacteria and their by-products and the three-dimensional (3D) sealing of the root canals (1). Despite technological advancements in instrumentation techniques and irrigation systems, clinicians may prefer to treat root canals in multiple sessions using an intracanal medicament to aid disinfection of the root canals (2). Calcium hydroxide is widely used, as it has antibacterial and anti-inflammatory properties, primarily due to the high pH value of the surrounding environment, approximately 12.5, after its dissolution (3,4). Despite the antimicrobial and anti-inflammatory advantages of calcium hydroxide, its remnants may prevent sealers from penetrating to the root-canal walls (5). Therefore, before obturation, the root-canal walls should be free of calcium hydroxide (6). Most studies in the literature have reported the insufficiency of various irrigation solutions and techniques to completely remove calcium hydroxide from root-canal walls (7,8).

Recently, the TRUShape 3D Conforming File (Dentsply Tulsa Dental Specialties; Johnson, WA, USA) with an S-shaped curve and blue colour has been introduced. This new instrument system includes four instruments: 20/.06 v, 25/.06 v, 30/.06 v and 40/.06 v. The v indicates that the files have variable, reduced tapers. According to the manufacturer, the S- shaped curve enables preservation of more tooth structure than ordinary NiTi-instrument systems while cleaning and shaping the root canal.

The XP-endo Finisher (FKG Dentaire; La Chaux-de-Fonds, Switzerland) is another novel NiTi-instrument system that has a C-shape in the apical half of the file. It is reported to clean the root canal while preserving dentin and can be used following any root-canal preparation

technique that results in an apical size of 25 or more. This single file is ISO 25 in diameter, has no taper (25/.00) and expands up to 6 mm in diameter, or 100 times more than an equivalent-sized file. Unlike ordinary NiTi instruments, the shape of the XP-endo Finisher alters with changes in temperature. Due to its metallurgy, the file changes from the M-phase to the A-phase when exposed to the temperature within the root canal. In the rotation mode, the A-phase shape enables the file to access and clean areas with memorised shape. The file can be returned to its original straight shape (M-phase) manually after it has cooled.

It is thought that their irregular designs will put these instruments in contact with more dentin than ordinary NiTi instruments (9,10). However, currently there are no data available on the removal of calcium hydroxide after using the TRUShape 3D Conforming File and the XP-endo Finisher. The aim of this study was to compare the efficacy of the XP-endo Finisher and the TRUShape 3D Conforming File via continuous irrigation with needle and ultrasonic irrigation techniques for removing calcium hydroxide from artificially created grooves in root-canal walls.

Materials and methods

The study used 32 human mandibular premolar teeth with straight roots and a single root canal. The teeth, which had been extracted for orthodontic or periodontal reasons, were stored in distilled water at 4°C until use. To obtain a standardised root length, decoronation was performed at 14 mm from the terminus of the apex. Instrumentation of the root canals was achieved using the ProTaper system (Dentsply Maillefer; Ballagiues, Switzerland) up to size 50 (F5). Two millilitres of 2.5% NaOCl was used to irrigate the root canals between instruments.

The specimens were fixed in a silicone impression material (Optosil; Heraeus Kulzer; Hanau, Germany) contained in a mould. When the specimens were removed from the impression material, two grooves were prepared on the buccal and lingual surfaces of each root with a diamond disk under copious water irrigation, avoiding penetration into the root canal. The roots were split into two halves with a small chisel, and two grooves (approximately 3 mm long, 1 mm wide and 1 mm deep) were artificially created in the root canals at a distance of 8 11 mm (coronal) or 2 5 mm (apical) from the apex. To remove debris in the grooves and root canals, brushing was performed using a toothbrush, and final irrigation was performed using 5 mL of 2.5% NaOCl on the grooves and 5 mL of 17% EDTA on the root canals, each for 60 s. After the canals were dried, the grooves were filled with calcium hydroxide (Kalsin; Spot Dis Deposu A.S.; Izmir, Turkey), which was prepared using its own distilled water at a powder-to-liquid ratio of 1:1. To simulate a closed system in the clinical situation, each root was coated with wax. To prevent modelling wax from entering the root canals, a gutta-percha point was introduced into each root canal during the coating. The specimens were embedded in silicone impression material, and a cotton pellet and Cavit (Espe; Seefeld, Germany) were packed into the access of each. The specimens were stored at 100% humidity at 37°C for 1 week before the temporary restorative materials were removed and the specimens were divided randomly into four groups, as follows.

Needle irrigation

The root canal was irrigated for 60 s using 5 mL of 17% EDTA via a size 30 gauge, close-ended, tipped needle with a side-port opening (Canal Clean; Biodent Co. Ltd.; Paju, Korea).

Ultrasonic irrigation via continuous irrigation

An ultrasonic file (Varios U File; Nakanishi; Tochigi, Japan) (size 25, 0.02 taper) was placed into the canal 1 mm short of the working length, and 5 mL of 17% EDTA was ultrasonically activated for 60 s. Ultrasonic irrigation was performed with a piezoelectrical ultrasonic unit (NSK Varios 750; Nakanishi; Tochigi, Japan) at power setting 5 (the maximum). A second practitioner performed continuous irrigation with a syringe and needle.

XP-endo finisher via continuous irrigation

An XP-endo Finisher file (size 25, 0.00 taper) (FKG Dentaire; La Chaux-de-Fonds, Switzerland) was introduced into the root canal at a distance of 1 mm from the working length. The irrigation needle was placed as close as possible to the working length without interfering with the rotary instrument. During rotary instrumentation, a second practitioner performed continuous irrigation with a syringe and needle. The file was rotated at a speed of 800 rpm with a gentle in-and-out motion throughout the working length (1 Ncm torque) under continuous irrigation using 5 mL of EDTA for 60 s.

TRUShape 3D conforming file via continuous irrigation

A size 25 TRUShape 3D Conforming file (0.06 taper) (Dentsply Tulsa Dental Specialties; Johnson, WA, USA) was used with the same protocol as in the XP-endo Finisher group at a speed of 300 rpm (3 Ncm torque) (Fig. 3).

For all groups, the average flow rate of the irrigating solution was 0.083 mL s^{-1}. A final flush was performed using 5 mL of distilled water for all groups. After the root canals were dried with paper points, the roots were disassembled to evaluate the remaining calcium hydroxide. A mobile phone was attached to a stereomicroscope (Novex; Arnhem, Holland), and images were obtained at 25× magnification and transferred to a computer. Two calibrated, blinded observers scored the amount of calcium hydroxide using the scale described by van der Sluis, Wu (11), as follows.

- 0: Groove was empty.
- 1: Calcium hydroxide was present in less than half of the groove.
- 2: Calcium hydroxide covered more than half of the groove.
- 3: The groove was completely filled with calcium hydroxide.

To determine intra-individual reproducibility, the examiners evaluated the photographs 1 week later, and a Kappa test was used to analyse inter-examiner agreement. Data were statistically analysed using the Kruskal–Wallis and Mann–Whitney *U*-tests, with Bonferroni correction and at a 95% confidence level ($P < 0.05$).

Results

The reliability between the observers was very good (Kappa value = 0.892), with the differences between the matched scores never exceeding one unit. Intra-individual reproducibility for the observers was 99.2% (127/128) and 98.4% (126/128).

For both the coronal and apical thirds, the Mann–Whitney *U*-test showed needle irrigation to have poorer scores than the other groups ($P < .001$). The XP-endo Finisher and the TRUShape 3D Conforming File via continuous irrigation had scores similar to those of ultrasonic irrigation in removing calcium hydroxide (Figs. 1,2). In all groups, poorer scores were observed in coronal thirds than in apical thirds ($P = .005$) (Table 1).

Discussion

This study compared the efficacy of TRUShape 3D Conforming Files, XP-endo Finisher instruments and ultrasonic irrigation to that of needle irrigation for removing calcium hydroxide dressing from artificially created grooves in mandibular premolars. Previously, several methods for evaluating the amount of calcium hydroxide remaining on root-canal walls have been described (7,11–14). Artificially created grooves have been found to enable standardising the volume of calcium hydroxide and to facilitate scoring (11–13), which is why the present study created grooves on the root-canal walls. One limitation of this study was that in the interest of standardisation, only straight roots were used.

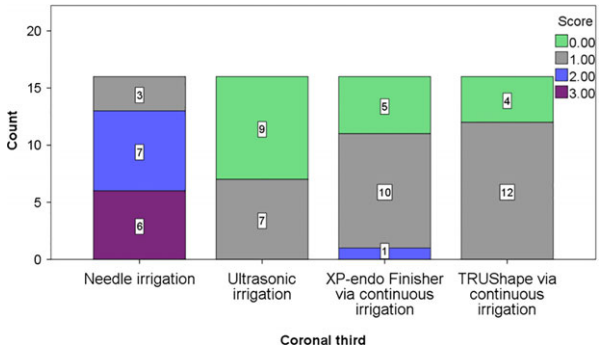

Figure 1 Distribution of scores for removing calcium hydroxide for coronal third: score 0, groove was empty; score 1, calcium hydroxide was present in less than half of the groove; score 2, calcium hydroxide covered more than half of the groove; score 3, the groove was completely filled with calcium hydroxide.

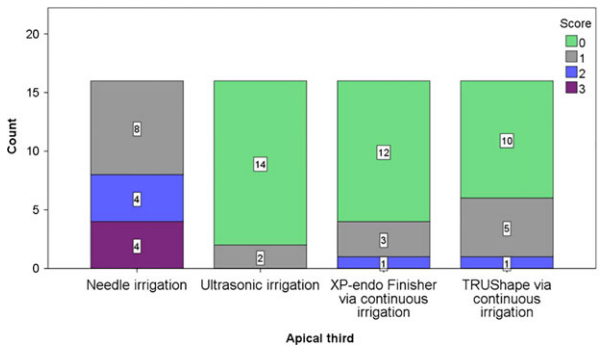

Figure 2 Distribution of scores for removing calcium hydroxide for apical third.

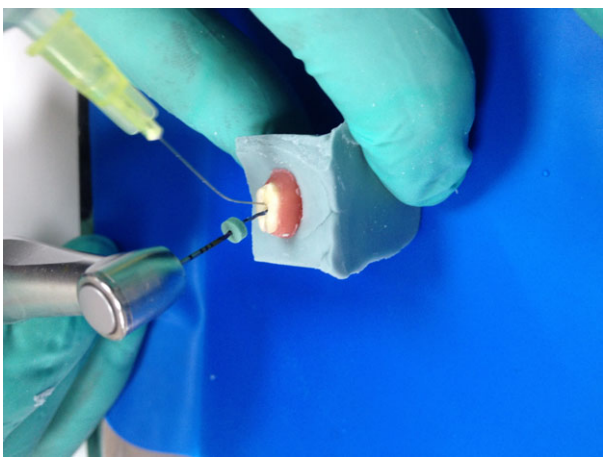

Figure 3 Continuous irrigation while rotary instrumentation.

Table 1 Mean and standard deviations of the study groups

	Needle irrigation	Ultrasonic irrigation	XP-endo finisher via continuous irrigation	TRUShape 3D conforming file via continuous irrigation
Mean ± standard deviation	1.96 ± 0.82	0.28 ± 0.45	0.53 ± 0.62	0.59 ± 0.55

Studies in the literature have extensively reported that calcium hydroxide was not completely removed by ultrasonic irrigation. However, that method has been found to be better than conventional irrigation in removing calcium hydroxide from root canals (11,12). Those findings are in agreement with the results of the present study.

This study used newly developed rotary systems with irregular geometry with 5 mL of 17% EDTA in continuous irrigation. In the interest of standardisation, the same protocol was applied to the ultrasonic and needle-irrigation groups. In addition, because the XP-endo Finisher has a number 25 tip size and a .00 taper, the TRUShape 3D Conforming File with the number 25 tip size was also used. Using this size file tip with the TRUShape 3D Conforming File also served another purpose. According to the manufacturers' instructions, the XP-endo Finisher has no effect on canal morphology, but TRUShape 3D Conforming Files can alter canal morphology. Therefore, using the 25/.06 v TRUShape 3D Conforming File prevented such alteration, since it was smaller than the ProTaper Universal F5.

A device has been developed that can be attached to an endodontic hand piece to allow continuous irrigation during rotary instrumentation. This device may allow greater volume, flow and exchange of irrigant than irrigation with a syringe and needle (15). However, Walters *et al.* (16) showed that the efficacy of canal debridement with this device did not differ significantly from that of continuous needle irrigation in conjunction with rotary instrumentation. We expected that the TRUShape 3D Confirming File and the XP-endo Finisher would not only contact the artificially created grooves with their irregular geometry but would also agitate the irrigants by continuous irrigation during rotary instrumentation. In this regard, a further limitation of this study was that it did not use a rotary file with a regular shape as a control. Continuous irrigation in conjunction with rotary instrumentation could be effective whether the files were irregular or not.

According to the results of this study, the TRUShape 3D Conforming File and the XP-endo Finisher are similar to ultrasonic irrigation and better than conventional needle irrigation for removing calcium hydroxide medicament. The literature contains no data in this regard for the TRUShape 3D Conforming File or the XP-endo Finisher, so a direct comparison with the results of previous studies was not possible. However, in one recent study, Bortoluzzi *et al.* (9) reported that the TRUShape 3D Conforming File system increased the elimination of canal-wall bacteria from oval-shaped root canals, a finding that may support the findings of this study.

Conclusions

Within the limitations of this study, it can be concluded that the TRUShape 3D Conforming File and the XP-endo Finisher via continuous irrigation can be beneficial in removing calcium hydroxide from root-canal walls.

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The authors have no conflicts of interest to declare.

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