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Original research

EFFICACY OF XP-ENDO FINISHER AND PASSIVE ULTRASONIC IRRIGATION ON MODIFIED TRIPLE ANTIBIOTIC PASTE REMOVAL

Ecehan Hazar[1],
*Baran Can Sağlam[2],
Sibel Koçak[3],
Mustafa Murat Koçak[4]

ORCID IDs of the authors:
E.H.0000-0002-7610-9622
B.C.S.0000-0002-2090-5304
S.K.0000-0003-2354-7108
M.M.K.0000-0003-3881-589X

[1] Department of Endodontics, Faculty of Dentistry, Zonguldak Bülent Ecevit University, Zonguldak, Turkey.
[2] Department of Endodontics, Faculty of Dentistry, Zonguldak Bülent Ecevit University, Zonguldak, Turkey.
[3] Department of Endodontics, Faculty of Dentistry, Zonguldak Bülent Ecevit University, Zonguldak, Turkey.
[4] Department of Endodontics, Faculty of Dentistry, Zonguldak Bülent Ecevit University, Zonguldak, Turkey.

ABSTRACT

Objectives: The aim of this study was to compare conventional needle irrigation (CNI), passive ultrasonic irrigation (PUI), and XP-endo Finisher (XPF) techniques in terms of modified triple antibiotic paste (mTAP) removal.

Materials and Methods: A total of 30 mandibular premolars were instrumented to a size F3 file. A mixture of mTAP was prepared by mixing 3 antibiotics, including 250 mg ciprofloxacin, 250 mg metronidazole, and 150 mg clindamycin, with 1 ml distilled water and applied into the root canals. The teeth were allocated into 3 equal groups, irrigation/agitation was performed and teeth were divided into two halves. The removal of mTAP was evaluated with a scanning electron microscope by using the 4 grade scoring system.

Results: In the apical thirds, significant difference was found between PUI and CNI groups ($p<0.05$), whilst no significant difference was found among the other irrigation activation regimens ($p> 0.05$). No statistically significant difference was found between all groups in the middle third. In the coronal thirds, XPF removed significantly more mTAP than the CNI group ($p<0.05$). However, no difference was recorded among other groups ($p>0.05$).

Conclusions: Passive ultrasonic irrigation and XPF file agitation demonstrated superior efficacy in removing mTAP from root canals compared to CNI.

Keywords: Root canal therapy, ultrasonics, root canal medicaments

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***Corresponding Author**
Zonguldak Bülent Ecevit University, Faculty of Dentistry, Department of Endodontics, Kozlu, Zonguldak, Turkey.
Phone: +90 5058743527 **E-mail:** barancansaglam@gmail.com

INTRODUCTION

Microorganisms are the main factors in initiation and progression of pulpal and periapical diseases.[1] Unfortunately, biomechanical preparation and conventional irrigation of the root canals are unable to achieve removal of microorganisms completely.[2] Thus, using of intracanal medication with calcium hydroxide or antibiotic pastes becomes a necessity for disinfection of root canals. During the root canal treatment, intracanal medication is important to eliminate the microorganisms and their remnants.[3]

Antibiotic pastes have been specially used for revascularization treatment to obtain a disinfected root canal system and to induce the stem cells and growth factors.[4] The widely used antibiotic paste which was developed by Hoshino *et al*.[5] is called triple antibiotic paste (TAP) including metronidazole, ciprofloxacin, and minocycline. TAP was modified by removing the minocycline, which may cause discoloration of teeth; for this reason, clindamycin was added instead. Clindamycin containing modified triple antibiotic paste (mTAP) was accepted as a successful intracanal medicament for endodontic regeneration treatment.[6,7] The intracanal medicaments should be effectively removed to obtain a better adaptation of root canal obturation materials. Therefore, complete removal of antibiotic paste remnants is essential before root canal obturation.[8,9] It has also been reported that TAP was detrimental to the apical stem cells and affect to sealer setting and penetration.[10]

The conventional needle irrigation (CNI) technique is a commonly used method for removing any root canal content including root canal medicaments. However, CNI is unable to remove the TAP, completely.[11] For this reason, studies should focus on the improvement of TAP removal with irrigation activation techniques.

XP-endo Finisher file (XPF, FKG Dentaire SA, La Chaux-de-Fonds, Switzerland) is a novel shape-memory nickel titanium file which has been developed for irrigation agitation. It is produced with a special alloy technology called Maxwire. When cooled, it is in martensite phase and the file has a straight form. At the body temperature, the instrument converts into a spoon shape due to the austenitic phase. During the rotation in the root canal, the instrument achieves a specific shape with a diameter of 3 mm in the last 10 mm. The movement of XPF file up and down for 7 to 8 mm is required inside the root canal, resulting in the contact of the instrument with the canal walls that provides the turbulence of irrigation solutions.[12,13]

According to our knowledge, no study evaluated that removal of mTAP by using XPF file. The present study compared the efficacy of CNI, passive ultrasonic irrigation (PUI), and XPF agitation techniques on mTAP removal. The null hypothesis was that different irrigation/agitation techniques did not affect the removal of mTAP.

MATERIALS AND METHODS

Thirty non-carious human mandibular premolars with similar morphology and mature apices were selected. Periapical radiographs were taken to determine the presence of single and straight root canal anatomy. The crowns were removed with a diamond burr under water coolant to adjust a standardized length of 14 mm. The working length was established by subtracting 1 mm from the length which was recorded by using an inserted 10 K file visible at the apical foramen.

The root canals were instrumented with ProTaper Universal system (Dentsply Maillefer, Ballaigues, Switzerland) to a size F3 file (30/.09). Irrigation was performed using 2 ml of 2.5% sodium hypochlorite (NaOCl) after each file. The teeth were embedded in Eppendorf vials (Labosel, İstanbul, Turkey) with a silicone impression material (Optosil; Heraeus Kulzer, Hanau, Germany). After setting time, the roots were removed from the Eppendorf vials and split longitudinally into 2 halves with a diamond disk avoiding any damage on the root canal dentin. The specimens were reassembled and peripheries of the roots were covered with wax and then placed in the Eppendorf vials. 2 ml of 2.5% NaOCl and 2 ml of 17% ethylenediaminetetraacetic acid was used as final irrigant for 2 min, for each.

mTAP Application

A dense mixture of mTAP was prepared by mixing 3 antibiotics, including 250 mg ciprofloxacin, 250 mg metronidazole, and 150 mg clindamycin, with 1 ml distilled water.[14] The application of mTAP mixture was performed with a lentulo spiral, and a completely filling was performed when the medicament was visible at the apical foramen. The access cavities were temporarily sealed (Cavit G, ESPE, Seefeld, Germany), and the teeth were stored at 37 ^{0}C with 100% humidity for 21 days. The specimens were divided into 3 groups according to the irrigation/agitation protocol (n = 10);

Group 1 conventional needle irrigation (CNI): 27 G needle was inserted 1 mm shorter than the working length. Irrigation was performed with 6 ml 2.5 % NaOCl for 60 seconds.

Group 2 passive ultrasonic irrigation (PUI): 6 ml 2.5 % NaOCl was agitated using an ultrasonic size 25 file (Acteon Satelec, Merignac, France) with an ultrasonic handpiece (VDW Ultra, Satelec, France). Ultrasonic tip was inserted 1 mm shorter than the WL by avoiding any contact to the canal walls. The tip was activated at power setting 6 for 1 min, and the irrigation was continued by another researcher at the same time.

Group 3 XP-endo Finisher (XPF): The XPF file was used at 800 rpm with 1 Ncm. The root canal was irrigated with 6 ml 2.5% NaOCl warmed at 37°C for 60 seconds. XPF was used for 1 minute at 1 mm shorter than WL. Parietal movements and continuous irrigation were applied during the procedure.

Scanning Electron Microscopy (SEM) evaluation

The roots were disassembled for SEM evaluation. SEM images were provided from three surfaces of roots, including coronal, middle, and apical thirds at×1000 magnification.

Criteria for the degree of mTAP removal and cleanliness of the dentinal walls were established by modification of the scoring system described by Salgado *et al.*[15]

0 = Total cleanliness

1 = Good cleanliness (up to 20%)

2 = Partial cleanliness (20–60%)

3 = No cleanliness (more than 60%) (Figure 1).

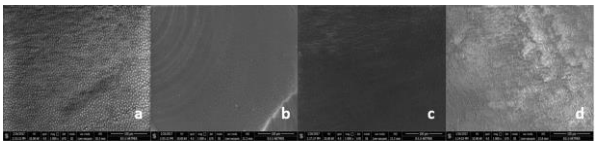

Figure 1. Representative SEM images of mTAP removal scores; score 0 (a), score 1 (b), score 2 (c) and score 3 (d).

Statistical Analysis

Statistical analysis was performed with SPSS 19.0 software (SPSSInc., Chicago, IL, USA). Variables were expressed as mean ± standard deviation. Groups were compared with the Kruskal-Wallis test. The Dunn's test was used for post-hoc test after Kruskal-Wallis test. *p* value of less than 0.05 was considered statistically significant for all tests.

RESULTS

Table 1 presents the mean and standard deviation values of each group.

Table 1. The mean, standard deviation, minimum and maximum values of each group.

Region	Group	N	Mean	Standard deviation	Minimum	Maximum
Apical Third	NI	10	2.50	.527	2	3
	PUI	10	1.70	.675	1	3
	XPF	10	1.90	.738	1	3
Middle Third	NI	10	1.50	.707	1	3
	PUI	10	1.10	.568	0	2
	XPF	10	1.20	.632	0	2
Coronal Third	NI	10	1.40	.516	1	2
	PUI	10	.90	.316	0	1
	XPF	10	.60	.516	0	1

For the apical thirds, a statistically significant difference was found between PUI group and CNI group ($p<0.05$), whilst no significant difference was found among the other groups ($p>0.05$). In the middle third, no significant difference was found among all groups ($p>0.05$). In the coronal thirds, XPF group demonstrated the highest mTAP removal activity and a significant difference was found between XPF and CNI groups ($p<0.05$). However, no difference was found among the other groups ($p> 0.05$).

The comparison of root thirds of each group demonstrated significant differences between coronal and apical thirds, and between middle and

apical thirds in the CNI group ($p<0.05$). PUI and XPF groups demonstrated significant differences between apical and coronal thirds for mTAP removal ($p<0.05$). There was no significant difference between coronal and middle thirds in any group ($p>0.05$).

DISCUSSION

Root canal treatment aims to disinfect the root canal system completely. Antibiotic pastes are used for this purpose, especially in revascularization treatment. In order to eliminate adverse effects, the removal of pastes is essential after the disinfection procedures.[8,9] Previously published studies have reported that complete removal of antibiotic pastes was not possible.[16,17] In the present study, three techniques were compared for removal of mTAP in 3 root canal regions, including apical-middle-coronal.

In previous studies, different antibiotics such as cefaclor or clindamycin were used instead of minocycline due to its discoloration effect.[7,18] In the current study, a clindamycin-modified triple antibiotic paste consisting ciprofloxacin, metronidazole, and clindamycin was used since this combination achieve efficient root canal disinfection and is biologically safe.[19] The clindamycin-modified triple antibiotic paste has a clinically proven efficacy. Lin *et al.*[20] used clindamycin-modified triple antibiotic paste in 69 regenerative endodontic treatments, 12-months follow-up revealed healing of all periapical lesions without any symptoms.

Various measuring techniques were used in recent studies such as stereomicroscope, SEM analysis or photographs to measure the amount of residual antibiotic paste.[15,18,21] In the current study, the amount of residual antibiotic paste was measured with the scoring system which was described by Salgado *et al.*[15] using SEM images. The remnants of antibiotic pastes were examined at an×20 magnification with a stereomicroscope.[16] The present study evaluated the removal of mTAP in dentin tubules at ×1000 magnification using SEM.

Removal of TAP from root canals was evaluated with different irrigation agitation techniques such as needle irrigation, sonic irrigation, PUI, EndoVac (SybronEndo, Coppell, TX), CanalBrush (Coltene/Whaledent GmbH+ Co KG, Langenau, Germany), and EndoActivator (Dentsply, Tulsa, OK, USA).[16,18,22] Additionally, XPF was used to remove the antibiotic paste in a recent study.[23] When using the XPF file in root canal, the instrument become a spoon shape in its austenite phase and this shape provides more contact of the file to the root canal dentin, which may obtain higher cleaning efficacy.[12] The asymmetric structure of XPF results in a streaming effect of the irrigation solution when used with high speed. The streaming was also reported to be effective far from the surface of the files in the biofilm removal from the artificial grooves.[24] According to our results, XPF group showed better scores than the conventional needle irrigation group for cleaning efficacy in all thirds of the root canal. This finding also supported some previous results.[23,25] Similarly, Türkaydın *et al.*[23] compared the removal of TAP using CNI, PUI, and XPF in the apical thirds and reported that XPF removed TAP mixture more efficiently than the needle irrigation and PUI groups, albeit significantly. However, no difference was obtained between the needle irrigation and PUI groups.

In the middle and apical thirds, no significant differences were found between conventional irrigation and XPF. Similarly, Göktürk *et al.*[16] reported that in the apical third, no significant difference was seen between conventional needle irrigation and XPF. Only PUI presented significantly better cleaning efficacy in comparison with conventional needle irrigation. The superiority of PUI activation in the apical third could be explained with the higher velocity of irrigant flow and its efficiency in a flushing out loose mTAP from root canals.[26] XPF group showed significantly better cleaning efficacy than the other groups in the coronal third of the root canals. Although lower scores were obtained in the PUI group than the conventional needle irrigation in the coronal third, no significant difference was found. These findings could be related to the specific shape of the XPF instrument during rotation, and a relative reduction in the effectiveness of PUI from the apex to the coronal thirds.[27]

According to the results of the intragroup comparisons among the root canal thirds, the apical showed significantly higher scores than coronal thirds

in all groups. Thus, we may conclude that the cleaning of the apical third is more difficult than other root canal thirds. Based on our results, PUI and XPF were superior to the NI and the cleanliness of root canal third was affected by irrigation systems. Consequently, the null hypothesis was rejected. Nevertheless, none of the irrigation methods could render the root canal systems free of mTAP.

CONCLUSIONS

Compared to needle irrigation passive ultrasonic irrigation and XPF file agitation were found to be more effective in removing mTAP from root canals.

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None

CONFLICTS OF INTEREST

None

XP-Endo Finisher ve Pasif Ultrasonik İrrigasyonun Modifiye Üçlü Antibiyotik Patını Uzaklaştırma Etkinliği

ÖZ

Amaç: *Bu çalışmanın amacı klasik şırınga irrigasyonu (CNI), pasif ultrasonik irrigasyon (PUI) ve XP-endo Finisher (XPF) tekniklerinin modifiye üçlü antibiyotik patını (mTAP) uzaklaştırması açısından karşılaştırılmasıdır.* ***Gereç ve Yöntemler:*** *Otuz adet alt çene küçük azı dişi F3 eğe boyutuna kadar prepare edildi. mTAP, 250 mg siprofloksasin, 250 mg metronidazol, and 150 mg klindamisin içeren karışımın 1ml distile su ile karıştırılması ile hazırlandı ve kök kanallarına uygulandı. Dişler üç eşit gruba ayrıldı, irrigasyon/aktivasyon uygulandı ve dişler iki eşit parçaya ayrıldı. mTAP uzaklaştırılması trama elektron mikroskobu ile 4 aşamalı skorlama metodu ile değerlendirildi.* ***Bulgular:*** *Apikal üçlüde CNI ile PUI grupları arasında anlamlı fark bulunmasına rağmen (p<0,05), diğer irrigasyon aktivasyon yöntemleri arasında anlamlı fark bulunmadı (p>0,05). Orta üçlüde tüm gruplar arasında istatistiksel olarak anlamlı bir fark bulunmadı (p>0,05). Koronal üçlüde, XPF CNI grubundan anlmalı derecede daha fazla mTAP uzaklaştırdı (p<0,05). Ancak diğer gruplar arasdına anlamlı fark görülmedi (p>0,05).* ***Sonuçlar:*** *Pasif ultrasonik irrigasyon ve XPF eğe aktivasyonu, klasik şırınga irrigasyonuna göre kök kanallarından mTAP'ın uzaklaştırılmasında daha üstündür.* ***Anahtar kelimeler:*** *Kök kanal tedavisi, ultrasonik, kök kanalı ilaçları*

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