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Original Article

Evaluation of apically extruded debris from root canal filling removal of the mesiobuccal canal of maxillary molars using XP shaper and protaper with two different irrigation

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ABSTRACT

Background: Periapical extrusion of debris for root retreatment will effectively improve the posttreatment inflammation and pain. The aim of this study was to investigate the extruded debris for root retreatment using XP shaper and ProTaper files.

Materials and Methods: In his experimental laboratory study, 40 extracted human maxillary molars were used in this laboratory study. After disinfection and equalization of length, the samples were treated with a passive step-back technique and dressed. The samples placed in the tubes for retreatment were divided into four groups: (1) XP shaper file and hypochlorite, (2) XP shaper file and ethylenediaminetetraacetic acid (EDTA), (3) ProTaper file and hypochlorite, and (4) ProTaper file and EDTA. Then, the teeth were taken out of the tubes, and cleaned to collect the remaining apical debris. The weight of the tube and the extruded debris was measured again. Data were analyzed using the Kruskal–Wallis test (α =0.05).

Results: The highest average of extruded debris was related to the XP shaper file with EDTA solution, and the lowest average was related to the ProTaper file with hypochlorite solution. Between the two files used with EDTA and hypochlorite solution, the average debris extrusion of the XP shaper file with EDTA solution was significantly higher ($P < 0.05$) compared to the ProTaper and XP shaper files with hypochlorite solution ($P < 0.05$).

Conclusion: Regardless of the type of irrigant material, the ProTaper file can be a more suitable option than the XP shaper file for retreatment of the tooth root canal with minimal debris extrusion.

Key Words: Retreatment, root canal preparation, XP shaper file

INTRODUCTION

After the failure of primary root canal treatment, nonsurgical retreatment of endodontics is the first choice to extrude or reduce microbial infection. The main objective of this treatment is to completely extrude the previous filling materials from inside the root canal to access the apical part of the root to clean, shape, and refill it.[1,2] It has been shown that for the extrusion of previous root canal filling materials, these materials may be directed toward the apical part of the root along with necrotic tissues, bacteria, or detergents used during retreatment. These materials in

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the apical are known as the cause of post-treatment inflammation and pain.[3]

There are many techniques for gutta-percha extrusion from the root canal, including using hand files, rotary nickel-titanium devices, heating devices, ultrasonic devices, lasers, and/or solvents.[4,5] For the retreatment, canal preparation tools and techniques show different amounts of extruded apical debris. Several factors, such as the use of solutions, preparation methods, size, and type of file, affect the amount of debris extrusion.[6-8]

The ProTaper file has three retreatment files, D1, D2, and D3, which are used to extrude root-filling materials. D1 is designed to extrude filling materials from the coronal part of the root canal, and D2 and D3 are used to extrude filling materials from the middle and apical parts of the canals.[3] Recent innovations in endodontics devices have led to the production of single-file systems. These files have shown their efficiency and positive effects on canal preparation so that they can involve more canal walls than the multi-file system.

XP shaper is a single file system with unique metallurgy. It has a reinforced tip with six cutting edges. This unique design allows for increasing the apical diameter and thickness by at least 30.04 while maintaining the 3D shape of the root canal anatomy. By using an XP shaper, the cleaning stage is performed more reliably and prevents secondary infection in the canal. Its benefits are a significant reduction in patient pain, no need for recapitulation due to the effective extrusion of debris from the canal, and high efficiency on the retreatment of roots with previous root canal treatment.[9]

Cleansing plays an important role in the treatment of the root of the tooth. During root canal preparation and thereafter, the cleanser plays an important role in extruding microorganisms and dentin residues in the dental canal. Given that root canal treatment will not be successful without proper cleaning, the canal cleanser should prevent the accumulation and compression of soft and hard tissue residues in the canal at the apical end of the root and the extrusion of these materials to the areas around the tooth root. Various materials have been introduced as root canal cleansers, the most common of which are saline, sodium hypochlorite, Ethylenediaminetetraacetic acid (EDTA) alone or with sodium hypochlorite, chlorhexidine, citric acid, mixture of tetracycline, acid and detergent (MTAD), tetraclin, omix, potassium iodide, and etidronic acid.

5.25% sodium hypochlorite solution has been used as a common cleansing agent in endodontic treatments due to its antimicrobial composition of hypochlorous acid. This solution can kill viruses and spores, and the dissolving effect on necrotic tissues is more than the effect on living tissues.[10,11] EDTA is also a chelating agent that is combined with the calcium ion of the dentin and reduces micro-hardness, increases the permeability of the dentin tubules, and extrudes the smear layer.[12,13]

In a study by Gokturk *et al*.,[14] sodium hypochlorite showed the highest debris extrusion, and EDTA showed the lowest. In their study, Huang *et al*.[15] concluded that debris extrusion is inevitable in all root canal retreatment systems, but pro-taper files will perform better than other files. Sarıyılmaz *et al*.[16] found no difference between the studied groups in terms of the apical debris extrusion according to the devices and the cleanser inside the canal.

Given the importance of the effect of postretreatment extruded debris on post-treatment inflammation and pain and since various studies have shown different results, the objective of this study was to investigate and compare the extruded debris for the root retreatment from the mesiobuccal molar canal with 15°–20° curve using XP shaper and ProTaper files and EDTA and hypochlorite solution.

MATERIALS AND METHODS

This experimental laboratory study (ethic code: IR.IAU.KHUISF.REC.1400.031) was conducted on 40 mesiobuccal canals of extracted human maxillary molar teeth with a 15°–20°degree curve (due to the curve and small diameter). Schneider's method was used to measure the canal curve. For this purpose, periapical radiographs were prepared from the buccal lingual and mesiodistal dimensions of teeth.

Teeth that were severe curves or problems in the root and canal system (internal and/or external and root fracture), apex size, or teeth with open apex were excluded from the study.

For this purpose, periapical radiographs were prepared from the buccal-lingual and mesio-buccal dimensions of the teeth. Teeth that were severely deaf or had problems in the root and canal system (internal or external analysis and root fracture) were excluded from the study.

The surface of the teeth was cleaned from the remaining debris by a periodontal curette and placed in 5.25% sodium hypochlorite (Morvabon, Iran) and formalin (Daroko, Iran) solution for disinfection. The crowns of the teeth were shortened to equalize the length so that the length of all canals was 19 mm, and the access cavity was prepared. The length of the canal was obtained by placing K File 15 (Mani, Japan) in the canal and subtracting 1 mm from its length after observing the tip of the file from the end of the root. The teeth root was treated by the passive step-back technique. The samples were filled with gutta percha (Meta biomed, Korea) and AH26 sealer (Dentsply, Switzerland) by cold lateral compression technique.

Endodontic teeth were bandaged and placed in an incubator (Behdad, Iran) in an environment with a temperature of 37°C and 100% humidity for 2 weeks to set the sealer.[2,17] Then, the weight of 40 Eppendorf tubes (Q-LEB, China) was measured three times by a digital scale (Sartorius Analytical, Germany) with an accuracy of 0.001. The average weight of each was recorded separately. To prevent debris from coming out of the retreatment's lateral canals, the tooth's surface, except for 1 mm around the apical and access foramen, was covered with two layers of nail polish.

Next, by making a hole in the rubber tube, the teeth were inserted into the rubber up to the furcation, and the surrounding was sealed with wax. The teeth were randomly divided into four experimental groups of 10 for retreatment.

- Group 1: XP shaper file (Dentsply, Switzerland) and hypochlorite solution
- Group 2: XP shaper file and EDTA solution (Morvabon, Iran)
- Group 3: ProTaper file (Dentsply, Switzerland) and hypochlorite solution
- Group 4: ProTaper file and EDTA solution

Retreatment was performed using the speed and torque recommended by the file manufacturer. For the ProTaper and XP shaper files, an electric motor at 250 and 800 rpm and torque of 2 (1.5 for D3) and 1 N was used, respectively. Cleansing during work was done in three groups with 5 ml of 2.5% hypochlorite and in the other three groups with 5 ml of 17% EDTA. In the group with EDTA solution, the material was allowed for 1 min for cleansing.[18] After finishing the retreatment, the tooth was extruded from the Eppendorf tube, and the apical part of the tooth was cleaned with 1 ml of distilled water to collect the remaining debris. Then, the Eppendorf tubes were incubated at 70°C for 5 days. After the evaporation of the liquids, the weight of the Eppendorf tube and the debris collected in it was measured by a digital scale and compared with the average weight of each tube. The obtained data were analyzed using the Kruskal–Wallis test and SPSS version 24 (SPSS Inc., Chicago, IL, USA). The error level was considered 5%.

RESULTS

As shown in Table 1, the extruded debris in the four groups was significant ($P < 0.001$), and the average of the extruded debris was not the same in the groups.

In a pair-wise comparison of the groups, the mean extruded debris in the ProTaper file-hypochlorite solution group was significantly lower than the ProTaper file-EDTA solution and XP shaper file-EDTA solution groups ($P < 0.001$). The mean extruded debris in the ProTaper file-hypochlorite solution group was not significantly different from the XP shaper file-hypochlorite solution group ($P = 0.187$).

The average extruded debris in the ProTaper file-EDTA solution group increased significantly compared to the ProTaper file-hypochlorite solution group ($P < 0.05$), with no significant difference between the two XP shaper groups. The average of extruded debris in the XP shaper file-hypochlorite solution group was significantly reduced compared to the XP shaper file-EDTA solution group. The average of extruded debris in the XP shaper file-EDTA solution group was significantly increased compared to the ProTaper file-hypochlorite solution and the XP shaper file-hypochlorite solution groups ($P < 0.05$) [Figure 1].

DISCUSSION

After the failure of primary root canal treatment, nonsurgical re-treatment of endodontics is the first

Table 1: The extruded debris in the four groups (µg)

System	No	Mean±SD	Maximum	Minimum	*P*
Pro taper					
Hypochlorite	10	0.0508±0.00504	0.0581	0.0450	<0.001
EDTA	10	0.1186±0.02462	0.1525	0.0907	
XP shaper					
Hypochlorite	10	0.0831±0.8732	0.3271	0.0186	
EDTA	10	0.1949±0.06691	0.2612	0.0379	

SD: Standard deviation; EDTA: Ethylenediaminetetraacetic acid

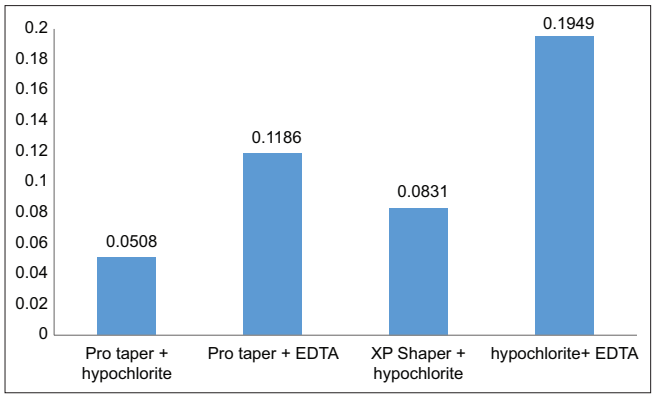

Figure 1: The mean extruded debris in four groups. EDTA: Ethylenediaminetetraacetic acid.

choice to eliminate or reduce microbial infections. The main purpose of this treatment is to completely remove the previous filling materials from inside the root canal to access the apical part of the root and to clean, shape, and refill it.[1,2]

In the present study, the extruded debris for the root retreatment from the molar mesiobuccal canal was investigated and compared using the XP shaper and ProTaper files and EDTA and hypochlorite solution.

The reason for selecting the XP shaper file in the present study was its advantages, including its special shape that causes snake-like movement and high flexibility with continuous rotation at high speed and minimum torque.

In general, the type of file and the cleansing affect the apically extruded debris. A difference was in the use of sequential and single file systems. On the one hand, because hypochlorite and EDTA are the most common and suitable cleansing solutions available, the cumulative effect of files and cleaning materials was investigated in the present study. Since most of the studies were conducted on single-canal teeth with no crown, most root-treated teeth problems are related to molar teeth with crowns. This study used the mesiobuccal root of the upper first molar.

Given the importance of selecting the right method for root retreatment, there are still contradictions in this field. Several factors, such as the type of cleansing solution used, canal preparation methods, size, type of file, type of tooth, and crown of the root canal, affect the apical extrusion of debris.[6-8] In a study by Chandrasekar *et al*.,[19] the apically extruded debris was the lowest in the H file group. In a Topçuoğlu *et al*.'s[20] study, the extruded debris by File H was significantly higher than in rotary systems.

In a study by Huang *et al*.,[15] debris extrusion was present in all systems used for endodontic retreatment. In a study by Elashiry *et al*.,[21] all files showed some apically extruded debris. Uzunoglu *et al*.[22] stated that the number of taper files used for the retreatment was effective on the extruded debris. However, in their study, Çanakçi *et al*.[6] showed that reciprocating systems push a greater amount of debris to the apical area, and some researchers related the apically-extruded debris to the type of cleansing used inside the canal.[5,15]

According to the results of the present study, there was apical debris extrusion in all four investigated groups, which is consistent with the results of other studies,[14] indicating that apical debris extrusion is inevitable for the primary treatment and retreatment of the root.

According to the results of the present study, the highest periapical debris extrusion was observed using the XP shaper file and EDTA solution, which is inconsistent with the results of some studies.[14,18,23,24] According to the study results, perhaps the reason for more debris extrusion in the XP shaper group is that the file sequence, such as the ProTaper prepared by the Crown-Down technique, causes less debris extrusion. In addition, the presence of more space due to the narrower core and the special shape that causes the snake-like movement, like the XP shaper file, causes more apically extruded debris. Despite more debris extrusion, combining the XP shaper file and ETDA solution may be more effective in cleaning the canal. The reason for more debris extrusion in the EDTA solution groups in this study can be attributed to its chelating agent, and the reason for more apically extruded debris, compared to other studies, is an increase in temperature by a heater for the treatment. Of course, in different studies, debris extrusion investigated on other types of files is different.[1,6,14,25-28]

In a study by Savadkouhi *et al*.,[29] the XP shaper file had less debris extrusion than the one-shape system. In a study by AlOmari *et al*.,[1] the XP shaper file had the highest coronal gutta-percha extrusion and the lowest apical debris extrusion for the retreatment. In addition, Azim *et al*.[10] reported that the XP shaper file had the lowest apical debris for the retreatment. In general, however, in rotary systems that prepare the root canal by the Crown-down technique, due to the file being designed and the forward movements

inside the canal, most of the debris is extruded coronally, and very little debris exits the apical area. While hand files by the passive step back cause most of the debris to be pushed to the apical area.[30] Beeson *et al*.[31] also, by comparing manual preparation using the passive step back and the 29 profile series system, showed that in the group where the passive step back was used up to the apical foramen area, the debris extrusion was significantly higher. Myers and Montgomery[32] compared the Canal Master rotary system with the passive back step in debris extrusion. They concluded that in the passive step back, by preparing up to the apical foramen area, less debris was pushed to the periapical area. This difference in the results can be attributed to the different sizes and thicknesses of the compared files, the type of teeth, the type of files compared, the type of cleanser, and the technique and skill of the operator.

Hinrichs *et al*.[33] showed that debris extrusion was directly related to the cleansing solution for the type of cleanser and its relationship with debris extrusion for the treatment. Nevertheless, in a study by Gokturk *et al*.,[14] the highest debris extrusion was obtained from sodium hypochlorite solution, and the lowest was obtained from EDTA solution.

Other confounding factors, such as the concentration of the cleanser, affect the solubility of the cleanser. On the other hand, most of the studies have been conducted on single-canal teeth. While in this study, the narrowness and curve of the canals affect debris extrusion and the effect of canal cleanser. Perhaps, this difference in the results is attributed to the simultaneous examination of two types of devices and two types of cleansing solution because, in other studies, the role of devices in measuring the apical debris extrusion has been investigated more to eliminate the effect of cleanser from distilled water is used. Therefore, the concentration of materials and the environment's temperature can also have an effect. In addition, the canal type and curve were also effective factors in the difference between the present study and other studies.

According to the results of the present study, the ProTaper file causes less periapical debris extrusion, which may be attributed to the sequence of this file and the canal preparation technique (the Crown-Down technique). On the other hand, it may be said that the chelation of canal cleansing solution has a direct effect on the apical debris extrusion, which is confirmed by the results of the present study.

CONCLUSION

Regardless of the type of device and cleanser, apical debris extrusion was observed in the four groups. The highest periapical debris extrusion was observed using the XP shaper file and EDTA solution. According to the study results, it can be said that in addition to selecting the type of file for the retreatment, the type of cleansing solution should be considered an effective factor in canal debris extrusion and driving debris to the periapical area.

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Conflicts of interest

The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or non-financial in this article.

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