Published online: 2019-09-23

Original Article

Impact of different file systems on the amount of apically extruded debris during endodontic retreatment

Emel Uzunoglu[1], Sevinc Aktemur Turker[2]

[1]Department of Endodontics, Faculty of Dentistry, Hacettepe University, Ankara, Turkiye,
[2]Department of Endodontics, Faculty of Dentistry, Bülent Ecevit University, Zonguldak, Turkiye

Correspondence: Dr. Emel Uzunoglu
Email: emel_dt@hotmail.com

ABSTRACT

Objective: The goal of present study was to determine the effect of different nickel–titanium file systems on the amount of apically extruded debris during endodontic retreatment: D-RaCe retreatment systems, EdgeFile XR retreatment rotary files, and Reciproc R40. **Materials and Methods:** Thirty-six single-rooted prepared mandibular premolar teeth were filled with Gutta-percha and AH Plus sealer. The teeth were then randomly assigned into three groups (n = 12) for retreatment. The endodontic retreatment was performed as follows: D-RaCe, EdgeFile XR, Reciproc 40. Debris extruded apically during the retreatment was collected into preweighed Eppendorf tubes. An incubator was used to store tubes at 70°C for 5 days. The initial weight was subtracted from final weight of the Eppendorf tubes to calculate the weight of the dry extruded debris for each group. The data obtained were evaluated using Welch analysis of variance and Games-Howell *post-hoc* tests ($P < 0.05$). **Results:** All files resulted in apical extrusion of debris. Reciproc caused significantly less debris extrusion compared to D-RaCe and EdgeFile XR ($P < 0.05$). **Conclusions:** The findings revealed that during endodontic retreatment, number, and taper of files might have an influence on the amount of apically extruded debris during endodontic retreatment.

Key words: Endodontics, nickel–titanium alloy, retreatment

INTRODUCTION

Endodontic retreatment has to be done completely after ineffective root canal treatment in order to facilitate the proper chemomechanical preparation of the root canal system and to preserve tooth integrity. Endodontic instruments are used with light or medium pressure in apical way during retreatment that necrotic pulp tissues, bacteria, irrigants, or obturation materials might be extruded into the apical area. These apically extruded materials have been considered clinically responsible for flare-up and postoperative inflammation or even failure of apical healing.[1,2]

Endodontic retreatment might be difficult and take longer time than the initial treatment.[3] Manufacturers have been developed special instrument systems, which are used with an engine-driven motor and continuous rotation such as ProTaper Universal Retreatment system (Dentsply Maillefer, Ballaigues, Switzerland), the Mtwo Retreatment system (VDW,

Access this article online
Quick Response Code:
Website: www.eurjdent.com

How to cite this article: Uzunoglu E, Turker SA. Impact of different file systems on the amount of apically extruded debris during endodontic retreatment. Eur J Dent 2016;10:210-4.

DOI: 10.4103/1305-7456.178306

Munich, Germany), R-Endo system (Micro-Mega, Besançon, France), and D-RaCe (FKG Dentaire, La Chaux-de-Fonds, Switzerland) in order to promote retreatment procedures.[4,5] New concepts were introduced in which root canal preparation is completed with different motions. Reciproc is a reciprocating instrumentation system, which includes three sizes of instruments (R25, R40, and R50) to be used according to the initial canal diameter.[6] Root canals could be prepared and cleaned with only one of these Reciproc instruments. This instrument is also advocated for retreatment purposes to remove any residual filling material.[5,7-9]

Recently, EdgeFile XR retreatment nickel–titanium (Ni–Ti) rotary files that are made of an annealed heat-treated Ni-Ti alloy brand named Fire-Wire™, have been introduced to the market. The deformation and strength characteristics of metals and metal alloys could be changed with heat treatment. According to manufacturer Fire-Wire™ Ni–Ti yields performance-enhancing durability that provides incredible flexibility, so that XR files will enhance and expedite the endodontic retreatment. System includes four files - R1 (25/0.12), R2 (25/0.08), R3 (25/0.06), R4 (25/0.04) – that are used in crown-down manner. All files have constant taper and parabolic cross section.

There are few studies evaluating the amount of apically extruded debris during the removal of root canal filling material using the Reciproc and D-RaCe instruments.[4,5,9] Furthermore, no studies have quantitatively assessed the amount of debris extruded apically in the retreatment procedure performed using EdgeFile XR retreatment system. Therefore, the goal of present study was to quantitatively determine the amount of debris extruded apically during the retreatment using the Reciproc, D-RaCe, and EdgeFile XR systems. The null hypothesis was that there would be no difference regarding apically extruded debris during retreatment with these files.

MATERIALS AND METHODS

Thirty-six extracted human mandibular premolars with complete root formation and working lengths (WLs) of approximately 21 mm were selected. Periapical radiographs were taken in the buccolingual and mesiodistal direction in each tooth. Only teeth with single and straight root canal (<10°) according to the Schneider method[10] were included in the study. Specimens in similar dimensions with an initial apical diameter corresponding to a size 15 K-file (Mani Inc., Tochigi, Japan) were selected. To standardize the canal morphology, only roots with oval-shaped canals according to criteria (long/short cross-section diameter ratios of ≥ 2.5, at 5 mm from the apex) that were mentioned previously by De-Deus *et al*.[11] were selected. A 0.9% saline solution was used to store teeth until use.

Root canal preparation and obturation

For reference point, the buccal cusp edge of each tooth was flattened. Endodontic access cavities were prepared with a diamond bur in a high-speed hand piece. The WL was established as 1 mm shorter than the length of the root. A master apical size 35 with K files (Mani Inc., Tochigi, Japan) was used to prepare root canals by using the balance force technique. Step back technique was performed by using K-files #40–50 (Mani Inc., Tochigi, Japan). Root canals were irrigated with 2 mL of 2.5% NaOCl (Sultan, WA, USA) between each file. The irrigation needle (NaviTip 31-gauge needle; Ultradent, South Jordan, UT, USA) was placed as deep as possible into the canal without resistance until it was 1 mm short of the predetermined WL. On completion of instrumentation, each root canal was irrigated with 10 mL of 17% ethylenediaminetetraacetic acid (Vista Dental Products, Racine, WI, USA) and 10 mL distilled water and then dried with paper points (Diadent, Chungcheongbuk-do, Korea). Master Gutta-percha cones of size #35 and taper 0.02 (Dentsply Maillefer, Ballaigues, Switzerland) were placed into the root canal to the WL. AH Plus sealer (Dentsply DeTrey, Konstanz, Germany) was used as sealer. Additional Gutta-percha cones were placed to the depth at which resistance was met. Mesiodistal and buccolingual radiographs were taken to confirm complete filling. The excess Gutta-percha in the coronal portion was removed with a heated plugger, and the root canal openings of all specimens were sealed with temporary filling material (Cavit; 3M ESPE, Seefeld, Germany). The teeth were stored at 37°C and 100% humidity for 1 week to allow setting of the sealer. Root canal cleaning, shaping, filling, and retreatment procedures were performed by a single operator to avoid inter-operator variability.

Debris collection

A similar experimental model described previously was used for determining extruded debris.[5,12,13] Stoppers were separated from the Eppendorf tubes. An analytical balance (Radwag, Radom, Poland) with an accuracy of 10^{-4} g. was used to measure the initial weights of the tubes. Three consecutive weights were obtained for each tube, and the mean value was calculated. A hole was created on each stopper. Each tooth was inserted up to the cementoenamel junction, and a 27-gauge

needle (Ultradent, South Jordan, UT, USA) was placed alongside the stopper. This acted as a drainage cannula and helped to balance the air pressure inside and outside the tubes. Then, each stopper with the tooth and the needle was attached to its Eppendorf tube, and the tubes were fitted into vials with cyanoacrylate. A rubber-dam sheet was used to prevent leakage of overflowing irrigant and also the root apex shielded from operator during the instrumentation procedure.

Retreatment techniques

The 36 teeth were randomly assigned into three groups with 12 specimens in each group. The groups were arranged according to filling material removal systems, which have been used: Reciproc R40 (VDW, Munich, Germany) EdgeFile XR retreatment rotary files (EdgeEndo, Albuquerque, NM, USA) and D-RaCe retreatment systems (FKG, Dentaire, La Chaux-de-Fonds, Switzerland).

Group R40; R40 file was used in a slow in-and-out pecking motion with a 3-mm amplitude limit. Gentle apical pressure was combined with a brushing motion against the lateral walls of the root canal.[14] After three complete pecking movements, the instrument was removed from the canal, and its flutes were cleaned off by insertion into a clean stand with a sponge.

Group EdgeFile; R1 (25/0.12), R2 (25/0.08), R3 (25/0.06) and R4 (25/0.04) files were used in crown-down manner with light to medium pressure in apical way, respectively. The sequence was repeated until R4 reaches to WL. Final apical preparation was then performed using the EdgeFile X3-C_4 file (size 40/0.06 taper) at a speed of 500 rpm and a torque of 3 Ncm as EdgeFile XR retreatment rotary files.

Group D-RaCe; D-RaCe retreatment instruments were used as follows: DR1 (size 30/0.10 taper) at a speed of 1000 rpm and a torque of 1.5 Ncm for the cervical third and the beginning of the middle third and DR2 (size 25/0.04 taper) at a speed of 600 rpm and a torque of 1 Ncm to the WL. The DR2 instrument was used with light apical pressure until the WL was reached. Final apical preparation was performed with the RaCe instrument (size 40/0.04 taper) at a speed of 600 rpm and a torque of 1 Ncm.

All instruments were used with a 16:1 contra-angle hand-piece powered by a torque-limited endodontic motor (X-Smart Plus, Dentsply Maillefer, Ballaigues, Switzerland) according to manufacturer instructions. A single experienced operator performed all root canal filling removal protocols. The root filling removal was judged complete when the WL was reached, and no residual filling material was observed in the instrument flutes.[4] No solvent was applied to facilitate material removal in all groups.

Determination of debris amount

When retreatment procedures were completed, 5 mL of distilled water was used to irrigate root canals as a final irrigant. The irrigant was delivered by 5 mL disposable plastic syringes (Ultradent, South Jordan, UT, USA). The irrigation needle (NaviTip 31-gauge needle; Ultradent, South Jordan, UT, USA) was placed as deep as possible into the canal without resistance until it was 1 mm short of the predetermined WL. Then, root canals were dried with paper points (Diadent, Chungcheongbuk-do, Korea), and the teeth were removed from the Eppendorf tubes. All of the tubes were incubated at 70°C for 5 days to evaporate the irrigant in the Eppendorf tubes, before being weighed again.[12] After the incubation period, the tubes were weighed again 3 times. The average of these measurements was considered to be the weight of the tube plus the debris. The difference between pre- and post-treatment weights was calculated, and statistical evaluation was performed using SPSS 21.0 software (SPSS Inc., Chicago, IL, USA). Normality distribution of data was determined by Shapiro–Wilk test. The data obtained were analyzed using Welch analysis of variance (ANOVA) followed by *post-hoc* Games-Howell tests ($P < 0.05$).

RESULTS

The mean and the standard deviation values of each experimental group are shown in Table 1. There was a statistically significant difference regarding apically extruded debris among groups depending to Welch ANOVA test ($P < 0.05$). Pairwise comparison revealed that Reciproc was associated with less apical extruded debris and was statistically different form D-RaCe and EdgeFile XR; P values were 0.01 and 0.043, respectively. Also there was statistically significant difference between D-RaCe and EdgeFile XR groups ($P = 0.08$).

Table 1: Mean and standard deviation values of apically extruded debris in experimental groups (g)

Retreatment systems	Mean	SD	Number of samples
D-RaCe[a]	0.00196	0.00071	12
EdgeFile[b]	0.00089	0.00038	12
Reciproc[c]	0.00045	0.00023	12

SD: Standard deviation. *Groups with the different superscript letters ([a, b, c]) were significantly different ($P<0.05$)

DISCUSSION

Apical extrusion of debris, which is one crucial reason of postoperative pain and discomfort,[15] is still unavoidable.[4,5,9,12,13] On the other hand, there are various studies that reported favorable effects of Ni–Ti rotary instruments (either introduced for retreatment or for preparation procedures) compared to conventional techniques on amount of apically extruded debris.[4,5,16,17] There are less retreatment systems on the market compared to preparation systems. Furthermore there are few studies evaluated these systems effects on the amount of apically extruded debris during endodontic retreatment.[4,5,14,16-18] Hence, the aim of this study was to evaluate the effect of two retreatment systems (D-RaCe and EdgeFile XR) and one reciprocating single-file system (Reciproc 40) on the amount of apically extruded debris. The Reciproc is made of "M-Wire" and able to prepare canals with only a single instrument and has an identical S-shaped cross-sectional design with sharp cutting edges. R40 file has a tip size 40 with a taper 6% over the first 3 mm. There are controversial results regarding Reciproc files' debris extrusion potential during primary root canal treatments.[12,19-21] Koçak *et al*.[12] and De-Deus *et al*.[19] reported that there was less apically extruded debris with Reciproc, however Bürklein *et al*.[21] and Bürklein and Schäfer[20] reported that there was more amount of debris extruded apically with Reciproc. There are limited studies that use Reciproc for endodontic retreatment. Reciproc system resulted in more apical debris extrusion than the Mtwo system according to Lu *et al*.[14] However, Dincer *et al*.[5] and Silva *et al*.[9] reported that Reciproc was associated with less debris extrusion when compared with a conventional rotary retreatment system such as ProTaper Universal retreatment system, and Mtwo retreatment system. The result of present study was consistent with these two studies. Reciproc produced significantly less amount of apical extruded debris than the other groups. One possible reason of this result might be the number of files that were used for retreatment; the other one might be the motion kinetics of files.[9] D-RaCe and EdgeFile XR were rotated continuously inside the root canal. D-RaCe was associated with more apical extruded debris compared to other groups. The D-RaCe set consists of two NiTi files – DR1 (30/0.10) and DR2 (25/0.04). Topçuoglu *et al*.[4] reported that there was no statistical difference between the ProTaper Universal, D-RaCe, and R-Endo retreatment groups. EdgeFile XR retreatment system is composed of four files R1 (25/0.12), R2 (25/0.08), R3 (25/0.06), and R4 (25/0.04), with same apical diameter with different tapers. They are made of an annealed heat-treated Ni–Ti alloy brand named Fire-Wire™. EdgeFile XR system caused less apical extruded debris compared to D-RaCe, even the number of files that were used during retreatment were more than D-RaCe. The alteration of taper and apical diameter between two files of D-RaCe is more prominent, than EdgeFile XR system. This extreme change between files in D-RaCe group might have an impact on apical pressure that was applied to instruments during retreatment. Hence this might result in more apical extruded debris. Instrumentation techniques and the design of the instruments have been shown to be effective on amount of apical debris extrusion.[17,22,23]

R40 file was chosen because the apical diameter of the master apical file in the initial canal preparation was size 35 and this was larger than that of the retreatment systems. Therefore, in the present study, supplementary instrumentation was performed using RaCe instrument (40/0.04) and EdgeFile X3-C_4 instrument (40/0.06). Marques da Silva *et al*.[24] reported that supplementary instrumentation performed after the use of ProTaper and D-RaCe retreatment files provided more effective cleaning than the use of only retreatment instruments in the apical third. However, there is no current study evaluating the effect of supplementary instrumentation on apically extruded debris.

Distilled water was preferred as an irrigation solution to avoid any possible crystallization of sodium hypochlorite that could change the weight of dentin debris and compromise the reliability of the results.[25] It is important to emphasize that file systems were compared in an experimental model using that collected apically extruded debris from extracted teeth. This technique allows a comparison of the file systems under identical conditions and has been used in many studies previously,[4,5,12,13,20,21,26] but it does have limitations.[25] The main disadvantage of the method is that vital periapical tissues cannot be mimicked. Apical extrusion was not limited, because of the absence of a physical backpressure provided by periapical tissues *in vivo*.[27] This is an imminent shortcoming of *in vitro* designs with no periapical resistance; as a result certain degree of caution should be taken when transferring the present results to the clinical situation. Furthermore, this study was limited to teeth with mature root morphology. The observed results should not be generalized to teeth with immature root development and open apices.

CONCLUSION

Within the limitations of this *in vitro* study, all instrumentation techniques produced debris extrusion. Null hypothesis was rejected, as there were significant differences among all groups regarding apically extruded debris. It can be concluded that properties of file systems (metal alloy, number of files, motion kinetics, taper, apical diameter) might have an impact on amount of apically extruded debris during endodontic retreatment. Further studies are needed to evaluate the novel retreatment system EdgeFile XR retreatment rotary files, which is made from Fire-Wire™.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

REFERENCES

1. Nair PN. On the causes of persistent apical periodontitis: A review. Int Endod J 2006;39:249-81.
2. Tinaz AC, Alacam T, Uzun O, Maden M, Kayaoglu G. The effect of disruption of apical constriction on periapical extrusion. J Endod 2005;31:533-5.
3. Duncan HF, Chong BS. Removal of root filling materials. Endod Topics 2008;19:33-57.
4. Topçuoglu HS, Akti A, Tuncay Ö, Dinçer AN, Düzgün S, Topçuoglu G. Evaluation of debris extruded apically during the removal of root canal filling material using ProTaper, D-RaCe, and R-Endo rotary nickel-titanium retreatment instruments and hand files. J Endod 2014;40:2066-9.
5. Dincer AN, Er O, Canakci BC. Evaluation of apically extruded debris during root canal retreatment with several NiTi systems. Int Endod J 2015;48:1194-8.
6. Altunbas D, Kutuk B, Kustarci A. Shaping ability of reciprocating single-file and full-sequence rotary instrumentation systems in simulated curved canals. Eur J Dent 2015;9:346-51.
7. de Souza PF, Oliveira Goncalves LC, Franco Marques AA, Sponchiado Junior EC, Roberti Garcia Lda F, de Carvalho FM. Root canal retreatment using reciprocating and continuous rotary nickel-titanium instruments. Eur J Dent 2015;9:234-9.
8. Fruchi Lde C, Ordinola-Zapata R, Cavenago BC, Hungaro Duarte MA, Bueno CE, De Martin AS. Efficacy of reciprocating instruments for removing filling material in curved canals obturated with a single-cone technique: A micro-computed tomographic analysis. J Endod 2014;40:1000-4.
9. Silva EJ, Sá L, Belladonna FG, Neves AA, Accorsi-Mendonça T, Vieira VT, *et al.* Reciprocating versus rotary systems for root filling removal: Assessment of the apically extruded material. J Endod 2014;40:2077-80.
10. Schneider SW. A comparison of canal preparations in straight and curved root canals. Oral Surg Oral Med Oral Pathol 1971;32:271-5.
11. De-Deus G, Reis C, Beznos D, de Abranches AM, Coutinho-Filho T, Paciornik S. Limited ability of three commonly used thermoplasticized gutta-percha techniques in filling oval-shaped canals. J Endod 2008;34:1401-5.
12. Koçak S, Koçak MM, Saglam BC, Türker SA, Sagsen B, Er Ö. Apical extrusion of debris using self-adjusting file, reciprocating single-file, and 2 rotary instrumentation systems. J Endod 2013;39:1278-80.
13. Myers GL, Montgomery S. A comparison of weights of debris extruded apically by conventional filing and canal master techniques. J Endod 1991;17:275-9.
14. Lu Y, Wang R, Zhang L, Li HL, Zheng QH, Zhou XD, *et al.* Apically extruded debris and irrigant with two Ni-Ti systems and hand files when removing root fillings: A laboratory study. Int Endod J 2013;46:1125-30.
15. Seltzer S, Naidorf IJ. Flare-ups in endodontics: I. Etiological factors. J Endod 1985;11:472-8.
16. Somma F, Cammarota G, Plotino G, Grande NM, Pameijer CH. The effectiveness of manual and mechanical instrumentation for the retreatment of three different root canal filling materials. J Endod 2008;34:466-9.
17. Huang X, Ling J, Wei X, Gu L. Quantitative evaluation of debris extruded apically by using ProTaper universal tulsa rotary system in endodontic retreatment. J Endod 2007;33:1102-5.
18. Mollo A, Botti G, Prinicipi Goldoni N, Randellini E, Paragliola R, Chazine M, *et al.* Efficacy of two Ni-Ti systems and hand files for removing gutta-percha from root canals. Int Endod J 2012;45:1-6.
19. De-Deus G, Neves A, Silva EJ, Mendonça TA, Lourenço C, Calixto C, *et al.* Apically extruded dentin debris by reciprocating single-file and multi-file rotary system. Clin Oral Investig 2015;19:357-61.
20. Bürklein S, Schäfer E. Apically extruded debris with reciprocating single-file and full-sequence rotary instrumentation systems. J Endod 2012;38:850-2.
21. Bürklein S, Benten S, Schäfer E. Quantitative evaluation of apically extruded debris with different single-file systems: Reciproc, F360 and OneShape versus Mtwo. Int Endod J 2014;47:405-9.
22. Tanalp J, Kaptan F, Sert S, Kayahan B, Bayirl G. Quantitative evaluation of the amount of apically extruded debris using 3 different rotary instrumentation systems. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2006;101:250-7.
23. al-Omari MA, Dummer PM. Canal blockage and debris extrusion with eight preparation techniques. J Endod 1995;21:154-8.
24. Marques da Silva B, Baratto-Filho F, Leonardi DP, Henrique Borges A, Volpato L, Branco Barletta F. Effectiveness of ProTaper, D-RaCe, and Mtwo retreatment files with and without supplementary instruments in the removal of root canal filling material. Int Endod J 2012;45:927-32.
25. Tanalp J, Güngör T. Apical extrusion of debris: A literature review of an inherent occurrence during root canal treatment. Int Endod J 2014;47:211-21.
26. Ozsu D, Karatas E, Arslan H, Topcu MC. Quantitative evaluation of apically extruded debris during root canal instrumentation with ProTaper universal, ProTaper next, WaveOne, and self-adjusting file systems. Eur J Dent 2014;8:504-8.
27. Bonaccorso A, Cantatore G, Condorelli GG, Schäfer E, Tripi TR. Shaping ability of four nickel-titanium rotary instruments in simulated S-shaped canals. J Endod 2009;35:883-6.