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The effect of XP-Endo Finisher and XP-Endo Finisher R supplementary files on the apical debris extrusion during retreatment

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Purpose: The enhanced filling material removal efficiency of XP-Endo Finisher (XPF) and XP-Endo Finisher R (XPFR) files was reported in several studies. However, the impact of this efficiency on the debris extrusion is unknown. Therefore, this study was planned to evaluate the amount of apically extruded debris using these instruments during retreatment.

Methods: Forty-five mandibular premolar teeth were instrumented with ProTaper Next system and filled with gutta-percha and an epoxy resin-based sealer using single cone technique. Teeth were randomly divided into three groups according to the file used for root filling material removal (n = 15): Reciproc, Reciproc + XPF, Reciproc + XPFR. Apically extruded debris was collected in pre-weighed Eppendorf tubes. The dry weight of the extruded debris was calculated by subtracting the weight of the empty tube from that of the tube containing debris. Distribution of data was determined by Shapiro–Wilk test. Groups were compared with one-way analysis of variance. The significance level was set at p = .05.

Results: All file systems were associated with apical debris extrusion. No statistically significant difference was found among groups (p> .05).

Conclusion: XPF and XPFR files when used as a supplementary file for improving retreatment have no significant effect on the amount of apically extruded debris.

Keywords: Apically extruded debris, endodontic retreatment, XP-Endo Finisher, XP-Endo Finisher R.

Introduction

Nonsurgical root canal retreatment is a primary option when the initial root canal treatment fails. The complete removal of existing root canal filling materials is an important step of retreatment procedure to provide an effective recleaning, disinfection, and subsequent refilling of the root canal system. Hand files, nickel titanium rotary, or reciprocating instruments with different designs and alloys have been used for removing the existing filling materials (1,2). Nevertheless, none of the different techniques and file systems can provide complete removal of the filling materials from the root canals. For this reason, supplementary approaches have been proposed to increase the removal of residual filling material and cleaning of root canals (3–5).

XP-Endo Finisher (XPF; FKG Dentaire, La Chaux-de-Fonds, Switzerland) has been introduced with the purpose of improving root canal cleaning for use as a supplemen-

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tary final step following root canal preparation with any file system of diameter #25 or larger. XPF is moved up and down for 7–8 mm inside the canal, thereby causing turbulence of the irrigation solution. Recently, XP-Endo Finisher R (XPFR; FKG Dentaire, La Chaux-de- Fonds, Switzerland) file has been suggested to use as an additional approach in retreatment procedures to maximize root canal filling removal, especially in the curvature or oval areas. It can be applied as a supplementary final step following removing filling material with any file system of diameter #30 or larger (5).

Retreatment techniques cause various amounts of apically extruded debris (6,7). It includes pulp remnants, microorganism, root canal filling materials, or irrigation solutions (7) and can lead to periapical inflammation, flare-ups, post-operative pain, delay of periapical healing, and long-term failure (8). To date, to the best of the authors' knowledge, no study has evaluated the extent of apical extrusion of debris by the XPF and XPFR supplementary files when used in filling removal. Therefore, the aim of this study was to compare the amount of apically extruded debris after the use of XPF and XPFR files in retreatment procedure. The null hypotheses were that there would be no significant effect of these files on the amount of apically extruded debris; and there would be no significant difference in the amounts of apically extruded debris between the XPF and XPFR files.

Materials and Methods

The study protocol was approved by the university of non-interventional clinical research ethics board (protocol no: 2020/13–6). Forty-five extracted straight single-rooted mandibular premolars without previous endodontic treatment, immature apices, caries, cracks, resorption, or calcification were selected. Teeth were decoronated to provide a 16 mm root length. Only teeth with an initial apical size equivalent to a size 10 K-file were selected. A size 10 K-file was placed into the canal until its tip was visible at the apical foramen. The working length was determined 0.5 mm short of this length. Root canals were prepared with the ProTaper Next system (Dentsply Maillefer, Ballaigues, Switzerland) up to an X3 file at WL according to the manufacturer's instructions at 300 rpm and 2 Nm torque with an endodontic motor (X-Smart Plus, Dentsply, Maillefer, Ballaigues, Switzerland). The canals were irrigated with 5 ml 2.5% NaOCl during root canal preparation. After preparation, for final irrigation, 5 ml 17% EDTA and 10 mL distilled water were used and the root canals were dried using paper points. The root canals were filled with X3 gutta-percha cones (Dentsply, Maillefer, Ballaigues, Switzerland) and an epoxy resin-based sealer (Dia-Proseal, Dia-

Fig. 1. Representative image of apparatus for collection debris.

dent, Cheongju, Korea) with the single cone technique. The excess gutta-percha was cut off with a hot instrument, and the top of the root filling was condensed vertically with a plugger. Digital radiographs were taken to confirm the extend of root filling. The filled roots were stored at 37°C in 100% humidity for 1 week to allow the sealer to set.

The experimental model used to evaluate apical debris extrusion was as described on previous works (9,10) (Figure 1). Caps 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 weight of the tubes. Three consecutive measurements were taken for each tube, and the average of the measurements was calculated. A round hole was created on each cap. Each tooth was inserted into the cap and fixed with cyanoacrylate to prevent the unintentional leakage of the irrigation solution. A 27-gauge needle (Ultradent, South Jordan, UT, USA) was placed alongside the cap to help to balance the air pressure inside and outside the tubes. Then, caps with the teeth and the needles were attached to its Eppendorf tubes, and the tubes were fitted into vials. A rubber dam sheet was used to shield the root apex from operator during the instrumentation procedure. The specimens were randomly divided into three groups using a web program (www.randomizer.org).

Retreatment Protocols

The root fillings were removed using Reciproc file (25.08 taper) powered with an endodontic motor (X-Smart Plus, Dentsply Sirona Endodontics) until the WL was reached.

After reaching the WL with R25 file, the R40 file (40.06 taper) was used in further apical enlargement. Files were used in reciprocal motion using in-and-out pecking motions of 3 mm in amplitude. After three pecking motions, the instrument was removed and cleaned. Reciproc + XPF: Reciproc files (R25 and R40) were used initially to remove the filling materials as described in Reciproc group. Later, XPF file was used according to the manufacturer's instructions. Instruments were operated with X-Smart Plus at 1000 rpm and 1 Ncm for 1 min. Instruments were used in slow and gentle 7–8 mm lengthwise movements up to the WL. During instrume ntation, distilled water (preheated to 37°C) was used as an irrigation solution. Reciproc + XPFR: The initial retreatment protocol was performed with Reciproc files as described previously. Later, XPFR files were used in a similar way to that of XPF files.

Each instrument was used in two canals and was then discarded. Retreatment procedures were completed when canal walls were smooth and free of visible debris and no obvious filling material was seen on the files. Eppendorf tubes were removed from the vials. To collect adhered debris at the root surface, the apical part of each tooth was washed with 1 ml distilled water. During the retreatment procedure, a total of 10 mL of distilled water were used for each root canal and solvent was not used. Specimens were stored in an incubator at 70°C for 5 days to evaporate the distilled water. The value in grams of the extruded debris was determined by subtracting the initial mean value from the final mean value of each Eppendorf tube.

Statistical Analysis

Statistical analysis was performed with SPSS 15.0 software (SPSS Inc., Chicago, IL, USA). Distribution of data was determined by the Shapiro–Wilk test. Variables were expressed as mean ± standard deviation (SD). Apically extruded debris among groups was compared with the one-way analysis of variance. P< .05 was considered statistically significant..

Results

Table 1 shows mean and SD values of groups. Both instruments were associated with apical debris extrusion. No significant difference was found among groups (p> .05). The mean ± SD values of debris extrusion for XPF and XPFR supplementary files were found as 63 x 10^{-5} g ± 24 x 10^{-5} and 78 x 10^{-5} ± 38 x 10^{-5}, respectively.

Discussion

XPF and its variation XPFR files have been recently introduced as supplementary files. To date, several studies have evaluated the performance of the XPF instruments in removal of calcium hydroxide paste (11), bacteria (12), and hard-tissue debris (13). In addition, several studies reported that XPF files significantly enhanced removal of filling material from root canals (3,5,14,15). Alves et al. (3) reported that the finishing instrument XPF significantly improved filling material removal after the use of both Reciproc and Mtwo files. Silva et al. (5) evaluated the XPF and XPFR supplementary files and concluded that both files were effective in removing filling materials without any significant difference. The XPFR has been developed for retreatment cases and has similar features to the XPF with the main differences being a larger tip (size 30 for XPFR and size 25 for XPF) and the semi-active tip which makes it stiffer and therefore more aggressive than XPF file (14). According to the manufacturer, when these files are placed inside the canal in rotation mode, the A-phase shape allows the file to access and clean areas that other instruments might not be able to reach, without damaging dentine or altering the original canal shape. To the best of the authors' knowledge, there are no available data about apically extruded debris of these files during retreatment in the literature. Due to the favorable ability of these XP-Endo instruments to remove the filling material from the root canal space, this study was planned to evaluate the amount of apically extruded debris while using these instruments during retreatment after the use of Reciproc. Single-rooted mandibular premolar teeth were used and special care was taken to attain groups that were as similar as possible in terms of anatomical features. Only teeth with compatible foramen to size 10 K-files were selected. The manufacturer of the XPF and XPFR files indicates that these instruments may be used as a universal complementary stage after canal preparation with any rotary or reciprocating file system, provided that the size of the final file is #25 or larger for XPF and #30 or lager for XPFR. Therefore, root canals were enlarged up to Reciproc R40 file before using XP-

Table 1. Mean weights and standard deviations (SD) of apically extruded debris in groups (g)

Groups	N	Mean±SD	Minimum	Maximum
Reciproc[a]	15	0.00053±0.00026	0.000267	0.000967
Reciproc + XP-Endo Finisher[a]	15	0.00063±0.00024	0.000267	0.001133
Reciproc + XP-Endo Finisher R[a]	15	0.00078±0.00038	0.000100	0.001400

*Groups with same superscript letter was not significantly different (p=0.05).

Endo files. The findings of the present study revealed that using XPF and XPFR files for improving retreatment have no significant effect on the amount of apically extruded debris. Moreover, there was no significant difference between the XPF and XPFR files. Therefore, the null hypotheses were accepted. Manufacturer claims that these files have the shape memory principles of the alloy MaxWire and have unique cross-section design (triangular shaped with off-centered design) that removes debris with preservation of dentine. These properties of XPF instruments might explain the insignificant effect on the amount of debris extrusion during the retreatment procedure. No previous studies have evaluated apically extruded debris during retreatment procedure using XP-Endo files. Therefore, the findings of our study cannot be directly compared with the findings of a study in the literature. However, there is only one study that evaluated the debris extrusion of XPF file when used after ProTaper Next system in endodontic treatment (16). In that study, XPF was compared with SAF system and results demonstrated that final preparation with XPF file contributed to additional amount of debris. The different results can be attributed to the different study designs. In their study, XPF was not used for retreatment procedure. In addition, ProGlider and ProTaper Next system were used before the use of XPF. However, in our study, XPF was used after the use of Reciproc files in retreatment procedure.

The main limitation of this study design 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* (17). Therefore, certain degree of caution should be taken when transferring the present results to the clinical situation.

Conclusion

Under the conditions and limitations of this study, the results show that using XPF and XPFR as supplementary files for improving retreatment have no significant effect on the amount of apically extruded debris. Both instruments produced similar amount of debris extrusion.

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Ethical Approval: The study protocol was approved by the Zonguldak Bülent Ecevit University of Non-Interventional Clinical Research Ethics Board (protocol no: 2020/13–6).

Informed consent: Written informed consent was obtained from patients who participated in this study.

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