Original Article

Cleaning efficacy and debris extrusion of supplementary file systems XP-endo Finisher and XP-endo Finisher R in endodontic retreatment

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Abstract

Aim: To evaluate cleaning efficacy and debris extrusion of supplementary file systems XP Endo Finisher (XPEF) and XP Endo Finisher R (XPEFR) in endodontic retreatment.

Materials and Methods: Thirty single-rooted teeth with single canals were selected, canal preparation done till file #30 6% and obturation completed using lateral condensation technique with AH Plus sealer. The samples were stored at 37°C in a 100% humidity incubator for 7 days. The samples were distributed across the three groups according to the method of retreatment ($n = 10$): Group I: Neo Endo retreatment (NER) files, Group II: NER files + XPEF, and Group III: NER files + XPEFR. Removal of gutta percha using each file system according to the distributed groups was performed. The extruded debris was collected in an Eppendorf tube, dried in a hot air oven, and weighed. Teeth were sliced longitudinally using carborundum discs. Coronal, middle, and apical thirds were assessed for cleaning efficacy under a stereomicroscope. Results were tabulated and subjected to the statistical analysis using the Kruskal–Wallis *H*-test followed by *post hoc* turkey HSD test. All statistical tests were carried out at significance level $P < 0.05$.

Results: It was seen that Group II (NER files + XPEF) exhibited better cleaning efficacy than Group III (NER files + XPEFR), although the results were not statistically significant. Greater debris extrusion was seen with Group III when compared to Group II.

Conclusion: Supplementary files XPEF/XPEFR enhance the cleaning efficacy in endodontic retreatment, but the debris extrusion of XPEFR is more than XPEF.

Keywords: Cleaning efficacy; debris extrusion; retreatment; stereomicroscope; XP endo finisher

INTRODUCTION

The primary goals of root canal therapy are to clean, shape, and seal the root canal complex in its entirety. Even though initial root canal therapy has been a highly predictable and effective procedure, treatment-related failures might nevertheless occur. Recent literature reports that initial root canal treatment records a success rate of 85%. Persistent infection residing in canals which are unclean, in dentinal tubules, or in the convoluted anatomy of the root canal system might result in lack of healing.[1]

In cases of persistent infections and failed endodontic therapy, *Enterococcus faecalis* and *Candida albicans* have been identified as the species most commonly recovered from such canals.[2] Many techniques have been advocated for the removal of gutta-percha in failed root canal treatments. These include heat or chemical solvents used with hand

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files, engine-driven rotary files or ultrasonic instruments.[3] The use of rotary systems to remove gutta-percha with solvents is popular due to their improved efficiency and effectiveness. The end-cutting tips on the retreatment files are specifically designed to improve en masse removal of GP and penetration, hence enhancing their efficiency.[4]

XP Endo Finisher (XPEF) files (FKG Dentaire, La Chaux-de-Fonds, Switzerland) was introduced as a final step to improve root canal cleaning while conserving dentin. In previous studies, it is seen that this file system can efficiently clean very narrow and curved root canals which may be possible due its design. It is a nontapered Nickel–Titanium instrument with a tip diameter of 0.25 mm and is made of special alloy, MaxWire.[5] The XP Endo Finisher R (XPEFR) is a variant of the XPEF file and is designed for retreatment cases with a bigger core diameter (tip # 30). A stiffer and aggressive nature is due to alterations in the instrument tip.[5] The goal of these adjustments is to improve its ability to remove gutta-percha and sealer that remain after traditional retreatment procedure. Neo Endo retreatment (NER) files (Orikam, India) are available in three sizes with varying taper and lengths N1 (30/9%), N2 (25/8%), and N3 (20/7%) for removal of gutta percha from the coronal third, middle third, and apical third, respectively.

An important consideration during the retreatment procedure is apical extrusion of intracanal contents like residual pulp tissues and microorganisms leading to flare ups and postoperative pain.[6] Extruded debris during retreatment can be more than that during the initial treatment. Several methods have been employed for the evaluation of the remaining root canal filling after retreatment procedures. These include 2D radiographic imaging, micro-computed tomography (CT), scanning electron microscope, cone-beam CT, and stereomicroscope.[6] The advantage of stereomicroscope specifically is a constant object-device distance which ensures standardization of the image. Apart from this, it has digital qualitative scoring which is more precise than the manual method.[6]

This study aims at evaluating the cleaning efficacy and debris extrusion in endodontic re-treatment cases using NER files alone, NER + XPEF, and NER + XPEFR systems. The null hypothesis is that there is no difference in the cleaning efficacy and debris extrusion between the various systems.

MATERIALS AND METHODS

Thirty single rooted, noncarious intact permanent teeth with straight single canals, and closed apices were selected for the study. Digital radiographs were taken to confirm the number and configuration of the canal anatomy. Soft tissue and calculi were mechanically removed from the root surfaces and the samples were stored in normal saline. The samples were decoronated using high-speed diamond tapered bur to enable straight line access and a standard length of 16 mm was taken.

A #10 Hand K-file (Mani Inc., Japan) was introduced into the root canal until the tip was seen from the apical foramen. Working length was measured as a length 0.5 mm less than the point at which the tip of the file just protrudes from the apex. The canals were prepared using Hero Shaper gold file system up to 30/0.06 through gentle pecking motion to the working length using an Endomotor (E-Connect, Orikam, Gurugram). At each instrument change, canals were irrigated using side vented 30G irrigation needles (SuperEndo, China) with 1 ml of 3.0% sodium hypochlorite (NaOCl) 2 mm away from the WL. After root canal preparation, samples were irrigated using 17% EDTA (Prime Dental Products, Mumbai, India) for 1 min. Rinsing was performed with 3% NaOCl and then finally flushed with distilled water. The canals were dried using absorbent paper points (Dentsply, USA). Obturation was done with single-cone obturation technique using AH Plus sealer (Dentsply Sirona, USA). The quality and the apical extension of the obturation were evaluated by digital radiography in the buccolingual and mesiodistal directions.

The access cavities were sealed using temporary filling material Cavit G (3M ESPE, Germany). The samples were then stored at 37°C in a 100% humidity incubator for 7 days. The samples were then randomly allocated into three groups (n = 10) according to the retreatment procedure.

Retreatment procedure

Group A: (Neo Endo retreatment files) (n = 10)

The coronal third of the filling was removed using N1 (30/9%) instrument, middle third filling by N2 (25/8%) instrument, and apical third using N3 (20/7%) instrument. The files were used with speed and torque settings according to the manufacturer's instructions that is 300 rpm and 1.5 Ncm, respectively. Irrigation was performed using 1 mL of 3% NaOCl with each instrument change.

Group B: (Neo Endo retreatment files + XP Endo Finisher) (n = 10)

Retreatment was performed using N1, N2, and N3 files, respectively, as described in group A. In addition, XPEF files were used following retreatment procedure as described in group B. Irrigation was performed using 1 ml of 3% NaOCl with each instrument change.

Group C: (Neo Endo retreatmentfiles + XP Endo Finisher R) (n = 10)

Retreatment was performed using N1, N2, and N3 files, respectively, as described in group A. In addition, XPEFR

files was used following retreatment procedure at speed of 800 rpm and torque of 1N/cm. Instrument was activated for 1 min using 7–8 mm lengthwise movements up to the WL. Irrigation was performed using 1 mL of 3% NaOCl with each instrument change.

The assessor of the outcome was blinded after assignment to intervention.

Method of evaluation

Empty vials with holes in stopper were weighed with electronic balance. Holes were drilled on top of Eppendorf tube stoppers (Biopur, Germany). Root samples were inserted up to cemento-enamel junction in stopper of the tube. 27G needle was inserted next to stopper to equalize internal and external pressures and sealed with adhesive to stop any irrigant leakage around the tube. The Eppendorf tube stopper including the tooth was attached to the vial. After the completion of the retreatment procedure, the stoppers of vials and Eppendorf tubes were removed. The surface of the root was washed with 1 mL distilled water and collected in the vial.

The vials were stored in hot air oven at 50°C for 10 days to evaporate distilled water before weighing dry debris. Dried debris was weighed with an electronic balance that has an accuracy of 10^{-4}. Two shallow longitudinal grooves were made in the buccolingual direction of roots. Each sample was then split longitudinally into mesial and distal halves using carborundum disc. The longitudinal sections were evaluated using a stereomicroscope at ×10 magnification.

Statistical analysis

The confidence intervals were set at 95% and a $P \leq 0.05$ was considered statistically significant. Descriptive statistics were used to summarize the micro tensile bond strength. One-way ANOVA was performed and *post hoc* Tukey's test was used for intergroup comparison.

RESULTS

As shown in Table 1 and Figure 1a-c, Group II (NER + XPEF) shows the maximum cleaning efficacy with least amount of remaining obturating material in apical, middle, and coronal thirds (18.82, 23.19, and 22.65, respectively) (green areas in the images) followed by Group III (NER + XPEFR) (19.86, 26.12, and 29.16, respectively). Group I (NER files) alone was least effective in the removal of root canal filling material with maximum amount of remaining obturating material (30.63, 28.21, and 35.92, respectively). Statistically significant difference was found on comparing Group II with Group I ($P = 0.049$).

Regarding the amount of debris extrusion, it was seen that Group II (NER files + XPEF) showed lesser debris extrusion with a mean value of 0.193 followed by Group III (NER files + XPEFR) with 0.198. Maximum debris extrusion was seen with Group I (NER files) with 0.217, as shown in Table 2. Statistically significant results were obtained on comparison between Group I and Group II with $P < 0.001$.

DISCUSSION

Inadequate cleaning and shape of the canal, obturation, iatrogenic events, re-infection of the root canal system, and loss of the coronal seal following root canal therapy are all the potential causes of endodontic failures.[7] If the tooth has adequate bone support and is structurally sound or restorable, treated teeth with periapical lesion can be salvaged with conventional retreatment or surgical methods.[1] The examples of methods which have

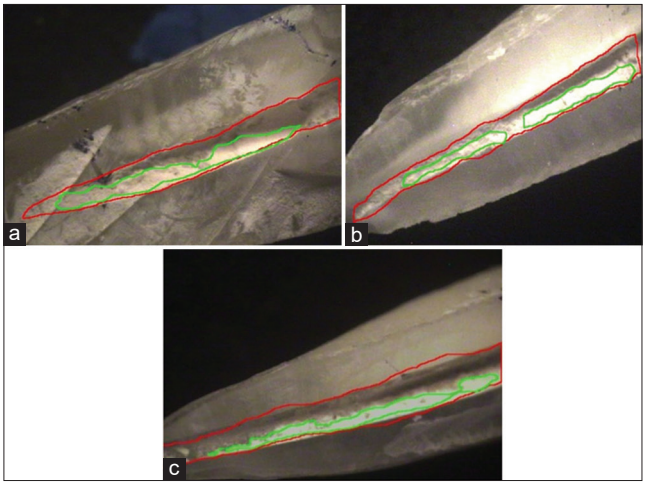

Figure 1: Representative stereomicroscopic photograph of remaining filling material in the apical third of root canal at ×10 using stereomicroscope. (a) Neo Endo retreatment (NER) files, (b) NER files + XP Endo Finisher, (c) NER files + XP Endo Finisher R

Table 1: Overall comparison of percentage remaining material among three study groups at various levels using Kruskal–Wallis *H*-test

	Apical, mean (SD)	Middle, mean (SD)	Coronal, mean (SD)
Group I (NER files)	30.63 (7.91)	28.21 (9.35)	35.92 (11.85)
Group II (NER+XPEF)	18.82 (8.09)	23.19 (9.09)	22.65 (11.27)
Group III (NER+XPEFR)	19.86 (16.45)	26.12 (22.0)	29.16 (17.44)
Kruskal–Wallis *H*-test	*H*=8.434	*H*=1.518	*H*=5.977
P	0.015*	0.468	0.048*

*Significant. SD: Standard deviation, NER: NeoEndo retreatment, XPEF: XP-endo Finisher, XPEFR: XP-Endo Finisher R

Table 2: Descriptive statistics of amount of debris extrusion, respectively

	Mean	SD	SE	Minimum	Maximum
Group I (NER files)	0.217	0.011	0.003	0.21	0.24
Group II (NER + XPEF)	0.193	0.014	0.004	0.17	0.21
Group III (NER + XPEFR)	0.198	0.004	0.001	0.19	0.20

SD: Standard deviation, NER: Neo Endo retreatment, XPEF: XP-endo Finisher, XPEFR: XP-Endo Finisher R, SE: Standard error

been used to remove the root canal filling material are endodontic hand files, rotary instruments made of nickel titanium, Gates Glidden burs, instruments used along with heat, ultrasonics or solvents. Densely packed filling material could be difficult to remove even with the use of a solvent.[8] Removal of the canal filling material has deleterious sequleae like postoperative pain and slower healing. This is mainly due to expulsion of microbes with their toxins, infected organic and inorganic debris.[9]

NiTi files such as XPEF and XPEFR are made with MaxWire alloy (Martensite-Austenite Electropolish Flex), an innovative thermomechanical procedure that has the advantage of increased flexibility and cyclic fatigue resistance. Instruments that contain the MaxWire have temperature controlled shape alteration. The file shows martensitic phase (M-phase) and austenitic phase (A-phase). The straight M-phase design is seen when file is at the room temperature while the A-phase which has a 1.5 mm depth spoon shape is seen at body temperature. This spoon shape is seen for a length of 10 mm from the tip.[10] This file shape and associated motion ensures constant flow and movement of the irrigant. XPEFR with a nontapered design and tip size of 0.3 mm was introduced to help in better debridement during retreatment. One more advantage was that the XPEFR was more effective in removing remaining canal filling material.[10] The NER files are claimed to restrict the surface engagement zone in dentin due to its parallelogram cross-section and micro-grinding production technique which results in a positive cutting edge.[11]

Regarding the removal of the root canal remnants, it was seen that XPEF had better cleaning efficacy as compared to XPEFR. This could be because XPEF has a narrower tip diameter (#25) as compared to XPEFR (#30) which allows more range of motion and hence better cleaning. One of the disadvantages of conventional retreatment files is that complete access to all parts of the canal is difficult when used in rotary motion. The A-phase of the XPEF and XPEFR files helps in greater accessibility and cleansing ability.[12] In the current study, XPEFR showed more extrusion of debris as compared to the XPEF which can be attributed to the former's larger core diameter (#30). This makes it stiffer and thus more aggressive.[5] Since the core diameter of XPEFR is larger than the XPEF, it ensures more thorough removal of the filling material with the greater application of force. However, increased apical expulsion of debris is an undesirable consequence of the XPEFR file.[8]

One of the unique features of XPEF and XPEFR files is that there will be alternate expansion and contractions due to the irregularities in the canal wall.[5] Due to this, agitation of the irrigant takes place thus improving the cleaning efficiency.[13] In addition, the use of XPEF files had a significant effect on bacterial count reduction.[13]

Stereomicroscope is one of the commonly employed aids when evaluating the various aspects in endodontic treatment such as amount of remaining pulp tissue, variations in anatomy, deficiency in canal filling, and residual amount of gutta-percha in the canal. It has also been proved to be a valuable aid for evaluating root canal failure. Stereomicroscope is a tool with proven applicability for the analysis of the exterior morphology of teeth.[14-16]

CONCLUSION

Supplementary techniques reduce the volume of remaining filling materials to some extent. Within the limitations of the study, more efficient cleaning of the canal space and removal of remaining canal filling material during retreatment were found with both XPEF and XPEFR. However, it was seen that XPEFR had more debris extrusion than the XPEF files.

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Conflicts of interest
There are no conflicts of interest.

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