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Apically Extruded Debris by a Supplementary File Used for Retreatment of Oval-shaped Canals: An In-vitro Study

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ABSTRACT

Background: Endodontic retreatment has become a routine procedure in modern dentistry. Retreatment procedures often result in the extrusion of debris through the apex and into the periradicular tissues, which may lead to post-operative pain and inflammation. Thus, investigating the effect of instrumentation protocols on the amount of extruded debris is important. Endodontists often must resort to supplementary techniques after retreatment to enhance canal cleaning. Therefore, the present study investigated the amount of extruded debris by a novel supplementary file. ***Aim of the study:*** To evaluate the amount of apically extruded debris during retreatment using Reciproc R40 compared to that extruded by Reciproc R40 followed by supplementary instrumentation using XP-endo Finisher R. ***Materials and Methods:*** Eighteen single-rooted, single-canalled mandibular premolars were instrumented with RaCe EVO rotary file system and obturated using gutta-percha and bioceramic sealer. Specimens were then randomly assigned to one of two groups according to the retreatment method (n=9): Group 1: Reciproc R40, Group 2: Reciproc R40 + XP-endo Finisher R. Pre-weighed Eppendorf tubes were fixed to the specimens to collect the apically extruded debris. The dry weight of extruded debris was then calculated. ***Results:*** All groups were associated with debris extrusion with no significant differences. ***Conclusions:*** XP-endo Finisher R used as a supplementary file for enhancing retreatment of oval-shaped canals had no significant effect on the amount of apically extruded debris.

Keywords: endodontic retreatment, apically extruded debris, Eppendorf tubes, Reciproc, XP-endo Finisher R.

INTRODUCTION

The increased emphasis on natural tooth preservation in modern dentistry has resulted in a high demand for conservative, non-surgical endodontic retreatment. Even with the advances in prosthetic and surgical replacement of teeth, a healthy natural tooth remains superior to loss and prosthetic replacement.[1] According to Torabinejad et

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al., initial root canal therapy has a success rate of 80-95%.[2] Despite this high success rate, the small percentage of failures needs to be properly managed. Posttreatment disease can result from various factors, mainly stemming from insufficient cleaning, shaping, or sealing of the root canal.[3]

Root canal filling material can be removed by several methods including the use of manual files, machine-driven nickel-titanium files, combined with or without chemical solvents. Compared to initial endodontic treatment, retreatment procedures can be more difficult and time-consuming. However, the introduction of machine-driven instrumentation has facilitated the procedure and reduced both operator and patient fatigue.[4] Furthermore, studies have shown that rotary instrumentation results in less extruded debris than manual instrumentation.[5]

Apical extrusion of debris can potentially contribute to the occurrence of acute flare-ups and post-operative pain.[4] Furthermore, debris expelled into the periapical tissue can carry filling material, dentin, microbes, irrigants and medicaments, all of which can act as foreign bodies initiating an inflammatory reaction and eventually causing apical periodontitis.[6] Although all instrumentation techniques cause debris extrusion, different retreatment techniques can result in varying amounts of extruded debris.[5,6] Moreover, the amount of extruded debris is usually higher in cases of retreatment rather than cases of initial endodontic treatment,[7] which can affect the intensity of the inflammatory reaction.[8]

Reciproc files (VDW, Munich, Germany) are used in reciprocating motion and are a single file system available in three sizes: R25 (#25/0.08), R40 (#40/0.06) and R50 (#50/0.05). They have an S-shaped cross-section, which increases their cutting efficiency and causes them to progress smoothly through the obturating material within the root canal space.[9] The NiTi alloy from which they are manufactured is subjected to a heat treatment and the resultant alloy is called M-Wire. When compared to conventional NiTi alloy, M-Wire possesses greater flexibility and cyclic fatigue resistance.[10] Although not specifically developed for retreatment cases, Reciproc files have yielded promising results in this field.[11-16]

The XP-endo files are a novel NiTi system utilizing MaxWire alloy, which, at room temperature, is straight and at body temperature, undergoes a phase transformation, causing it to expand from its original size and transform into a spoon

shape, reaching a diameter of 3 mm on rotation. Thus, it can achieve contact with anatomical canal complexities that were previously difficult to reach.[10] Members of this family include XP-endo Shaper, XP-endo Finisher and XP-endo Finisher R. XP-endo Finisher R is a non-tapered file with a core diameter of #30, as opposed to the diameter #25 of its counterpart XP-endo Finisher, which is said to enhance residual filling removal while maintaining super elasticity and extreme flexibility.[17] It was introduced as a supplementary file after retreatment procedures to enhance cleaning of the root canal space.[16]

Several studies investigated the effect of reciprocating motion on debris extrusion and found that reciprocating systems resulted in a higher amount of debris extrusion than continuous rotation systems.[9,18-20] Regarding the effect of supplementary instrumentation by XP-endo Finisher R on the weight of extruded debris, the literature shows conflicting evidence.[21-23]

Therefore, the aim of this study was to compare the amount of apically extruded debris during retreatment by Reciproc R40 and retreatment by Reciproc R40, followed by supplementary instrumentation by XP-endo Finisher R.

MATERIALS AND METHODS

Materials

1. RaCe EVO rotary files (#15/0.04, #25/0.04, #25/0.06, #30/0.06, #35/0.06) (FKG Dentaire SA, La Chaux-de-Fonds, Switzerland)
2. Reciproc R40 (#40/0.06) (VDW, Munich, Germany)
3. XP-endo Finisher R (#30/0.00) (FKG Dentaire SA, La Chaux-de-Fonds, Switzerland)
4. Gutta-percha (#35/0.06, #20/0.04) (Meta Biomed, Chungcheongbuk-do, Republic of Korea)
5. CeraSeal bioceramic sealer (Meta Biomed, Chungcheongbuk-do, Republic of Korea)

Specimen preparation:

Teeth were cleaned of visible blood and gross debris using an ultrasonic scaling tip under continuous water coolant and stored in a closed vessel containing saline solution for hydration. They were sterilized by autoclaving at 121℃ at 15 lbs psi for 20 minutes.[24] The crowns were reduced in height to standardize tooth length at 19 mm before beginning primary root canal treatment for all specimens.

Root canal preparation:

Access cavities for all specimens were prepared under water coolant. Canal patency was confirmed using K-file #10, inserted

inside the canal until the tip of the file was seen through the apical foramen. The file was measured at this position, and the working length was determined by subtracting 0.5 mm from this measurement. Root canals were instrumented using RACE EVO rotary files (FKG Dentaire SA, La Chaux-de-Fonds, Switzerland) at a speed of 800 rpm and a torque of 1.5 Ncm, according to the manufacturer's instructions at the following sequence:

- Glide path was established using file #15/0.04,
- Initial shaping was performed using files #25/0.04, file #25/0.06, followed by file #30/0.06
- Final shaping was done using file #35/0.06.

Irrigation and patency using K-file #10 were done after the use of each instrument.

Irrigation protocol:

Fifteen ml of 2.5% sodium hypochlorite (NaOCl) irrigation was used during instrumentation using a 30-gauge side-vented needle inserted passively into the canal up to 2 mm short of the working length. The smear layer was removed using the final rinsing protocol: 1 ml of 17% EDTA solution for 1 minute, followed by another saline flush, followed by 1 ml of NaOCl and 1 ml of saline for 30 seconds each.[14] Finally, the canals were dried using paper points #35/0.06.

Root canal obturation:

CeraSeal bioceramic sealer was injected inside the canals using the provided plastic applicator. The canals were obturated using cold lateral compaction. A master cone #35/0.06 was fitted to the working length of each canal, followed by auxiliary gutta-percha cones #20/0.04 as needed. After the compaction of all auxiliary cones was completed, a condenser was heated and used to remove the excess gutta-percha up to the canal orifice.

All access cavities were sealed using temporary filling material, and the specimens were assessed radiographically in both mesiodistal and buccolingual directions to confirm the quality and apical extent of the obturation. The specimens were stored at 37°C and 100% humidity for two weeks.

Debris collection:

In all groups, the method described by Myers and Montgomery[25] was adopted for debris collection during retreatment procedures. Eighteen Eppendorf tubes were collected and labelled with the number of each specimen. Each tube was weighed three consecutive times using an electronic microbalance, with an accuracy of 0.001 gm (**Figure 1**). The mean value of the weight of

Figure (1): Photograph showing a microbalance.

each empty tube was calculated to obtain the pre-weight. All specimens were fitted to the pre-weighed Eppendorf tubes. Modelling wax was used to stabilize the specimens at the mouth of the tubes, leaving 2 mm of the cervical root third visible. A 25-gauge needle was inserted through the modelling wax to equalize the pressure inside and outside the tube. Each tube was placed at the mouth of a glass vial and stabilized using a rubber stopper, verifying that there was no contact between the tube and the glass vial. (**Figure 2**)

Specimen grouping and retreatment procedures:

Figure (2): Photograph showing the debris collection appa**ratus.**

Gates Glidden drill size 2 was used to remove the cervical 2 mm of filling material in both groups.

Group 1 (n=9): Reciproc R40 was used in a reciprocating motion according to the manufacturer's instructions to remove filling material from the remainder of the canal. Size R40 (#40/0.06) was mounted on a reciprocating handpiece at motion and speed angles CCW = 150° and CW = 50° and 300 rpm, respectively. The criteria for completion were: the reciprocating file reaching the full working length, smooth canal walls, and no evident filling material or debris seen on the file.

Group 2 (n=9): Filling material was removed by Reciproc R40 in the same

manner as in Group 1, followed by a supplementary removal step using XP-endo Finisher R #30/0.00. The file was mounted on a contra-angled hand-piece at a speed and torque of 800 rpm and 1 Ncm, respectively, and cooled using Endo Ice spray (Maquira, Maringa, Brazil). Each canal was filled with 2.5% NaOCl solution, and the file was inserted slightly into the canal without rotation. Then, rotation was started, and the instrument was gently threaded into the canal and moved in slow and gentle 7-8 mm vertical strokes, making small multi-directional movements, allowing the file to brush against the root canal walls. The criteria for completion were the XP-endo Finisher R file reaching the full working length, smooth canal walls and no evident filling material or debris seen on the file.

The canals were irrigated using 2.5% NaOCl solution throughout the entire procedure. Following instrumentation, the canals were flushed with 2 ml of sterile saline solution, followed by 1 ml of 17% EDTA solution for 1 minute, followed by another saline flush, followed by 1 ml of NaOCl and 1 ml of saline for 30 seconds each.[14] Finally, the canals were dried using paper points #40/0.06.

After the completion of retreatment procedures, the specimens were removed from the tubes, any debris remaining on the external root surface was scraped off with the inner edge of the Eppendorf tube, and the apex was flushed with 0.1 ml of distilled water to dislodge any adherent debris. The tubes were then transferred to an incubator and left for 14 days at 37℃ to allow the liquid to dry. The tubes containing the dry apically extruded debris were then weighed again three consecutive times, and the mean value of the post-weight was calculated. The difference between the mean pre-weight and the mean post-weight was calculated to obtain the mean weight of apically extruded debris.

RESULTS

No significant difference in the weight of extruded debris was found between both groups with a p-value (p=0.724). Group 1 showed a higher weight of extruded debris (7.80±1.57) than Group 2 (7.56±1.33). **(Figure 3, Table 1)**

DISCUSSION

Apical extrusion of contaminated debris is an important factor in the occurrence of post-operative pain. Debris expelled into the periapical tissue can carry previous filling material, dentin, microbes, irrigants, and medicaments, all of which can act as foreign bodies, initiating an inflammatory reaction and eventually causing apical periodontitis.[6]

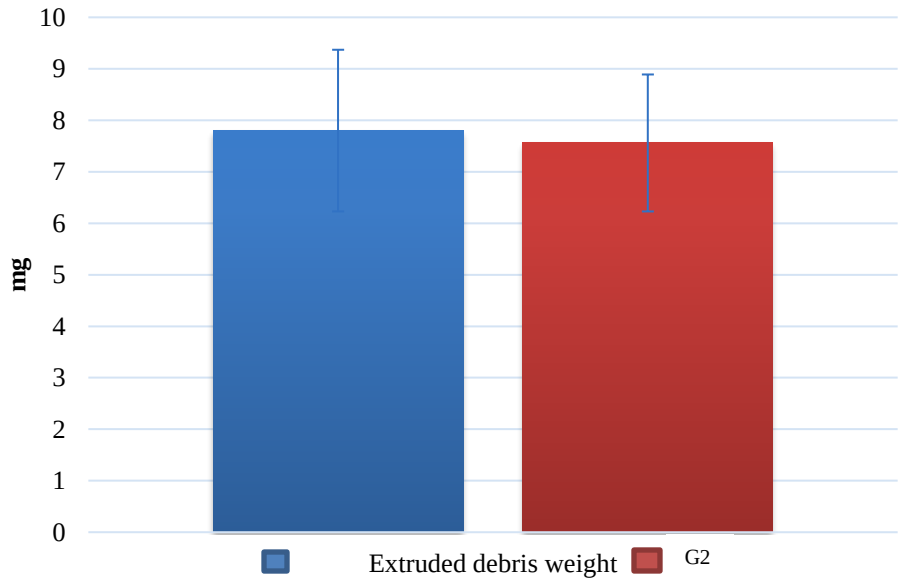

Figure (3): Bar chart showing mean and standard deviation (error bars) values of extruded debris weight (mg) for different groups.

Table (1): Intergroup comparison and summary statistics of extruded debris weight (mg) for different groups.

Extruded debris weight (mg) (Mean±SD)		p-value
Group 1	**Group 2**	
7.80±1.57	7.56±1.33	0.724ns

Significance level: (p<0.05), ns; non-significant (p>0.05).

The majority of studies investigating the amount of extruded debris have reported that almost all instrumentation techniques will result in some degree of debris extrusion.[26]

However, the amount of debris extruded through the apical foramen has been found to vary according to the instrumentation technique used.[27-29] Moreover, the amount of extruded debris is usually higher in cases of retreatment rather than cases of primary endodontic treatment,[7] which can affect the intensity of the inflammatory reaction.[8]

The amount of debris extrusion was evaluated by weighing them using an electronic microbalance with an accuracy of 0.001 gm. The debris collection apparatus was fabricated following the method described by Myers and Montgomery.[25] This method offers the advantage of being simple, accurate, and reproducible. Additionally, the use of a precise microbalance allows the calculation of very small values.[30] It was used successfully in various similar studies.[9,18,31]

This study found no significant difference regarding the weight of extruded debris, whether retreatment was performed

using Reciproc R40 (group 1) or was supplemented using XP-endo Finisher R (group 2). This was in agreement with Sariyilmaz et al.,[22] who found that the use of all investigated supplementary techniques (XP-endo Finisher, EndoActivator and PUI) resulted in minimal debris extrusion, and Turker et al.,[23] who found that supplementary use of XP-endo Finisher R after retreatment with R25 did not significantly increase the weight of extruded debris.

Several studies were conducted comparing the weight of extruded debris by multiple supplementary techniques. Shaheen et al.[27] found that XP-endo Finisher extruded the least amount of debris, whereas Hassan et al.[21] found that XP-endo Finisher R extruded more than XP-endo Finisher. They attributed this finding to the larger core diameter of the former.

It should be noted that several studies comparing the amount of extruded debris following retreatment by rotary and reciprocating systems found that reciprocating systems resulted in a higher amount of debris extrusion than continuous rotation systems.[18-20,26,32] The larger amount of extruded debris associated with reciprocating motion may be interpreted by the coronal transportation of debris promoted by continuous rotation.[9] In contrast, during reciprocating motion, coronal transportation of debris is interrupted by the counterclockwise rotation.[33] This may explain the findings of the present study, where it is probable that most of the extruded debris in subgroup B2 was due to the use of Reciproc R40, and the amount extruded by the use of XP-endo Finisher R was not sufficient to produce a significant difference.

CONCLUSION

Non-surgical endodontic retreatment using Reciproc R40 with or without adding a supplementary instrumentation step using XP-endo Finisher R presented a minimal amount of apically extruded debris.

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CONFLICTS OF INTEREST

The authors claim that they have no conflicts of interest.

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