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Research Paper: Comparison of Apically Extruded Debris in Maxillary Premolars using Neoniti A1, Reciproc and Only One File: An in Vitro Study

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ABSTRACT

Introduction: Apical extrusion of debris has been associated with postoperative pain, flare-up and delayed periapical healing. Studies reported that reciprocating instrumentation was associated with more debris extrusion than rotary instrumentation. The purpose of this study was to compare the amount of apically extruded debris using single-file rotary and reciprocating instrumentation systems.

Materials and Methods: Sixty human maxillary premolar teeth were randomly assigned to three groups (n = 20): Reciproc R25 (VDW, 25, 0.08), Neoniti A1 (NEOLIX, 25, 0.08), Only One File (Denco, 25, 0.08). Canal instrumentation was done according to the manufacturers' instructions. Measurements of debris were measured by Montgomery method. Brown-Forsythe test, robust and Games-Howell post hoc test were used for data analysis (α=0.05).

Results: The results of this study showed that the highest amount of debris extruded is in the Reciproc file and the lowest is in Neoniti A1. There was a significant difference between the means of the three groups ($P<0.05$). Games-Howell post-hoc test was showed that there is a significant difference in pair by pair comparison of groups ($P<0.05$).

Conclusion: Based on this in vitro study, all systems have some apical debris extrusion; however, it seems that rotary single-file instrumentation system was better than reciprocating single-file instrumentation systems in terms of the amount of debris extrusion.

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1. Introduction

One of the main stages of root canal treatment is mechanical preparation, which is done using manual and rotary instruments with rotational and reciprocal movement. Complete debridement of the root canal system is essential for successful endodontic treatment (1). All instrumentation techniques might extrude debris and irrigants through the apical foramen like a mechanical piston but the amount of extruded debris differs between instruments and file designs (2). Reducing the amount of extruded apical debris is one of the necessities to prevent posttreatment flare-ups (3, 4). Studies have shown that step-back technique produces more significant debris than rotary systems and balanced force technique (5, 6). Therefore, different single-file and full-sequence NiTi systems (rotary and reciprocating) have attracted attention (7).

Some studies showed that apical debris extrusion in full-sequence rotary systems is significantly higher compared to single-file rotary systems (7). Several times of instrumentation and irrigation could result in more debris extrusion compared to single-file systems (7). Besides, single-file instrumentation system makes the preparation process faster than full-sequence instrumentation systems (8, 9). Therefore, manufacturers have introduced new single-file systems with either rotational or reciprocal motion. To name a few, Reciproc (VDW) is a single-file system which is used in a reciprocating motion. It has an S-shaped horizontal cross-section with 2 cutting edges (8, 10) and is known as primary reference for single-file reciprocating instrumentation. Only One File system (Shenzhen DENCO Medical Co) is another single-file reciprocating system, made of a special heat-treated NiTi alloy called M-wire, which is claimed to increase flexibility and resistance to cyclic fatigue. The reason for choosing Only One File in this study was its availability and more suitable price than Reciproc.

It is widely acknowledged that single-file reciprocating systems were raised because of reducing cyclic-fatigue, better canal centering ability, reduction of taper lock (11, 12); Although some studies reported more debris extrusion, periapical inflammation and postoperative flare-ups in these systems (10, 13, 14).

Notably, Neoniti A1 (Neolix, Evron) rotary system is a rotary single-file system with a non-homogeneous rectangular section and multiple cones (15). Neolix rotary files have a progressive flexibility to better negotiate the curves and respect the canal anatomy. The built-in abrasive properties of the flutes and edges associate a greater and cutting action, avoiding smear layer risk (16, 17). The purpose of this study was to compare the amount of apical debris extrusion using two single-file reciprocating systems (Reciproc and Only One File) with one single-file rotary system (Neoniti A1).

2. Materials and Methods

This experimental study was approved by the Ethics Committee of Alborz University of Medical Sciences (Reg. No. IR.ABZUMS.REC.1401.287). Inclusion criteria for this study were: human maxillary premolar teeth that were extracted for orthodontic purposes, teeth with mature apices, teeth without resorption and severe curvature, teeth with two separate orifices, canals and apical foramens. The sample size was estimated similar to that used in previous studies (n=20). Sixty teeth were selected and were kept in normal saline until use. Each tooth was radiographed proximally to confirm it had 2 orifices, 2 separate canals and 2 apical foramens. Coronal portions of all teeth were cut from a height of 13 mm from the apex and access cavity was prepared using a diamond fissure bur and a high-speed handpiece (NSK). This study was done on the palatal canal. A #10 stainless steel K-file (Dentsply Maillefer, Ballaigues, Switzerland) was used to negotiate the canal and to ensure canal patency (Figure 1-a). Teeth with calcification, irregular anatomical structure, apical foramen larger than #15 K-file were excluded and replaced with a new tooth that met the inclusion criteria.

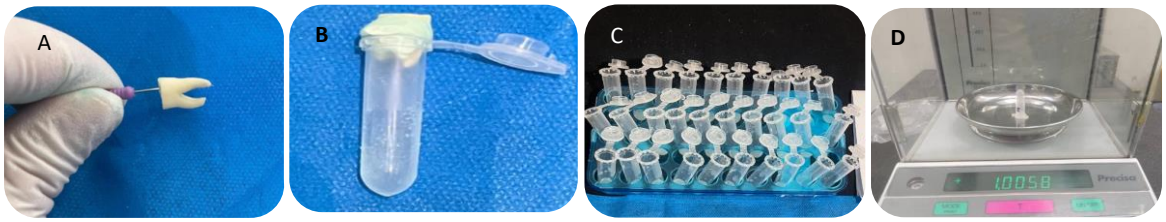

Figure 1. Sample Prcparation. A.Canal negotiation, B. teeth were mounted on the Eppendorf tubes using putty, C. The Eppendorf tubes after removing teeth and putty, D. Eppendorf tube was weighted 3 times on a precise electric balance

In fact, debris collection was done using the method proposed by Myers and Montgomery (18). Moreover, empty Eppendorf tubes were weighed 3 times using a digital microbalance to take the average weight. To prevent any leakage, the teeth were mounted on the Eppendorf tubes using putty (Figure 1-b). Preparation steps were conducted by one operator with an electric motor (E-CONNECT, Eighteeth, Changzhou, Jiangsu Province, China) and all instruments were used in accordance with their manufacturers' instructions. Accordingly, the teeth were randomly divided into 3 groups as follows:

1. *Neoniti A1* (size 25, 0.08 taper, Neolix, Châtres-la-Forêt, France): File was used at a rotational speed of 350 rpm and a torque of 1.5N/cm with brushing and gentle in-and-out motions at working length. File was withdrawn from the canal after three in-and-out motions and the flutes were then cleaned. The canals were irrigated with double-distilled water and #10 K-file was used to confirm patency.

2. *Reciproc R25* (size 25, 0.08 taper, VDW, Munich, Germany): File was used with gentle in-and-out pecking motions (150˚ counter-clockwise then 30˚ clockwise rotation). After every three pecking motions, instrument flutes were cleaned. The canals were irrigated with double-distilled water and #10 K-file was used to confirm patency. This procedure was repeated until the file reached the WL.

3. *Only One File* (size 25, 0.08 taper, Shenzhen DENCO Medical Co., China): As mentioned in Reciproc group.

The irrigation needle (Ava LuerLock Syringe, 5ml, 27 G, Tehran, Iran) was placed as deep as possible inside the canal without encountering resistance and was not deeper than the predetermined WL minus 1 mm. The amount of irrigant was equal in all groups (5 ml double-distilled water between instrumentation, 1 ml of double-distilled water for final irrigation). Putty and teeth were removed. The Eppendorf tubes were placed in an incubator with a temperature of 70 degrees for 2 days to obtain the debris without moisture (Figure 1-c). Each Eppendorf tube was weighed 3 times on a Precisa electric balance (Dietikon, Switzerland) with an error of 0.001, and a weighted average was taken (Figure 1-d). The weight of the extruded debris was measured by subtracting the weight of empty Eppendorf tubes from the weight of debris-containing Eppendorf tubes.

It is worth mentioning that data analysis was conducted by employing SPSS version 26. More precisely, the assumption of normality was checked with Shapiro-Wilk Test. Additionally, Brown-Forsythe Robust Test was used to compare the mean of the quantitative variables; Besides, Games-Howell post-hoc test was used in pair-by-pair comparison of 3 groups. To be more exact, P values <0.05 were considered to be statistically significant.

3. Results

The present study showed that all three groups have apical debris extrusion. The highest number of debris extruded is in the Reciproc file and the lowest is in Neoniti A1(Table 1). Brown-Forsythe Robust Test showed significant difference between the means of the three groups (P<0.05). Games-Howell post-hoc test was showed that there is a significant difference in pair by pair comparison of groups (P<0.05). In terms of the average difference the biggest difference is between Reciproc and Neoniti

A1and the smallest difference is between Neoniti A1 and Only One File (Table 2).

Table 1. Amount of apically extruded debris produced by different systems (in gram)

File type	Number	Mean	standard deviation	Minimum	Maximum
Reciproc	20	0.0124	0.0004	0.0118	0.0131
Neolix	20	0.0075	0.0003	0.0070	0.0081
Only one file	20	0.0098	0.0008	0.0082	0.0113

Table 2. The difference in the average amount of extruded debris with only one file, Neoniti A1 and reciproc files

Groups	File type	Mean difference	Standard error of the mean	Minimum	Minimum	P value
Reciproc	Neoniti A1	0.0494	0.0001	0.0467	0.0520	0.000
	Only one file	0.0258	0.0002	0.0216	0.0297	0.000
Neoniti A1	reciproc	0.0492	0.0001	-0.0520	-0.0467	0.000
	Only one file	0.0233	0.0002	-0.0276	-0.0198	0.000
Only one file	reciproc	0.0258	0.0002	-0.0297	-0.0216	0.000
	Neoniti A1	0.0233	0.0002	0.0198	0.0276	0.000

4. Discussion

It is a well-established fact that mechanical preparation of the root canal is one of the most important stages of root canal treatment. In the past, the preparation was conducted only with the help of manual and non-flexible tools. However, today, rotating and reciprocating nickel-titanium tools have received more attention due to reducing the fatigue of the clinician and saving time (19, 20). Unfortunately, until now, all existing systems may extrude debris based on the geometry of the file and its motion, either rotational or reciprocal (21). This extruded debris may cause severe pain and sensitivity and even swelling, sometimes leading to treatment failure (22). Therefore, the purpose of the present study is to compare the amount of apical debris extrusion using rotary only one file, Neoniti A1and reciprocating files in maxillary premolar teeth. Considerably, based on the obtained results, all the three mentioned files cause measurable apical extrusion of debris. Consequently, the instrumentation technique and the design of tools related to root canal treatment affect the number of extruded debris. However, available evidence supports that apical inflammatory reaction is not influenced by the number of files but the type of movement and the instrument design (4). Particularly, in the present study similar to many other studies, in order to eliminate the variable and possible errors related to the operator, including hand pressure during filing or irrigation, one operator performed the entire instrumentation process. Also, distilled water was used instead of sodium hypochlorite as the main solution for washing the canal. Although distilled water is not preferred as the main detergent compared to sodium hypochlorite, having excellent antimicrobial activity, sodium hypochlorite may produce deposits that are reported to increase the weight of the extruded debris, affecting the reliability of the results (23, 24). As a matter of fact, in view of this study, the Neoniti A1 file produced the lowest amount of apical debris extrusion. According to the manufacturer, this file has a Gothic tip design and internal abrasion properties, reducing the torque required to cut the canal walls. In addition, the continuous rotation of the file may act like a screw conveyor and increase the coronal movement of dentin chips and dentin remnants; this rotation is present in the Neoniti A1 file (25, 26). It seems that the technology of making this file as well as its continuous rotation motion has helped to get less apical debris extrusion. Singbal et al. compared the apical debris extrusion during root canal preparation using two Ni-Ti single file rotation systems and demonstrated that the Neoniti A1 single-file system had less debris extrusion than one-shape file system (27); Besides; Mohammadi et al., evaluated the apical debris extruded from molar teeth with Reciproc, Protaper, Neoniti A1 and Hyflex rotary files and reported that the apical debris extruded by the Reciproc file has the highest amount, but there

is no special difference between the other files (28); these studies were in accordance with the results of the present study. Nevertheless, De Deus et al. demonstrated that Reciproc system is associated with less apical debris (29). The difference in the canal preparation technique or debris collection and evaporation method may explain this difference. To clarify this point, there are two types of factors that can affect debris extrusions: anatomical factors such as the anatomy of the apical constriction, dentin hardness, quantity and momentum of flow of the irrigant, and mechanical factors, such as the selection of the final apical size of the instrument and instrumentation techniques and files. In addition, the size of the irrigation needle and its depth into the canal may affect the quantity of debris extrusion (30).

Then again, Only One File system (Shenzhen DENCO Medical Co., China) is another single-file reciprocating system, made of a special heat-treated NiTi alloy called M-wire, which has been proved to increase file flexibility and resistance to cyclic fatigue (11, 31). Furthermore, its availability and more suitable price than Reciproc was the reason for choosing Only One File in this study. Since Only One File had a lower apical debris extrusion than the Reciproc file; besides, its affordable price and proper availability, it seems that this file can be a suitable alternative for the original Reciproc file to reduce flare-ups and post-treatment pain. Nonetheless, according to the limitation of this study, more clinical studies about reciprocal systems are suggested.

5. Conclusion

In the light of this in vitro study, almost all systems have some apical debris extrusion; however, it seems that rotary single-file instrumentation system (Neoniti A1) was better than reciprocating single-file instrumentation systems in terms of the amount of debris extrusion. Furthermore, it should be noted that between 2 reciprocating single files, Only One File was proved to be a suitable alternative for the original Reciproc file due to its lower apical debris extrusion, affordable price and proper availability.

Ethical Considerations

Compliance with ethical guidelines

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Authors'contributions

Somayeh Dehghan Banadkooki: Conceptualization, Methodology, Writing - Review & Editing **Zakiyeh Donyavi:** Resources, Investigation, Visualization **Narges Ranjpour:** Data curation, Writing - Original Draft **Nima Fathollahi:** Project administration, Supervision, Funding acquisition.

Conflict of Interests

The authors declare no conflict of interest.

Availability of data and material

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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can prepare a root canal effective with less steps, time saving, special screw thread and reciprocating motion.2024. [Link]