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Original Article

Comparing the effect of Reciproc R25 rotary file system on the amount of apical extrusion of debris via using it with different reciprocal angles

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Abstract

Aim: To compare the amount of apically extruded debris using Reciproc (R25) file with different reciprocal angles.
Methodology: In this research, 60 extracted mandibular premolars with a single root, a single canal, and a single apical foramen were used. Specimens, the working length of which was determined by a stainless steel 10-K file, were randomly distributed into three experimental groups (n = 20) as follows: Group 1 150° counterclockwise (CCW)-30° clockwise (CW); Group 2 180° CCW-60° CW; and Group 3 210° CCW-90° CW. For the irrigation, 10 mL of distilled water was administered via a syringe pump. The extruded debris was collected into Eppendorf tubes tared in advance. The distribution of data was analyzed using a Shapiro-Wilk test. A Kruskal-Wallis H test was used for statistical analysis. The null hypothesis is no significant difference between the groups in terms of the amount of apical extrusion of debris.
Results: There was no statistically significant difference between the groups with regard to amount of apical extrusion of debris ($p>0.05$). Nevertheless, the highest average amount of extrusion of debris was detected in group 1 and the lowest in group 3.
Conclusion: According to the results of this study, different reciprocal angles during chemomechanical preparation have no significant effect on the amount of apical extrusion of debris.

Keywords: Reciproc, kinematics, reciprocation, debris extrusion

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Introduction

During root canal instrumentation, infected dentin chips, necrotic pulp tissues, microorganisms, and irrigation solutions might extrude into periapical lesion (1, 2). This extrusion may cause some clinical conditions such as pain, inflammation, and acute fever (3, 4).

Today, there are many NiTi rotary file systems and root canal instrumentation techniques thanks to the advent of technology (5). However, as a result of the research, scientists have found that all systems and techniques cause debris extrusion (2, 6, 7). Having been specifically designed for reciprocal motion, Reciproc files differ from other canal files. The tips of the files have a non-cutting form, an S-shape cross-section, and sharp cutting edges (8). The spirals of the

files are reversely designed. While Reciproc files cut in the CCW direction, they extrude debris in the CW direction and are released. Thus, the risks for screwing and fractioning of the file are decreased. According to the manufacturer's instructions, the file rotates 150° in the cutting direction, while it rotates 30° in the direction of release. These angles have been discovered using the torsional resistance of the instruments (8, 9).

Previous research produced some contradictory results on apically extruded debris with different reciprocal angles (1, 10-12). Arslan et al. suggested that the 150° CCW – 30° CW and 270° CCW – 30° CW reciprocating motions extruded significantly less debris than continuous rotation. Contrary to this, Burklein et al. stated that the Reciproc file extruded more debris during apical extrusion than other conventional rotary instruments (1, 12).

The aim of this study is to compare the amounts of apical extrusion of debris using a Reciproc R25 file in root canal instrumentation with different reciprocal angles of 150° CCW – 30° CW, 180° CCW – 60° CW, and 210° CCW – 90° CW.

Materials and Methods

The research was evaluated at the 8th meeting on 19 July 2019 by the Ethics Committee of the Faculty of Dentistry of Dicle University and approved under protocol number 2019/32.

In this research, 60 mandibular premolars with a single root, a single canal, and a single apical foramen have been used. Specimens were chosen from teeth with a curvature of less than 10°. Dental calculus and soft tissue on the root surface were removed using periodontal scrapers. Radiographs of the teeth from the buccolingual and mesiodistal angles were taken, and single-canal samples without calculus and without internal and external resorption were included. In case the teeth were longer than 18 mm, the tubercle hills were bevelled down to a standard 18 mm. The canal cavities of the teeth were opened using a diamond bur with a dental aerator and water cooling. Standard apical potencies were obtained by applying double-layer nail polish on the apices of the teeth. A standard and round apical foramen was obtained by getting 1 mm from the apex using a size 10-K file. The working length was established by subtracting 1 mm from the measured length.

Preliminary instrumentation of the teeth was manually conducted at a working length using step-back technique and a file size of up to 20-K. During manual filing, 1 ml of distilled water was used for irrigation at each change of file. The instrumentation of root canals was performed with E Connect S Endomotor (Eighteeth, Changzhou Sifary Medical Technology, China) using a Reciproc R25 (VDW GmbH, Munich, Germany) rotary file on each tooth in accordance with the instructions of the manufacturer.

Irrigation was carried out using distilled water. A syringe pump (Mindray BeneFusion SP1, Shenzen, China) was used for standard irrigation. A 10-ml plastic injection was integrated into the device after installing IrriFlex (Produits Dentaires SA, Switzerland) irrigation tips. The syringe pump was programmed to pump distilled water at a constant speed, and pressure of 2 ml/min Irrigation was delivered at length 1 mm shorter than the working length.

Group 1. (150° CCW – 30° CW): Teeth in this group were shaped with the Reciproc R25 file system at a speed of 300 rpm and 2 N/cm torque, and a range of 150° CCW – 30° CW.

Group 2. (180° CCW – 60° CW): Teeth in this group were shaped with a Reciproc R25 file system at a speed of 300 rpm and 2 N/cm torque, and a range of 180° CCW – 60° CW.

Group 3. (210° CCW–90° CW): Teeth in this group were shaped with a Reciproc R25 file system at a speed of 300 rpm and 2 N/cm torque, and a range of 210° CCW – 90° CW.

The instrumentation process was performed by a single operator using minimal pressure. After every three pecks an in-and-out motion was made to prevent the file from getting stuck in the canal. After three pecks irrigation was carried out with 2 ml/min of distilled water. The remaining 1 ml was used to wash the debris extruded apically and gathered around the apex, and collected into an Eppendorf tube.

In our study, a mechanism that was developed by Myers and Montgomery and has been preferred by many researchers so far was used. The extruded debris and the irrigation solution were collected in 1.5-cc Eppendorf tubes. The tubes were previously numbered with acetate markers. After the numbering, each tube was weighed three times to 10-6 precision (Sartorius, Göttingen, Germany), and the average tares were calculated.

Teeth that had already had their composite molds prepared were fixed to the Eppendorf tubes using double layers of Teflon tape. A 27-gauge injector was fixed between the composite block and the Eppendorf tube to balance the internal and the external pressure. The mechanism was then settled into a glass bottle. After preparation and irrigation of each tooth, it was taken out, and the lid of the tube was closed tightly. The Eppendorf tubes were then placed in an incubator at 70°C for three days to evaporate the liquid inside. A second weighing was conducted to determine the weight including the debris.

Statistical Analysis

The data were analyzed using the SPSS software version 22 (IBM SPSS Inc., Armonk, NY, USA). While researching the normal distribution of variables, a Shapiro-Wilk test was used due to number the units, and the significance level was set at $p<0.05$ to interpret the results.

During the examination of differences among the groups, the Kruskal-Wallis H test was used if the variables were not normally distributed.

Results

Three groups of files caused apical extrusion of debris. Conclusive statistics are presented in Table 1. Amounts of debris extrusion from least to greatest were Group 3 (210° CCW – 90° CW), Group 2 (180° CCW – 60° CW), and Group 1 (150° CCW – 30° CW). There was no statistically significant difference between the groups and the null hypothesis was accepted as a result of the research.

Table 1. The mean, standard deviation, median, and minimum and maximum values of apically - extruded debris according to groups.

Group (n=20)	Mean ± (SD)	Median (Min-Max)	p	H
Group 1	*0.382 ± 0.204*	*0.335 (0.154 - 0.971)*		
Group 2	0.295 ± 0.289	0.196 (0.033 - 1.102)	0.059	5.664
Group 3	*0.269 ± 0.243*	*0.198 (0 - 0.803)*		

Discussion

Chemomechanical preparation is one of the crucial steps in canal treatment. Extrusion of debris, causing acute fever and periodontal diseases, decreases the success rate of canal treatment (13). In this research, the effect of the different reciprocal angles on the amount of apical extrusion of debris was evaluated.

Similar to our study, Arslan et al. compared the amount of apically-extruded debris using reciprocal motion at different angles. They worked with 150° CCW – 30° CW, 270o CCW – 30° CW, and 360o CCW – 30° CW and an R25 file with continuous rotation. They reported that the least amount of extrusion was associated with reciprocal motion of 150° CCW – 30° CW, and the most was with continuous rotation (12). However, there are some discrepancies between these conclusions and previous research (1, 7, 10). Kocak et al., performing instrumentation on mandibular premolars with Protaper F2, Revo-S SU, and Reciproc R25 files, compared the amount of the apical extrusion of debris, and could not find a statistically significant difference. In an extrusion report which used a single file and multiple files, Reciproc R25, F360, OneShape and Mtwo files were compared. It was concluded, Reciproc R25 was reported to extrude more debris from the apical (7). In other research comparing the single-file and multiple-file systems, the Reciproc file system was revealed to extrude more debris than WaveOne, Mtwo, and Protaper (1). The reasons for the different conclusions in these studies might be that not only the teeth but also the cross-sections of the single-file systems and the reciprocal motion, the number, and the angle of the files were different, as well.

In this study, Reciproc R25 and various kinematics were examined, and the apical extrusion of debris was compared at angles of 150° CCW – 30° CW, 180° CCW – 60° CW, and 210° CCW – 90° CW. Our literature review did not yield any previous insight into a comparison of these angles. In reciprocal motion, while the file cuts in the CCW direction, it is released in the CW direction. The manufacturer defines the working principal of the Reciproc file as 150° CCW – 30° CW reciprocal motion. Thus, an entire rotation consists of three motions. With these reciprocal motions, it is provided that the file is centered, the debris is extracted from the coronal, and the file is subject to less cyclic fatigue. We used different angles in our research with the aim of both performing more cutting and allowing concordant release of the file by increasing the angles up to a certain extent. Thus, we sought to determine whether there was a statistically significant difference between the angles used and the angles proposed by the manufacturer in terms of the apical extrusion of debris.

On the other hand, the irrigation procedure might affect the amount of apically extruded debris as well as chemomechanical preparation. Various techniques, ranging from different needles to different irrigation methods, were used in the research (14, 15). In our study, irrigation was carried out at a length 1 mm shorter than the working length using side-vented IrriFlex needles. Unlike other studies, a syringe pump was preferred in our research to keep the speed and the pressure of irrigation at a constant level.

In apically extruded debris works, NaOCl, utilized widely in clinics, was used as the irrigation solution (16, 17). However, other research has suggested the use of distilled water, claiming that NaOCl could affect the weight of the debris as NaOCl crystals could form in debris collecting tubes (18, 19). Since there was no further research that employed the same angles as our study, a one-to-one comparison could not be made. The fact that periapical tissue cannot be reproduced in apical extrusion of debris is a significant limitation.

Conclusions

In this in vitro study conducted on an extracted tooth, no significant effect of different kinematics on the extrusion of debris from the apical foramen within the limitations was acknowledged. Although not statistically significant, a lesser amount of debris extrusion was observed in proportion to an increase in CW and CCW angles.

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Ethical Approval: Ethics committee approval was received for this study from Human Ethics Research Committee at Dicle University Faculty of Dentistry and approved under protocol number 2019/32.

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