Effect of a Glide Path with Rotary Files on Apical Extrusion of Intra-Canal Debris during Root Canal Preparation Using a Reciproc System: an in vitro Study

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Abstract

During root canal preparation using reciprocating single-file systems, intra-canal debris maybe extruded into periradicular tissues, which may cause undesired consequences. Manufacturers of these systems did not consider the creation of a glide path before their use in canal preparation. Therefore, this research aims to evaluate the effect of a glide path with rotary files on the amount of apically extruded debris during root canal preparation using the Reciproc system.

Sixty freshly extracted single-rooted mandibular premolar teeth were randomly divided into two groups (n=30 for each group) for canal instrumentation. Endodontic access cavities were prepared in each tooth. In the first group, a glide path was created using PathFile instruments; the second group did not have a glide path. The teeth were then instrumented with the Reciproc system. The debris extruded apically during instrumentation was collected into pre-weighed Eppendorf tubes. The tubes were then stored in an incubator at 70 °C for 5 days. The weight of the dry extruded debris was established by subtracting the pre-instrumentation and post-instrumentation weight of the Eppendorf tubes for each group. The data were analyzed using independent sample T-tests.

The Reciproc file extruded significantly less debris in the group with a glide path than in the group without a glide path ($P < 0.05$).

The Reciproc system was associated with apical extrusion of debris. Creating a glide path prior to canal instrumentation reduced the amount of apically extruded debris.

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Introduction

The aims of endodontic instrumentation include debridement and disinfection of the root canal system in addition to creating an appropriate shape to achieve a complete 3D obturation [1]. During root canal preparation, pulp tissue, dentine chips, irrigants, and microorganisms may be extruded beyond the apical foramen [2]. Apically extruded materials may cause undesired consequences such as flare-ups, periapical inflammation, postoperative pain, and delay of periapical healing [3, 4].

Currently, all root canal preparation techniques and instruments are associated with extrusion of debris [5-7]. The amount of this debris varies depending on the selected preparation techniques and the design of the instruments [8-10].

Single-file systems have been developed to prepare root canals with only one instrument. In 2010, one new single-file system manufactured from M-wire alloy; Reciproc (VDW Munich, Germany), was introduced into the market. This file prepare root canals using a reciprocating motion in which the file continuously changes its rotating direction during the shaping procedure with a larger rotating angle in the cutting direction (counterclockwise) and a smaller angle in the reverse direction (clockwise) [11]. The reciprocating movement reduces stress on the instrument, which reduces the risk of cyclic fatigue caused by tension and compression [12]. Several studies on single file reciprocating systems have evaluated the amount of debris extruded from the apical foramen relative to the preparation system used [13-16].

On the other hand, Koçak et al. (2013) stated that advances in instrument design may

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influence the amount of debris extrusion including the different tapers and cross sections as well as the use of different operational principles [17]. Pre-flaring canals when creating a glide path can prevent instrument fracture, taper lock, and shaping aberrations [18]. The glide path was defined as a smooth radicular patency from the root canal orifice to the apical construction [19]. Several companies have manufactured different rotary pathfinding instruments to create an initial glide path. The PathFile NiTi rotary system (Dentsply Maillefer, Ballaigues, Switzerland) was produced for glide path preparation. The system has a square cross section and a 0.02 taper. It consists of three instruments with ISO 13, 16, and 19 tip sizes.

However, the manufacturers of single-file NiTi systems suggest that those systems do not need the baseline creation of a glide path before their use in canal preparation. The purpose of this study was to evaluate the effect of a glide path on the amount of apically extruded debris during root canal preparation using the Reciproc system (VDW, Munich, Germany).

Materials and methods

Extracted human single-rooted mandibular premolar teeth were used. The criteria for tooth selection included a single root canal, a completely formed apex, no visible root caries, and a curvature <5° according to Schneider (1971) [20]. Preoperative buccolingual and mesiodistal radiographs were taken of each tooth to verify the presence of a single canal. Endodontic access cavities were prepared using diamond burs (Dentsply Maillefer, Switzerland) with a high-speed handpiece under water-cooling. Apical canal patency was controlled with a size 10 K-file (Dentsply Maillefer, Switzerland). Canals that were greater than size 25 were excluded, and 60 teeth were finally selected. To obtain a reference point, the buccal cusp edge of each tooth was flattened using a high-speed bur and the length of all teeth was standardized to 19 mm. The working length was determined as 0.5 mm short of the length of a size 10 K-File visible at the apical foramen.

Debris collection

The experimental model described by Myers & Montgomery (1991) was used to evaluate apically extruded debris. The caps were separated from Eppendorf tubes, and their weight was determined using a microbalance with an accuracy of 10^{-5} g (Sartorius AG, Gottingen, Germany). Each tube was weighed three times, and the mean value was recorded. A hole was created in the cap and a 27-G needle was then placed alongside the cap to balance the air pressure inside and outside. Each tooth was inserted up to the cementoenamel junction. Then, each cap with the tooth and the needle was attached to an Eppendorf tube, and the tubes were fitted into vials. The entire Eppendorf tube was handled only by the vial. The Eppendorf tube was never handled with bare fingers. Sixty teeth were coded and then randomly assigned to two groups of 30 specimens each.

Root canal instrumentation

In group 1, a glide path was created in the canals using PathFile (Dentsply/Maillefer) instruments 1 (size 13, 0.02 taper), 2 (size 16, 0.02 taper), and 3 (size 19, 0.02 taper). Instruments were used to the working length at a rotational speed of 300 rpm and a torque of 5 N/cm. A glide path was not created in group 2. The teeth in both groups were then instrumented using a Reciproc (VDW, Munich, Germany) instrument (size 25, 0.08 taper) with the Reciproc-all program of an endodontic motor (VDW Silver). The Reciproc file was used with a slow pecking motion (in-and-out). The file was removed and cleaned after three pecks, and the canal was irrigated with distilled water. These procedures were repeated until the Reciproc file reached the working length. The canals in the two groups were irrigated with a total of 10 mL distilled water during instrumentation. The instruments were used to only prepare one canal.

Evaluation of apically extruded material

After the root canal preparation was complete, the stopper, needle, and the tooth were separated from the Eppendorf tube. The debris adherent to the external root surface was collected by washing the root with 1 mL distilled water in the tube. The tubes were then stored in an incubator at 70°C for 5 days to evaporate the distilled water. The weight calculation was performed by a second examiner blinded to the group assignment. All tubes were weighed three times using the same balance to calculate the mean. The amount of extruded debris was calculated by subtracting the original weight of the empty Eppendorf tube from the gross weight.

Statistical analysis

The amount of extruded debris was analyzed statistically using a Kolmogorov-Smirnov test followed by *independent samples T-test.* The level of significance was set at P value <0.05. All statistical analyses were performed with SPSS version 13.0 for Windows (SPSS Inc., Chicago, IL, USA).

Results

The mean values and the standard deviation of the apically extruded debris for each group are shown in Table 1. The results indicate that the Reciproc file caused measurable apical extrusion of debris. The Reciproc file extruded less debris in a group with a glide path than in a group without a glide path (P < 0.05).

Group	n	Mean	SD
Glide Path + Reciproc	30	0.064	0.044
Reciproc	30	0.096	0.048

Table 1. Weight of apically extruded debris in (mg).

Discussion

The pain and swelling after root canal treatment are often associated with the preparation procedures such as foreign body reactions to filling materials and irrigation solutions or inflammatory reaction against the intracanal contents forced through the periapical region (dentine particles, necrotic pulp tissue, or microorganisms). The inflammatory response is more severe with increasing amount of apically extruded debris [21]. Extrusion of intracanal debris and irrigants is common during root canal preparation and no technique or instrument has completely solved this problem [12, 21, 22].

There has been a rapid evolution of rotary instruments through the last decade, and many have been assessed for their debris extrusion potential and the amount of this debris [21, 23]. The NiTi single-file systems that operate in a reciprocal movement have recently become popular in root canal preparation. Studies show that files working with reciprocal movement cause apical extrusion of intracanal debris during root canal preparation. Bürklein and Schäfer (2012) determined that reciprocating motion might increase the apical extrusion of debris [4]. Elnaghy and Elsaka (2014) stated that the creation of a glide path in the root canal enhances the performance of NiTi instruments [24]. Zanette et al. (2014) reported that glide path preparation preserves a pathway to the working length and thus avoids extreme binding in the canal [25]. However, the manufacturers of single-file NiTi systems mentioned that the clinical procedure of those systems does not consider the creation of a glide path before their use in canal preparation. This study evaluated the effect of a glide path on the amount of apically extruded debris during root canal preparation using the Reciproc system.

There are many limitations associated with laboratory studies that evaluated the amount of apically extruded debris such as the necrotic tissues remaining within lateral canals and apical ramifications as well as the variations in the micro-hardness values of dentine, which could affect the results. In teeth with lower hardness, debris can be extruded into the periapical tissues more easily [26].

Straight single-root premolar teeth were used in this study because of the greater predictability of the cleaning/shaping procedures [12], the ease to get because they are more commonly removed in orthodontic treatment [27], and the elimination of possible complications in the curved canals, i.e., working length loss or nonstandard preparation [21]. Distilled water was used as an irrigant to avoid any crystallization of sodium hypochlorite [28] because sodium crystals that remain after the evaporation of the solution cannot be separated from the debris, and these crystal can markedly impact the results [26].

We used the experimental model of Myers & Montgomery [29]. Some limitations in this model could affect the results such as the absence of a material (foam, agar) that simulates the apical pressure of the periodontal ligament against extrusion of debris, the deficiency of control of dentine microhardness, operator ability, and the sensitivity of the analytical balance. This is due to the small amount of the measured debris [30]. Some caution is needed when transferring the laboratory results to the clinical situation. Apical extrusion was not limited because the physical back pressure provided by periapical tissues was absent; thus, gravity may have carried the irrigant solution out of the canal

[31]. However, most studies that evaluated the apical extrusion of debris used the technique described by Myers & Montgomery (1991) [2, 4, 8, 12, 17]. The literature reports that this technique has many advantages versus competing approaches because it allows quantitative separation between the amount of debris and the quantity of irrigant. Floral foam can simulate resistance of periapical tissues in some studies [32], but this material may absorb some debris and irrigant when used as a barrier [32]. Therefore, no attempt was made to simulate periapical resistance.

We found that apical extrusion of debris occurred in both groups with canal preparation. The Reciproc file extruded less debris in the group with a glide path than in the group without a glide path ($P < 0.05$). This result agrees well with Topçuoğlu (2015) who evaluated the effect of a glide path with PathFile instruments on the amount of apically extruded debris during canal preparation using Reciproc and WaveOne systems in curved canals. This group concluded that creating a glide path reduced the amount of apically extruded debris [33]. This is likely because creating a glide path reduced the pecking motions required to reach full WL with single file systems, and this reduced the debris extrusion. To the best of our knowledge, no previous study has evaluated the effect of a glide path before root canal preparation with a Reciproc system on apical debris extrusion.

Gunes and Yeter (2018) evaluated the amount of apically extruded debris with different glide path files (including the PathFile instrument 1 and instrument 2) before preparing root canals with a single-file reciprocating system (WaveOne Gold). They concluded that the glide path preparation had no effect on apical debris extrusion [34]. The difference between the results of this study and our study might be due to the use of different final glide path file sizes and different reciprocating systems.

Conclusions

In conclusion, canal preparation with the Reciproc system extruded debris within the limitations of this *in vitro* study. The amount of apically extruded debris decreased when a glide path was created with rotary files before canal preparation with the Reciproc system.

Declaration of Interest

The authors report no conflict of interest.

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