Assessment of Apically Extruded Debris Produced by the Self-Adjusting File System

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Abstract

Introduction: This study was designed to quantitatively evaluate the amount of apically extruded debris by the Self-Adjusting-File system (SAF; ReDent-Nova, Ra'anana, Israel). Hand and rotary instruments were used as references for comparison. **Methods:** Sixty mesial roots of mandibular molars were randomly assigned to 3 groups ($n = 20$). The root canals were instrumented with hand files using a crown-down technique. The ProTaper (Dentsply Maillefer, Ballaigues, Switzerland) and SAF systems were used according to the manufacturers' instructions. Sodium hypochlorite was used as an irrigant, and the apically extruded debris was collected in preweighted glass vials and dried afterward. The mean weight of debris was assessed with a microbalance and statistically analyzed using 1-way analysis of variance and the post hoc Tukey multiple comparison test. **Results:** Hand file instrumentation produced significantly more debris compared with the ProTaper and SAF systems ($P < .05$). The ProTaper system produced significantly more debris compared with the SAF system ($P < .05$). **Conclusions:** Under the conditions of this study, all systems caused apical debris extrusion. SAF instrumentation was associated with less debris extrusion compared with the use of hand and rotary files. *(J Endod 2014;40:526–529)*

Key Words

Anatomy, cone-beam computed tomography imaging, mandibular molars, morphology, root canal

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During root canal preparation procedures, dentin chips, pulp tissue, microorganisms, and/or irrigants may be extruded into the periradicular tissues. Extrusion of these elements may cause undesired consequences, such as induction of inflammation and postoperative pain and delay of periapical healing (1–3). Currently, all preparation techniques and instruments are associated with extrusion of debris; however, there are notable differences among the techniques. It is worthwhile noting that although apical extrusion of dentinal debris and irrigants has been observed with the use of all presently known root canal preparation techniques and instruments, less dentinal debris extrusion was associated with the use of motor-driven rotary instruments (4–7).

Initial reports of the Self-Adjusting File (SAF) system (ReDent-Nova, Ra'anana, Israel) displayed promising results (8–11). This innovative instrument consists of a hollow nickel-titanium (NiTi) file composed of a lightly abrasive metal lattice that allows for dentin removal with a back-and-forth grinding motion (12, 13). The metal lattice of the file is claimed to adapt itself intimately to the canal walls even in canals with long oval cross-sections. This hollow file is used with continuous irrigation provided by a peristaltic pump. The vibrating metal lattice of the file is claimed to have a scrubbing effect on the canal walls. Siqueira et al (8) defined the SAF system as a cleaning-shaping irrigation system because it simultaneously performs chemomechanical preparation of the root canal space. Moreover, histologic evaluation showed that the SAF system improved the debridement quality in oval-shaped canals (9). The back-and forth grinding motion combined with the continuous flow of always fresh sodium hypochlorite (NaOCl) may explain this effective cleanness resulting from the SAF system. Therefore, it is possible to assume that the SAF biomechanical preparation may have a positive impact on debris extrusion during root canal treatment. Hence, the present study was designed to quantitatively evaluate the amount of apically extruded debris by comparing the conventional sequence of the ProTaper Universal NiTi files (Dentsply Maillefer, Ballaigues, Switzerland) with the SAF system. Conventional crown-down hand file instrumentation was used as a reference for comparison. The null hypothesis tested was that there are no significant differences in the amount of debris extruded between the 2 tested NiTi systems (SAF vs ProTaper).

Materials and Methods

Sample Selection

This study was revised and approved by the Ethics Committee, Nucleus of Collective Health Studies. One hundred fifty left and right mandibular first molar teeth were initially collected. To select only moderately curved mesial roots and 2 separate canals, radiographs of each tooth were taken, digitized, and stored electronically. Root canal curvature was determined based on the angle of curvature initiated at the coronal aspect of the apical third of the root using the Schneider method (14). Angles of curvature were measured using an image analysis program (AxioVision 4.5; Carl Zeiss Vision, Hallbergmoos, Germany). Only those roots with angles of curvature ranging between 10° and 20° (moderate curvatures) were selected. In addition, only mesial root canals with an initial apical size equivalent to a size 10 K-file were selected for the study. Up to this point of specimen selection, 96 molar mesial roots met the selection criteria.

The working length (WL) was established by subtracting 1 mm from the canal length. After measurement, the length of all mesial roots was standardized to 13 mm to prevent the introduction of confounders, which might contribute to variations in the preparation procedures (15). Additionally, the foramen diameter of all teeth was standardized to a size 15 K-file. Because of the anatomic features, it was impossible to follow the predetermined apical preparation in 18 of the specimens. Therefore, only 78 molar teeth met the standardization values previously mentioned. To achieve equal groups, 18 teeth were saved, leaving a total sample size of just 60 mesial roots. The teeth were disinfected in 0.5% chloramine T, stored in distilled water at 4°C, and used within 6 months after extraction.

The use of different preparation techniques resulted in 3 groups with 20 specimens each. The groups were randomly distributed using a computer algorithm (http://www.random.org). Each tooth was labeled with a random 5-digit alphanumeric code corresponding to 1 of the 3 experimental groups to remove potential operator bias.

Root Canal Preparation

Hand-file Technique. The coronal and middle third of each canal was prepared using Gates-Glidden drill (Dentsply Maillefer) sizes 4, 3, and 2 up to the beginning of the canal curvature. The apical third was prepared with Flexofile (Dentsply/Maillefer) sizes 50, 45, 40, 35, and 30 at the (WL) using the balanced force movement (16). Thus, the canals in this group were instrumented with 9 instruments. Irrigation with 1 mL 5.25% sodium hypochlorite (NaOCl) was used between each instrument and applied with a syringe and an open-end needle. After every instrument, the needle was inserted as far as possible and retracted 2 mm before the application of irrigation. After the last instrument was used, the needle was placed 2 mm from the WL, and irrigation was applied. The smear layer was then removed with 3 mL 17% EDTA for 3 minutes. A total of 3 mL bidistilled water was then used for 3 minutes as a final rinse.

ProTaper Preparation. Twenty teeth were prepared with ProTaper Universal instruments used at 300 rpm with 2 Ncm torque (XSmart, Dentsply Maillefer). The following sequence was used: SX file (1/2 of the WL); S1 file (2/3 of the WL); S2 file (2/3 of the WL); and F1, F2, and F3 files (full WL). Shaping SX, S1, and S2 files were used in the canals with a buccal and lingual brushing motion according to the anatomy of each root canal. Irrigation with 1 mL 5.25% NaOCl was used between each instrument and applied with a syringe and an open-end needle. After every instrument, the needle was inserted as far as possible and retracted 2 mm before the application of irrigation. After the last instrument was used, the needle was placed 2 mm from the WL, and irrigation was applied. The smear layer was then removed with 3 mL 17% EDTA for 3 minutes. A total of 3 mL bidistilled water was then used for 3 minutes as a final rinse.

SAF Preparation. Twenty teeth were prepared with the SAF system. A glide path was established by using K-files to allow for insertion of a #20 K-file into the WL. The SAF file was operated by using in-and-out manual motion for 4 minutes in each canal, with continuous irrigation by using 5.25% NaOCl (0.4-mm amplitude and 5,000 vibrations per minute). The irrigant was continuously provided using a VATEA peristaltic pump (ReDent-Nova) at a rate of 4 mL/min. The smear layer was then removed with 3 mL 17% EDTA for 3 minutes. A total of 3 mL bidistilled water was then used for 3 minutes as a final rinse.

Debris Collection

The apparatus used to evaluate the collection of apically extruded debris had very minor adaptations from that described previously (17) (Fig. 1). Briefly, a 10-mL ampule with a rubber stopper was adjusted for use in this experiment. The plastic assay tubes were individually preweighed 3 times with a 10^{-5}-g precision analytic microbalance (Model 1101; ElbaTech, Isola d'Elba, Italy) to obtain the mean weight of each one. By using a heated instrument, a hole was made through the center of every rubber stopper in which the root was adapted by using pressure. A 30-G needle was inserted into the rubber stopper to balance internal and external pressures, allowing for debris extrusion. All of the plastic assay tubes were covered with black tape to blind the operator during canal instrumentation.

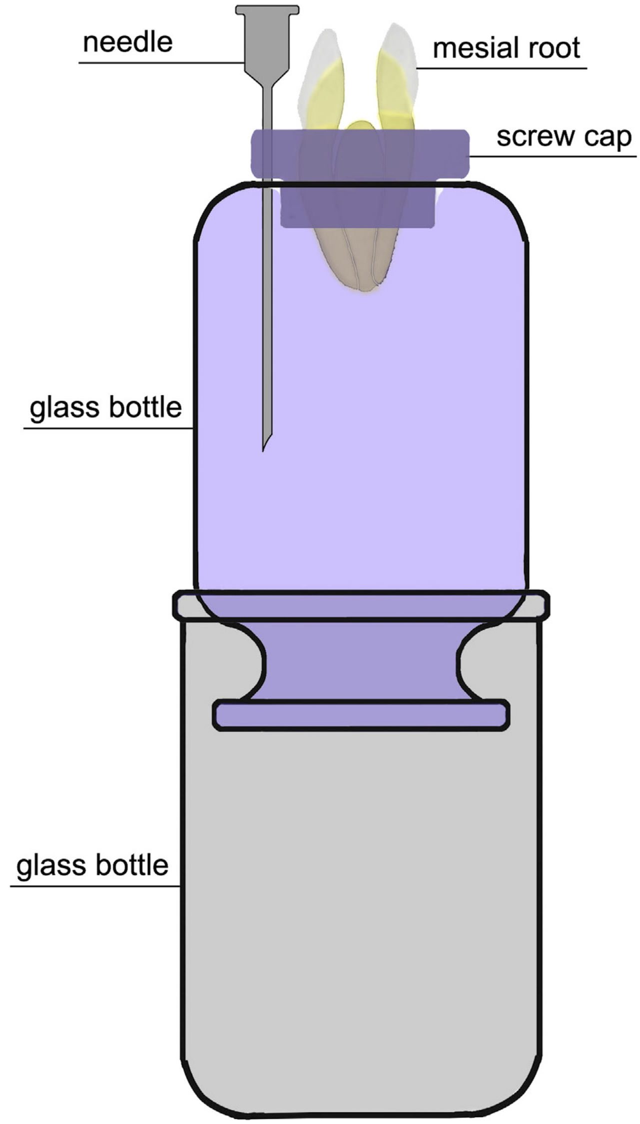

Figure 1. A schematic showing the modified apparatus used to evaluate the collection of apically extruded debris.

Teeth were instrumented into the collection assembly. After instrumentation, collection assembly was placed in a dry heat oven at a constant temperature of 140°C for 5 hours, allowing for irrigant evaporation. Three consecutive weight measurements were taken for each collection assembly, with the mean value recorded. The weight of the extruded debris was determined by subtracting the weight of the preweighed collection assembly from the final weight of the collection assembly.

Statistical Analysis

Because the preliminary analysis of the raw pooled data revealed a bell-shaped distribution (D'Agostino-Pearson omnibus normality