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Assessment of Apically Extruded Debris Produced by the Self-Adjusting File System and ProTaper Universal: An in-vitro study

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Abstract:

Aim: To compare the weight of debris extruded apically from teeth using Self- Adjusting File system and ProTaper Universal.

Materials and Methods: Twenty extracted human mandibular premolars with single canals were selected and randomly divided into two groups (n = 10 each) for instrumentation with two different file systems. Group 1: ProTaper Universal F2 (25.08; Dentsply Maillefer, Ballaigues, Switzerland). Group 2: Self-Adjusting File (SAF, 1.5-mm diameter; Re-Dent Nova, Ra'anana, Israel), and Debris extruding by instrumentation were collected into pre-weighed glass bottles. These bottles were then stored in an incubator at 70°C for 5 days. Bottles with extruded dry debris were then weighed to

obtain the final weight. Statistical analysis for the debris extruded apically was done using the significant test.

Results: The statistical analysis showed a significant difference between the two groups tested ($P < 0.001$). Self -Adjusting File (SAF) exhibited significantly less ($P < 0.001$) debris extrusion between the two groups tested.

Conclusion: Under the conditions of this study, both systems caused apical debris extrusion. The Self-Adjusting File (SAF) instrumentation was associated with less debris extrusion compared to ProTaper Universal.

Keywords: Apical extrusion, debris; instrumentation; ProTaper Universal; Self -Adjusting File (SAF)

Introduction

Complete debridement of the root canal space using files and irrigation solutions is critical to improving endodontic success. During root canal preparation procedures, dentin chips, pulp tissue, microorganisms, and/or irrigants may be extruded into the peri radicular tissues. Extrusion of these elements may cause undesired consequences, such as induction of inflammation and postoperative pain and delay of periapical healing [1]

The amount of debris extruded differs according to the preparation techniques because of the various available designs of the file systems and irrigation devices. All the instrumentation techniques used for biomechanical preparation result in apical extrusion of debris, even after the root canal preparation is maintained short of the apical terminus.[2]

Most nickel-titanium (NiTi) instrument systems work in a crown-down manner with push-pull rotation filing movements. An evolved generation in NiTi instrumentation files is marked by the introduction of single files systems for shaping and cleaning Like a self-adjusting file system (SAF).

Self-Adjusting File (SAF) system (Re Dent-Nova, Ra'anana, Israel) displayed promising results. This innovative instrument consists of a hollow nickel-titanium (NiTi) file composed of a lightly abrasive metal lattice that works in a back-and-forth grinding motion that causes dentin removal. The vibrating metal lattice of the file has a scrubbing effect on the canal walls .and this metal lattice of the file adapts 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.[3]

Siqueira et al defined the SAF system as a cleaning-shaping irrigation system because it simultaneously performs chemo-mechanical preparation of the root canal space. Moreover, the histologic evaluation showed that the SAF system improved the debridement quality in oval-shaped canals. 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.[4]

Materials and methods

A total of 20 extracted human mandibular premolars with single canals were collected. Soft-tissue remnants and calculi on the external root surface were removed mechanically. The top of the buccal cusp was flattened to create a reference point. Access cavities were prepared using a high-speed handpiece under continuous water cooling using round Bur and safe end bur. Canal patency was achieved with a size 15-K file (MANI). A size 15-K file was inserted into the root canal until the tip was visible at the apical foramen to determine the real length (RL). The working length (WL) was recorded as 1 mm less than that distance standardization according to Ingle's method. The teeth were then randomly divided into two experimental groups for different instrumentation techniques.

An analytical balance with an accuracy of 10-4 g was used to measure the initial weights of the bottle. Three consecutive weights were obtained for each bottle, and the mean was calculated. Each tooth was inserted up to the cementoenamel junction, and a 27-G needle was placed alongside the stopper for use as a drainage cannula and to balance the air pressure inside and outside the bottle

Then, each stopper with the tooth and the needle was attached to the bottle. (Fig 1)

Instrumentation

Shaping, cleaning, and irrigation were carried out as per the experimental groups.

The glide path for all the 20 samples was created till a # 20 K-file for all the groups and a new instrument/file (SAF, and PTU) was used for each sample.

Group 1: ProTaper Universal (PTU): Ten teeth were instrumented by ProTaper Universal (Dentsply Maillefer, Ballaigues, Switzerland) file system, used according to the manufacturer's instructions using a gentle in-and-out motion with torque- controlled endodontic motor at 300 rpm and a torque of 2.0 Ncm. The instrumentation sequence was SX at two-thirds of the WL, S1, and S2 at WL –1 mm and F1, F2 at the WL with a buccal and lingual brushing motion.

On meeting obstruction, the file was removed, the canal was irrigated, recapitulated, and the file was re-introduced into the canal again. The instrumentation was continued till the F1 and F2 both reached the working length.

Group 2: The Self-Adjusting File (SAF): Ten teeth were instrumented by Self-Adjusting File system (Re-Dent Nova, Ra'anana, Israel); A prior glide path established accommodated the 1.5 mm SAF. The SAF file was operated by using in-and-out manual motion for 4 minutes in the canal, with continuous irrigation by using distilled water (0.4-mm amplitude and 5,000 vibrations per minute), using VATEA peristaltic pump (Re Dent-Nova) at a rate of 4 mL/min. A total of 3 mL distilled water was then used for 3 minutes as a final rinse.

Irrigation for the rotary/reciprocating files

After each instrument (rotary) 2 mL of distilled water was used as an irrigant. Regardless of the file system used for cleaning and shaping, all the canals were irrigated using distilled water by a 27-gauge side-venting needle and syringe. Ethylenediaminetetraacetic acid (EDTA) gel was used as a lubricant throughout the instrumentation procedures for all the groups.

Debris collection and evaluation

Post instrumentation, the teeth were removed from the bottle and the debris adhering to the root surface was collected by washing off the apical area of the tooth with 1 ml of distilled water into the bottle. The bottle was stored in an incubator at 70^0 C for 5 days, to allow the moisture to evaporate, before weighing the dry debris, using an electronic balance.

Statistical analysis

Statistical analyses were performed with the SPSS software (ver. 18.0; SPSS Inc., Chicago, IL, USA). Variables are expressed as means SD. Continuous variables were compared with an independent-samples t-test for two groups. A P-value of <0.05 was considered to indicate statistical significance in all tests.

Results

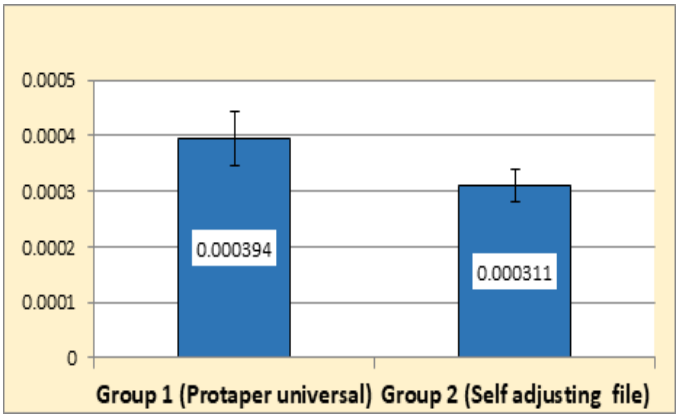
All specimens were associated with apical debris extrusion. A significant difference was found between the groups ($P < 0.001$). The PTU group had significantly greater amounts of extruded debris than the SAF group ($P < 0.001$). The lowest and highest amounts of debris for PTU and SAF groups**.**

Table 1: The mean values and standard deviations for both groups are listed

	Mean	SD	Mean Difference ± SE	Unpaired 't-test	P-value, Significance
Group 1 (Protaper universal)	0.000394	0.000049	0.000082 ± 0.000018	t = 4.476	p <0.001**
Group 2 (Self-adjusting file)	0.000311	0.000029			

*p<0.05 – significant difference

**p<0.001 – a highly significant difference



Graph 1: Amount of Debris Extrusion.

Figure 1: The experimental setup of the collection for extruded debris.

Discussion

According to the current results, apical debris extrusion occurred regardless of the instrumentation technique used. The ProTaper rotary system produced significantly more debris compared with the SAF system ($P < 0.05$). Therefore, the null hypothesis was rejected.

Two different file systems were compared in an experimental model that collected apically extruded debris.

The present results may be explained by differences in the instrument design and movement kinematics between the SAF and ProTaper rotary systems. The two files tested have different alloy properties and cross-sectional designs. The metal mesh in the SAF system is closely adapted to the canal walls and removes dentin with a back-and-forth grinding motion, providing a scrubbing action on the canal walls.[5] Moreover, the SAF allows continuous irrigation of the root canal throughout the procedure with additional activation of the irrigant by its vibrating motion that creates turbulence in the root canal. The irrigation fluid enters the file through a free-rotating hub being continuously replaced throughout the procedure, providing a fresh, fully active supply of irrigants. No positive pressure can be developed in the root canal space because the solution easily escapes through openings in the file lattice. The absence of positive pressure could favor a higher reduction of debris extrusion in the SAF group, which explains the better results observed in the present study.[6-7]

The PTU instruments have a convex triangular cross-sectional design, a non–cutting safety tip, and a fluted design that combines multiple tapers within the shaft.[8] Instruments with such a cross-sectional design are claimed to cut dentine more effectively and are composed of conventional NiTi alloy.[9]

The main disadvantage of the study is that vital Periapical tissues and the pressure at the apex that act as a barrier against apical extrusion cannot be mimicked under laboratory conditions. Although the technique allows a comparison of the file systems under identical conditions, it does have limitations. The selection of irrigation solutions could affect the quantitative values

of the extruded debris. The use of irrigants selected during routine endodontic procedures, such as NaOCl, seems more logical and reflects clinical conditions more precisely.[10]

However, sodium crystals cannot be separated from debris and might adversely affect the reliability of the experimental methodology. Therefore, distilled water was used as an irritant to prevent misleading weight measurements as a result of the possible crystallization of sodium hypochlorite solution.

The extrusion of intracanal debris can lead to postoperative pain and swelling after root canal treatment. Consequently, a reduction in debris extrusion during canal preparation is desirable to help prevent postoperative pain following the endodontic treatment. As is well known, the amount of debris varies according to the preparation technique and the cross-sectional design of the instrument.[11]

Under the condition of this study, it can be concluded that all systems caused apical debris extrusion. SAF instrumentation was associated with significantly less debris extrusion compared with the ProTaper Universal. From a clinical point of view, the present results are favorable to the SAF system. However, future studies might consider clinically evaluating the incidence of post instrumentation pain with these instrumentation systems because these may provide an in-depth understanding of SAF chemo mechanical preparation.

Conclusion

Within its limitations, it can be concluded that both the file systems used for instrumentation resulted in extrusion of debris even though the working length was maintained 1mm short of the apex. The SAF that used a vibratory motion with continuous irrigation resulted in significantly less debris extrusion when compared to ProTaper Universal.

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