

A Comparative Evaluation of Apical Debris Extruded During Instrumentation with Different Instrument Systems – an in-Vitro Study



Dental Science

KEYWORDS : apical debris extruded, SAF, Protaper Next, Hand Protaper

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ABSTRACT

Aim: The purpose of this in vitro study was to evaluate the amount of apically extruded debris using three different instrument systems. Instrument systems used were Hand protaper, Protaper next, and Self adjusting files. **Methods:** Forty-five freshly extracted human single-rooted mandibular premolar teeth with mature apices were selected. Working length was established and Forty-five teeth were randomly assigned to three groups of fifteen teeth each. Before canal instrumentation, Eppendorf vials preweighed to 10⁻⁵ precision were placed into the empty local anesthetic glass vial. The teeth were inserted up to the cemento-enamel junction into the Eppendorf vials, and then fixed with polyvinyl silicone. The teeth of the first, second and third groups were instrumented with ProTaper next, Self Adjusting Files and Hand protaper, respectively. The Eppendorf tubes were then stored in an incubator at 72°C for 4 days. The net weight of the extruded debris was determined by subtracting the initial weight from the last weight measured. **Results:** The results of this study showed that the SAF system caused least amount of apical debris extrusion where as hand ProTaper showed greater amount of apical debris extrusion. ProTaper Next rotary system performed better than hand ProTaper system. **Conclusion:** SAF instrumentation was associated with significantly less debris extrusion compared with the use of hand and rotary files. Thus we conclude that the Self Adjusting File system causes least amount of apical debris extrusion and hence will add to the success of endodontic treatment.

INTRODUCTION

If all the root canals had a smooth funnel shape from the foramen to the orifice, no curvature, no ramifications and the foramen were seated exactly at the radiographic apex, endodontic procedures would have been much simpler.¹ During root canal preparation procedures, dentin chips, pulp tissue, microorganisms, and irrigants may be extruded into the periradicular tissues. (Seltzer & Naidorf 1985). The apical extrusion of infected debris may have the potential of disrupting the balance between microbial aggression and host defense's, resulting in episodes of acute exacerbation and flare-ups.²

Van de Visse and Brilliant were the first to quantify the amount of debris extruded apically. They concluded that instrumentation without irrigation did not produce any significant collectable debris.³ In recent times, a new root canal instrumentation system, ProTaper Next (Dentsply Maillefer, Ballaigues, Switzerland), was introduced. This system is made with M wire nickel titanium alloy. The advantages of this M wire alloy are increased flexibility and greater resistance to cyclic fatigue of the instruments. Moreover, an offset design maximizes the augering of debris out of the canal compared with a file with a centered mass and axis of rotation.⁴

Initial reports of the 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 allows for dentin removal with a back-and-forth grinding motion. 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.⁵ The ProTaper systems (hand and rotary) have characteristic features which include a progressive taper and a modified guiding tip. They demonstrate a convex, triangular cross-section design, which results in a reduced contact area between the dentin and the cutting blade of the instrument.³

Using these new NiTi systems with different design features and kinematics are important for understanding how the differences affect debris extrusion.⁶

The purpose of this study is to evaluate and compare the amount of apically extruded debris using these three instrument systems.

MATERIALS AND METHOD

Selection and preparation of teeth

Forty-five freshly extracted human single-rooted mandibular premolar teeth with mature apices were selected. Teeth with calcification and open apices were excluded. Endodontic access cavities were prepared with a high-speed handpiece and pulpal remnants were extirpated using a broach. A 10 number K-file was introduced up to a point where it could barely be seen through the apex. The working length (WL) was established by subtracting 1 mm from this length. Forty-five teeth were randomly assigned to three groups of fifteen teeth each. All teeth were decorated at cemento-enamel junction.

Instrumentation and debris collection

Before canal instrumentation, Eppendorf vials preweighed to 10⁻⁵ precision were placed into the empty local anesthetic glass vial. The apical part of the root was suspended within the eppendorf vial, which acted as a collecting container for apical debris and irrigant extruded through the foramen of the root. The teeth were inserted up to the cemento-enamel junction into the Eppendorf vials, and then fixed with polyvinyl silicone; glass vial was vented with a 22-gauge needle along side the rubber stopper during instrumentation to equalize the air pressure inside and outside the apparatus. The teeth of the first, second and third groups were instrumented with ProTaper next, Self Adjusting Files and Hand protaper, respectively.

ProTaper Next

For each sample a glide path was confirmed using K-files to allow for insertion of a size 20 K-file up to the WL. The

root canals were prepared using the ProTaper Next system with gentle in and out motion at 300 rpm and 2 Ncm torque with a torque- controlled endodontic motor (X-Smart, Dentsply Maillefer). The instrumentation sequences were X1(17/04), X2 (25/06), X3(30/075), and X4 (40/06). All instruments were used at WL.

Self-adjusting file:

For each sample a glide path was confirmed using K-files to allow for insertion of a size 20 K-file upto the WL. The coronal third of the root canals were prepared using a size 3 Gates-Glidden bur, then canals were prepared to full working length using SAF. The SAF file used for the instrumentation was 21mm in length. This file was used at 5000 movements/min with an amplitude of 0.4 mm. Distilled water was continuously provided by a VATEA (ReDent-Nova) peristaltic pump at a rate of 2 ml/min. The SAF file was used for 4 min, and hence a total of 8 ml distilled water was used for irrigation. One operator completed canal preparation for all the samples

Hand Protaper Files

For each sample a glide path was confirmed using K-files to allow for insertion of a size 20 K-file up to the WL. S1 file was then used till the working length. If S1 file did not reach to the working length, Sx file was used for further coronal widening. S1 file was again instrumented in the canal till it reached the working length. S2 file was then use till working length for canal preparation. After preparing the canals with S1 and S2 shaping files, the finishing files F1, F2, F3, F4 files were used at full working length.

Debris collection

Once instrumentation was finished, the root canal was irrigated with 2 mL of distilled water and each tooth was then removed from the Eppendorf tube. The root surface was washed with 1 mL of distilled water into the Eppendorf tube to collect the debris adhering to the root surface. The Eppendorf tubes were then stored in an incubator at 72°C for 4 days for the distilled water to evaporate. The net weight of the extruded debris was determined by subtracting the initial weight from the last weight measured.

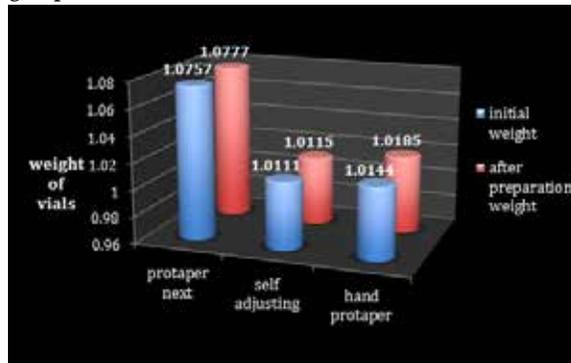
RESULTS

Table no. 1 : Descriptive data of the weights of the vials with apical debris extruded using three different instrument systems.

Instrument systems	Weight of apical debris	Initial weight of vials (g) (Mean ± SD)	After preparation weight of vial(g) (Mean ± SD)	Change in the weight (g) (Mean ± SD)
Protaper next (N = 15)		1.0757 ± 0.2547	1.0777 ± 0.2549	0.0020 ± 0.0007
Self-adjusting file (N=15)		1.0111 ± 0.0033	1.0115 ± 0.0030	0.0003 ± 0.0027
Hand protaper (N = 15)		1.0144 ± 0.0051	1.0185 ± 0.0058	0.0041 ± 0.0016

The table 1 shows values of mean and standard deviation of the weights of the vials before and after instrumentation, using three different instrument systems. From this table it is obvious that the Self Adjusting File group shows minimum change in the weights of the vials before and after instrumentation where as Hand Protaper group shows highest values.

Bar diagram showing comparison of weights of vials before and after instrumentation in all three experimental groups



DISCUSSION

Chemomechanical preparation of the root canal system is one of the major prerequisites of contemporary root canal treatment. Although various instrumentation and irrigation techniques have been introduced, one inherent problem related to all root canal shaping and cleaning procedures is the extrusion of intracanal debris and irrigants into the periradicular tissues.

Van de Visse & Brilliant (1975) attempted to compare apical extrusion of debris in root canals with or without irrigation. They concluded that irrigation was a procedure that facilitated the extrusion of intracanal debris periapically and that instrumentation without irrigants resulted in no collectible debris.⁷ Hence the present in vitro study was aimed at quantitative evaluation of the amount of debris extruded due to preparation of the root canals using ProTaper Next, Self Adjusting Files (SAF), and Hand ProTaper File systems. The results showed that SAF system caused the least amount of apical extrusion and Hand Protaper Files produced greater extrusion of debris. Protaper next was better than ProTaper file system. The selection of irrigation solution 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 (Tanalp & Gungor 2014). However, sodium crystals cannot be separated from debris and might adversely affect the reliability of the experimental methodology (Tanalp & Gungor 2014).⁹ Therefore, distilled water was used in this study as an irrigant to prevent misleading weight measurements as a result of possible crystallization of sodium hypochlorite solution.

Sheetal Ghivari *et al* conducted an in vitro study in which they evaluated and compared the amount of debris and irrigant extruded quantitatively by using two hand and rotary nickel titanium (Ni-Ti) instrumentation techniques. They concluded that hand instrumentation techniques (Step-back and Hand Protaper) extruded larger amount of debris and irrigant than the engine-driven techniques (K-3 and Rotary Protaper).⁸

Kocak *et al* (2014) in their in vitro study compared the amount of extruded debris after canal preparation using ProTaper Universal and ProTaper Next files. They concluded that ProTaper Next files were associated with significantly less extruded apical debris when compared to ProTaper Universal files.⁹ Ismail Davut Capar *et al* (2014) in their in vitro study evaluated the debris extrusion and instrumentation time with the ProTaper Universal rotary system, ProTaper Next, Twisted File Adaptive, and HyFlex

systems. They concluded that all the tested systems extruded debris. However, the ProTaper Next and Twisted File Adaptive instrumentation systems were associated with less debris extrusion compared with the ProTaper Universal and HyFlex system.¹⁰ The results of our study are in accordance to the studies mentioned above. In our study ProTaper Next group extruded less debris when compared to hand Protaper group. This could be due to the difference in alloy properties and cross sectional designs of ProTaper Next and hand ProTaper systems. The ProTaper Universal instruments are composed of conventional NiTi alloy and have a convex triangular cross-sectional design, a non-cutting safety tip and a flute design that combines multiple tapers within the shaft. Instruments with such a cross-sectional design are claimed to cut dentine more effectively (Bergmans et al. 2003), whereas the PTN files are made of M-Wire to increase flexibility and to improve cyclic fatigue. The design of the apical portion of the ProTaper Next files and their off-centered rectangular cross-section provides the non uniform and reduced contact points between the instrument and the root canal wall (Elnaghy 2014).⁹

In the present study also hand Protaper group extruded more debris when compared to ProTaper next and Self Adjusting Files. This also could be related to the time of contact between the file and root canal wall. The engine-driven file contacts the apical area for a lesser period of time and also the rotational speed and torque is fixed, whereas, the hand Protaper file prepares the apical area for an extended period of time and the rotational movement of the file is an operator controlled variable factor, extruding more amount of debris.⁸ **Gustavo Andre DeDeus et al** in their in vitro study evaluated the amount of apically extruded debris by comparing the conventional sequence of the ProTaper Universal NiTi files with the SAF system and they concluded that SAF instrumentation was associated with less debris extrusion compared with the use of Protaper Universal NiTi files.⁵ The results of present study are in similar to the above mentioned studies. The SAF group in our study resulted in the least extrusion of apical debris. The reason for better performance of Self Adjusting Files may be explained by differences in the instrument design and movement kinematics. 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. 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. Under the conditions of this in vitro study, it can be concluded that all systems caused apical debris extrusion. SAF instrumentation was associated with significantly less debris extrusion compared with the use of ProTaper Next and Hand ProTaper systems.

CONCLUSION.

Thus we conclude that self adjusting files causes least amount of apical debris extrusion and hence will add to the success of endodontic treatment.

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