Comparative evaluation of debris extrusion by three file systems with different cross-sectional design- An in-vitro study

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Abstract:

Background: To compare and evaluate debris extrusion by three file systems. **Materials & methods:** A 30 mandibular first premolars were randomly assigned to 3 groups (n = 10 teeth/group). The root canals were instrumented according to the manufacturers' instructions using the The debris extrusion was compared and statistically analyzed using analysis of variance and SPSS software. **Results:** The mean apically extruded weight of debris in WaveOne (0.0078 g) was more when compared with the Hyflex (0.0018 g). **Conclusion:** The WaveOne™ and ProTaper™ rotary instruments produced significantly more debris compared with Hyflex CM™ rotary instruments ($P < 0.05$).

Keywords: Debris, Rotary file, Waveone.

Introduction

The cleaning of the root canal system and the removal of inflamed and/or necrotic tissue remain one of the most important steps in endodontic therapy. [1] Dentine chips, pulp tissue fragments, necrotic tissue, microorganisms, and intracanal irrigants may be extruded from the apical foramen during the canal instrumentation, which may cause pain or flare-up. [2]

The apically extruded debris (AED) during root canal shaping and cleaning is a principal reason for the failure of the endodontic treatment procedure. [3] The chemomechanical disinfection of root canals is defined by shaping the root canals to be appropriately irrigated. [4] During instrumentation, infected pulp tissue remnants, dentinal chips, bacterial byproducts, and irrigation solutions can be pushed throughout the apical foramen to the periapical tissue. [5] Disrupting the integrity of the periapical tissue triggers an immunological reaction that leads to postoperative complications such as flare-ups, which in turn influence the prognosis of the endodontic treatment. [6] ProTaper™ (Dentsply Maillefer, Ballaigues, Switzerland) system exhibits progressively variable tapers of each instrument that develop a "progressive preparation" in both the vertical and horizontal directions. The ProTaper™ cross-sectional design mimics that of a reamer, with three machined cutting edges and convex core. [7] Hyflex™ CM nickel-titanium (NiTi) Files (Coltene-Whaledent, Allstetten, Switzerland) is produced by an innovative methodology (patent pending) which uses a unique process that controls the material's memory (a complex heating and cooling treatment). The cross-sectional design of Hyflex™ files is very much similar to EndoSequence. [8] Hyflex EDM (HEDM) (Coltene-Whaledent, Switzerland) is single rotary file system produced by innovative manufacturing process called "Electrical Discharge Machining" using a controlled memory Niti wire [9] which has advantages such as high precision, creation of various designs without tool constraints, and limited manufacturing stress to the file surface. This method also produces a rough surface, which can enhance the cutting abilities of the file. This entirely unique combination of flexibility and fracture resistance makes it possible to reduce the number of files required for cleaning and shaping during root canal treatment without having to compromise preservation of the root canal anatomy. They have a three different cross-sectional design with 3 cutting edges. The rectangular cross section at the tip provides more "core material," which results in high resistance to breakage of these files. Then the cross section becomes trapezoidal in the middle of the file and finally near the handle, the cross section changes to triangle which keeps the file more

flexible there. It can be labeled as a unique combination of flexibility and strength. Unlike other instruments, distorted Hyflex instruments are able to recuperate their original shape after a sterilization procedure. Hence, this study was conducted to compare and evaluate debris extrusion by three file systems.

Materials & methods

A 30 mandibular first premolars were randomly assigned to 3 groups (n = 10 teeth/group). The root canals were instrumented according to the manufacturers' instructions using the Reciprocating single-file system WaveOne™ and full-sequence rotary Hyflex CM™ and ProTaper™ instruments. The canals were then irrigated using bidistilled water. The debris that was extruded apically was collected in preweighed eppendorf tubes and assessed with an electronic balance and compared. The debris extrusion was compared and statistically analyzed using analysis of variance and SPSS software.

Results

A total of 30 teeth were enrolled. The mean extruded debris weight of the three groups were included. The mean apically extruded weight of debris in WaveOne (0.0078 g) was more when compared with the Hyflex (0.0018 g). WaveOne™ and ProTaper™ (0.0070 g) was significantly more when compared to Hyflex™ ($P < 0.05$). However, no statistical significant difference was obtained between WaveOne™ and ProTaper™ ($P > 0.05$).

Table: Amount of apically extruded debris

Debris extrusion (g)	ProTaper	Hyflex	WaveOne
Mean	0.0070	0.0018	0.0078
Standard deviation	0.0020	0.0008	0.0016

Discussion

A major objective of root canal therapy is to obtain a clean root canal system. Debris such as dentine chips, necrotic pulp tissue, microorganisms and irrigants may be extruded into the periradicular tissue during canal instrumentation which leads to endodontic flare-up. Apical extrusion of infected debris to the periradicular tissues is possibly one of the principle cause of this post-operative pain. [2] Many factors affect the amount of extruded debris such as the instrumentation technique, instrument type and size, preparation endpoint and irrigation solution. [10] Hence, this study was conducted to compare and evaluate debris extrusion by three file systems.

In the present study, a total of 30 teeth were enrolled. The mean extruded debris weight of the three groups were included. The mean apically extruded weight of debris in WaveOne (0.0078 g) was more when compared with the Hyflex (0.0018 g). A study by Surakanti JR et al, the WaveOne™ and ProTaper™ rotary instruments produced significantly more debris compared with Hyflex CM™ rotary instruments ($P < 0.05$). Under the conditions of the study, all systems that were used resulted in extrusion of apical debris. Full-sequence rotary instrumentation was associated with less debris extrusion compared with the use of reciprocating single-file systems. [11]

In the present study, WaveOne™ and ProTaper™ (0.0070 g) was significantly more when compared to Hyflex™ ($P < 0.05$). However, no statistical significant difference was obtained between WaveOne™ and ProTaper™ ($P > 0.05$). Another study by Sowjanya T et al, the Flexicon X1 reciprocating system showed the maximum amount of apical extrusion of debris among all the groups. The least amount of debris was observed in Flexicon X7 rotary instrument ($P > 0.05$). Flexicon X7 rotary extruded significantly lesser amount of debris than Flexicon X1 reciprocating and HEDM rotary file systems. [12] While a study by Patel et al., [13] documented that reciprocating instrumentation produces more apical debris, observed no significant difference in debris extrusion between single-file rotary and reciprocating systems. On the contrary, studies conducted by Uslu et al. [14] showed that single-file reciprocating systems extruded less debris compared to their counterpart rotary systems. Hyflex CM™ files have a cross-sectional design very similar to EndoSequence. [15] The cutting profile of each Hyflex CM™ file facilitates penetration in the canal and presents a root canal shape corresponding

with the original anatomy. A study by Bürklein et al. found that there was more debris in the apical part of the canals after canal preparation with WaveOne and ProTaper instruments as they are characterized by three cutting edges with radial lands to support the blades and a relatively small chip space. [16] ProTaper™ and WaveOne™ are characterized by a triangular or modified triangular cross-section resulting in a lower cutting efficiency and smaller chip space. 16 This design may enhance debris transportation toward the apex when used in combination with a reciprocal motion. Contrarily, in continuous rotation may improve coronal transportation of dentin chips and debris by acting like a screw conveyor. [17] Ruiz-Hubard et al. [18] found that extrusion of debris apically was less using a crown-down pressure less technique in curved and straight canals when compared with the step-back technique. Zarrabi et al. [19] compared ProFile, RaCe and Flex Master rotary instruments with the step-back technique using manual files and reported that the step-back technique extruded greater amounts of debris than the rotary instruments. Ghivari et al. found that step-back technique extruded a greater quantity of debris and irrigant in comparison to the other hand and rotary Ni-Ti systems.[20,21] Garlapati et al. showed that K3 rotary instruments using crown down technique extruded less number of bacteria. [22]

Earlier studies have shown that manual instrumentation produced significantly more debris than the rotary NiTi techniques and the balanced-force technique. [23] It was observed that rotation during instrumentation, with both the rotary and balanced-force techniques, tend to pull dentinal debris into the flutes of the file and direct it toward the coronal aspect of the canal. In case of engine-driven instruments early flaring of the coronal part of the preparation may improve instrument control during preparation of the apical third of the canal. The rotary motion tends to direct debris toward the orifice, avoiding its compaction in the root canal. [24]

Conclusion

The WaveOne™ and ProTaper™ rotary instruments produced significantly more debris compared with Hyflex CM™ rotary instruments ($P < 0.05$).

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