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ORIGINAL ARTICLE

Apical Debris Extrusion by Novel Endostar E5 Compared to Other Commercial Rotary Files: An in Vitro Study

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Abstract

Objective: To compare the amount of apical debris extrusion in samples instrumented by EndoStar E5, ProTaper Universal, and M-two rotary files. **Material and Methods:** Forty-five freshly extracted non-carious mandibular premolar teeth with single roots and single canals were acquired, and randomly divided into 3 groups (n=15). Samples in Groups 1, 2, and 3 were instrumented using EndoStar E5 (EE5), ProTaper Universal (PTU), and M-two (MTO) rotary file, respectively. Following instrumentation, the debris extruded was collected in pre-weighed Eppendorf tubes and stored in an incubator at 70°C for 5 days. Tubes containing the dry extruded debris were then weighed. One-way analysis of variance was applied to the weights obtained followed by Tukey's post hoc test for multiple comparison. **Results:** The mean debris extruded (mg) for the 3 groups were 1.23 (±0.72), 2.16 (±0.66), and 1.39 (±0.86) for EE5, PTU, and MTO respectively. Samples instrumented with PTU were associated with significantly higher debris extrusion ($p<0.01$) compared to EE5 and MTO. The groups EE5 and MTO did not differ in the amounts of debris extrusion ($p>0.05$). **Conclusion:** The novel EE5 and M-two rotary files result in less debris extrusion compared to PTU in mandibular premolars.

Keywords: Endodontics; Root Canal Therapy; Root Canal Preparation.

Introduction

The aim of root canal instrumentation is to thoroughly debride and disinfect the entire root canal system, and to create a suitable shape for a complete three-dimensional obturation. In an effort to obtain these goals, dentinal debris, necrotic pulp tissue, bacteria and their byproducts are extruded into the periradicular tissues leading to an inflammatory response, postoperative pain and possible delayed healing. Despite of any instrumentation techniques used for biomechanical preparation, all result in apical extrusion of debris; even after the root canal preparation is maintained short of the apical terminus [1-4].

Most of the commonly used motorized files instrument the root canal in a crown down manner and have reported to result in variable amounts of debris extrusion. Also the motorized files possess variable tapers and cross-sections and the use of different operational principles have been developed to improve working safety, to shorten the working time and to create a greater flare within the preparations. The newer systems also provide a cleaner and smoother preparation to receive the final obturation [1-7].

Push-pull motions tend to produce a more apical extrusion of debris than instrumentation techniques using a rotational motion [6,8]. Recently introduced rotary file system EndoStar E5 (EE5; Poldent Co. LTD., Warsaw, Poland) has no evidence of its effect of instrumentation on the debris extrusion. These files have a cross section similar to that of M-two rotary files (VDW GmbH, Munich, Germany) [9].

The aim of the current study was to observe the effect of novel EE5 instrumentation on the debris extrusion apically when compared to ProTaper Universal (PTU) and M-two (MTO).

Material and Methods

Sample Preparation

Forty-five extracted non-carious premolars with fully formed apices were acquired from a pool of freshly extracted teeth, not related to current study. The inclusion criteria considered for tooth selection included; single root canal, no visible root caries, no fractures or cracks under a stereoscopic microscope at x32 magnification, and no signs of internal or external resorption or calcification within the canal. The soft-tissue remnants and calculi (if any) on the external root surface were removed using an ultrasonics scaler. The cusp edges of each sample was flattened aiding as a fixed reference point for root canal instrumentation, followed by standard oval coronal access cavity preparation by an access cavity kit (Endo Z Access Kit, Dentsply Tulsa, OK, USA). Canal patency was achieved for all samples by a #10 K-file and the working length (WL) of each sample with single canal was established as 1 mm short of the length of a #10 K-file that was visible at the major diameter of the apical foramen. The teeth were then randomly divided into three experimental groups for instrumentation, and an experimental model previously described was used to assess the debris extruding apically [6].

Root Canal Instrumentation

- Group 1 - EndoStar E5 (EE5): This files system includes the following sizes; E5 1: size 30, 0.08% taper; E5 2: size 30, 0.06% taper; E5 3: size 30, 0.04% taper; E5 4: size 25, 0.04% taper and E5 5: size 20, 0.04% taper. The files were operated at 300 rpm with torque a setting of 2.5 Ncm using an endomotor (Xsmart Plus; Dentsply Maillefer, Ballaigues, Switzerland), according to manufacturers instruction.

- Group 2 - M-two (MTO): M-two Ni-Ti rotary instruments (VDW GmbH, Munich, Germany) were used in the same Endodontic motor (X-mart plus) at 300 rpm. The standard set for this system includes number 10 to number 25, and tapers ranging from 0.04 to 0.06 (size 10/0.04 taper, size 15/0.05 taper, size 20/0.06 taper, size 25/0.06 taper). The samples were instrumented in the above-mentioned sequence till working length with light apical pressure. The M-two endodontic instruments were used in a simultaneous technique without any early coronal enlargement.

- Group 3 - ProTaper Universal (PTU): ProTaper Universal rotary files (Dentsply Maillefer, Ballaigues, Switzerland) were used according to manufacturer's instructions in a pre-programed endodontic motor X-Smart Plus (Dentsply Maillefer, Ballaigues, Switzerland) using a gentle in and out brushing motion. The instrumentation sequence was SX at two-third of the working length (WL), S1 (17/0.06 taper) and S2 (20/0.06 taper) at 1 mm short of WL, and F1 (20/0.07 taper) and F2 (25/0.08 taper) at the WL already determined.

Debris Collection

The present study used the experimental model previously described [6]. A hole was created in a stopper and a 27-G needle was used alongside the stopper to equalize air pressure inside and outside the tubes. Each stopper with the tooth and the needle was attached to its Eppendorf tube, and the tubes were fitted into vials. Only the outer vial handled the entire apparatus. Before root canal instrumentation, the Eppendorf tubes were weighed to 10-6 precision by using a microbalance (Cubis, Sartorius Lab Instruments GmbH & Co. KG, Göttingen, Germany). Three consecutive measurements were taken for each tube, and the mean values were recorded. All vials were covered with aluminum foil to prevent the operator from observing debris extrusion while instrumentation.

Irrigation Protocol

During canal preparation, after each instrument the canals were irrigated with 5 mL of bi-distilled water using a syringe and 29-gauge side-vented needle NaviTip 31ga (Ultradent Products Inc., South Jordan, UT, USA). For all the groups, EDTA gel was used as a lubricant throughout the instrumentation procedure.

Evaluation of Apically Extruded Material

Following completion of entire instrumentation sequence for all the 3 groups, the teeth were removed from the tube and debris adhering to the root surface was collected in the centrifuge tube by washing off the apical area of the tooth with 1 ml distilled water. Before weighing the dry debris with an electronic balance, the centrifuge tube was stored in an incubator at 70^{0}C for 5 days, to allow the moisture to evaporate. A second examiner blinded to group assignment completed evaluation. The net weight of the dry debris was determined by subtracting the original weight of the empty Eppendorf tube from the gross weight.

Statistical Analysis

The raw pooled data of the weights were statistically analyzed by application of One-way analysis of variance (ANOVA) and Tukey's post hoc test using IBM SPSS Statistics version 22.0 (IBM Corporation, New York, USA) for MacBook OS. The level of significance was set at $p<0.05$.

Results

All specimens were associated with debris extrusion apically after root canal instrumentation. The means and standard deviations of debris extruded by the different instrumentation endodontic file sequences are presented in Table 1. The PTU rotary files were associated with significantly high debris extrusion when compared to EE5 ($p<0.01$), and MTO ($p<0.05$).

Table 1. Mean and standard deviation (SD) for the three instrumentation groups.

Instrumentation	N	Mean	SD	p-value	Post hoc Test
EE5	15	1.23	± 0.72	0.001	PTU <0.01 MTO >0.05
PTU	15	2.16	± 0.66		EE5 <0.01 MTO <0.05
MTO	15	1.39	± 0.86		PTU <0.05 EE5 >0.05

One-way ANOVA

Discussion

According to the results, all the three endodontic files extruded considerable amount of debris apically. The PTU rotary file sequence resulted maximum debris extrusion compared to EE5 ($p<0.01$), and MTO ($p<0.05$). The other two groups (EE5 and MTO) did not differ significantly in the amount of debris extrusion ($p>0.05$). Similar results of higher extrusion of debris with PTU have been reported in previous studies [1,5,10]. However, to the authors' knowledge the debris extrusion using the novel EE5 is yet to be reported in literature.

A common finding of most studies in endodontic literature is that the crown-down technique extrudes less debris and irrigants apically as compared to the step-back technique and that a linear filing motion extrudes more debris when compared to instruments used in rotational motion [8].

PTU files possess a triangular cross-section, with progressive tapering along the length leading to a smaller chip space area, and enhance the debris transportation towards the apical third [11]. It was previously mentioned that more extruded debris are associated with full sequence ProTaper Universal rotary files may be due to several times of irrigation and insertion of instrument in canal till length [12]. It can also be speculated that an aggressive, faster system, which removes a substantial amount of dentine in a shorter period of time, resists the coronal displacement the debris with the same efficiency as it cuts, thus possessing a risk of increased apical extrusion of debris. Also, the long pitch design of the ProTaper instruments may cause a greater amount of debris to be extruded [13,14].

M-two is used in single length method in which all the instruments were used till WL and very small hand files are used for initial glide path. In M-two files, the distance between the cutting blades increases from the instrument tip to the shaft, the progressive pitch and absence of radial lands produce less dentinal debris. Space for dentin removal is deeper at the back of the blade. This reduces the risk of apical extrusion [8]. The EE5 is similar in cross-section to the MTO rotary files [9]. In the current study they resulted in similar amount of debris extrusion apically and did not differ statistically from each other ($p>0.05$).

The selection of irrigation solution could affect the quantitative values of the extruded debris. The use of NaOCl seems more logical and reflects clinical conditions, as it is used during routine endodontic procedures. 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 irrigant to prevent misleading weight measurements as a result of possible crystallization of sodium hypochlorite solution in the current study [15]. The weight of extruded debris might also be affected by hydration from moisture in the air. Hence, in the present study, the tubes were weighed repeatedly for three times and for more precision the average was taken into consideration [4,16].

Conclusion

The novel EndoStar E5 resulted in less debris extrusion compared to ProTaper Universal, and similar debris when compared to M-two rotary endodontic files.

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Conflict of Interest: The authors declare no conflicts of interest.

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