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An *in vitro* comparative study of apically extruded debris resulting from conventional and three rotary (Profile, Race, FlexMaster) instrumentation techniques

Mohammad Hasan Zarrabi, Maryam Bidar and Hamid Jafarzadeh

Department of Endodontics, Dental School and Dental Research Center,
Mashad University of Medical Sciences, Mashad, Iran

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Abstract: **Canal preparation is one of the most important stages of endodontic therapy, and various techniques have been applied for it. The present study was conducted to compare the quantity of debris extruded from the apical foramen during canal preparation during the manual technique and with the use of three rotary systems (Profile, Race, FlexMaster). One hundred single-rooted premolars were divided into four groups of 25 teeth each. For collection of debris, vials containing distilled water and weighed before canal preparation were used. Groups H, P, R and F were prepared by the manual step-back technique, and with the use of the Profile system, Race system and FlexMaster system, respectively. After canal preparation, the vials were dried thoroughly and reweighed. The difference between the weights of the vials at the two stages was taken as the debris weight. The mean debris weights were compared by one-way ANOVA. Group H had the highest mean debris weight, which was significantly different from those of the rotary groups (*P* < 0.001). The lowest mean debris weight was related to group R, which was significantly different from that of group F but not significantly different from that of group P. It was concluded that the Race system induces less extruded debris than the manual technique and the FlexMaster system. (J. Oral Sci. 48, 85-88, 2006)**

Keywords: canal preparation; apical foramen; debris extrusion

Correspondence to Dr. Mohammad Hasan Zarrabi, Department of Endodontics, Mashad Dental School, Vakilabad Blv, Mashad, Iran P.O. Box: 91735-984
Tel: +98-511-8829501-15
Fax: +98-511-8829500
E-mail: mh.zarrabi@yahoo.com

Introduction

The ultimate object of canal preparation is the elimination of irritant factors and maintenance of healthy periapical tissues. Some of these irritants, such as necrotic debris, dentinal particles and irrigating solutions, may extrude from the apical foramen during canal preparation and induce flare-ups. Therefore, a technique that would minimize the extrusion of debris would help to reduce the incidence of such flare-ups.

Various investigations have proved that in all instrumentation techniques, debris can extrude apically and enter periapical tissues. Seltzer et al. (1) noted that if a canal preparation is confined to the canal space or extends beyond the apical foramen, then a periapical reaction would result in both situations. Myers and Montgomery (2) compared the Canal Master rotary system with the manual step-back technique and concluded that, up to the apical foramen, the latter resulted in less debris extrusion. Beeson et al. (3) compared the manual step-back technique and the Profile series 29 rotary system and showed that the former created more extrusion of debris. Reddy and Hicks (4) showed that both the Profile and Light speed techniques induced less debris extrusion than the manual technique.

Since very few investigations have compared the new rotary systems (Race, FlexMaster) with older techniques (conventional technique and the Profile rotary system) with regard to the amount of debris extruded, such studies can be very beneficial because a major problem facing dentists is the choice of the best rotary system for endodontic practice and the assessment of various parameters that influence this choice. One of these parameters is the extrusion of debris from the apical foramen. The purpose of this *in vitro* study was to compare the conventional and three rotary instrumentation techniques with regard to the amount of debris extruded.

Materials and Methods

For this *in vitro* study, which was approved by the Ethics Committee of Mashad University of Medical Sciences, one hundred human extracted single-rooted intact mandibular premolars with mature apices and curvature between 0-10 degrees were selected. All of these teeth had a single root canal and one apical foramen evident in radiographs. Teeth with calcification and open apices were excluded. For determination of canal curvature, Schneider's method employing buccolingual radiographs and the AutoCad software program (Auto Desk Inc., San Raphael, California) was used. For removal of soft tissues and attached elements, surface mechanical preparation was done using periodontal curettes (Hu-Friedy, Chicago, USA) followed by placement of teeth in 5.25% NaOCl for 1 h. To ensure complete similarity among specimens, all teeth were shortened to 15 mm by cutting the crown with an airmotor handpiece and diamond bur (Dentsply/Maillefer, Tulsa, USA). Pulpal remnants were extirpated using a broach (Moyco Union Broach, York, USA), and then the working length of each canal was determined using a No.15 K-file (Maillefer, Ballaigues, Switzerland). The file was placed in the canal until its tip became visible from the apical foramen. The working length was 0.5 mm shorter than this length. The teeth were then divided into four groups of 25 teeth each, with random processing.

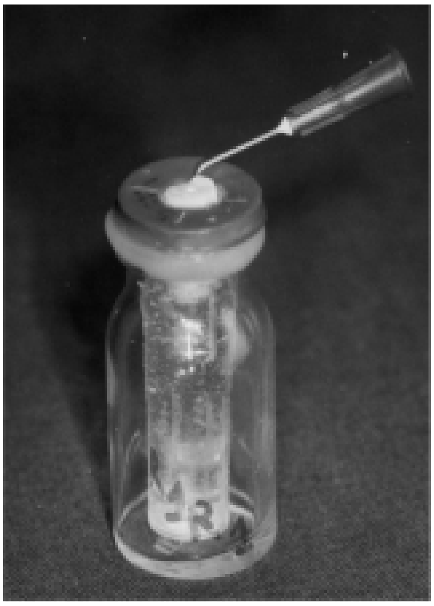

Fig. 1 System using a mounted tooth in a flask. A vial containing distilled water was placed in the glass flask and then the cap of the flask with a root inside its perforated area was placed in this system so that the apex was inside the water and the cap was sealed with glue.

All instruments were used according to the manufacturers' specifications by a single practitioner. In the rotary groups, an Endo IT Control electromotor (VDW, Munich, Germany), allowing automatic setting of the speed and torque for each selected file, was used. For canal irrigation, 1 ml of distilled water was applied after each instrumentation in a passive manner using a 28-gauge needle. Group H was prepared by the manual step-back technique using NiTi files (K-file NiTiFlex; Maillefer, Ballaigues, Switzerland) in a push and pull motion until the file became loose in the canal, and then the next file was applied. Apical preparation was continued up to No. 35, and after the completion of this stage, the step-back technique was used with a reduction of 1 mm for each subsequent file. Preparation of the coronal part of the canal was done by circumferential filing up to No. 60. Group P was prepared using a Profile system (0.04, 0.06, O.S; Maillefer, Ballaigues, Switzerland) at the recommended speed of 300 rpm. For coronal preparation in the crown down technique, O.S #4 and O.S #3 and then 0.06/30, 0.06/25, 0.04/30, 0.04/25 were used. For the apical preparation, 0.04/25, 0.04/30, 0.06/25 were used. Group R was prepared using the Race system (FKG Dentaire, La-Chaux-de-Fonds, Switzerland) at the recommended speed of 400 rpm. For safe application, we used a table devised by the manufacturer indicating the number of security points to deduct at each treatment in function with diverse parameters which influence metal fatigue. File sequences used were: 0.10/40, 0.08/35, 0.06/30, 0.04/25, 0.02/25. Group F was prepared by a FlexMaster system (Vereinigte Dentalwerke, Munich, Germany) at the recommended speed of 280 rpm. File sequences were: 0.06/25, 0.06/20, 0.04/30, 0.04/25, 0.02/20, 0.02/25, 0.02/30.

For collection of debris, the technique of Myers and Montgomery (2) was used. During canal preparation, all debris that had been extruded from the apical foramen was collected in one separate vial. Each vial containing distilled water was placed in the glass flask and then the plastic cap of the flask, with a root inside its perforated area, was placed in this system so that the apex was inside the water. For balance between the air pressure inside and outside the flask, a 25-gauge needle was used in the vial cap (Fig. 1). Before each procedure, the weight of each empty vial had been marked by a 0.0001 Sartorius weighing machine (Sartorius

Analytical, Gottingen, Germany). This balance is equipped with a backlit graphic display and the accuracy of measurement is determined by automatic internal calibration depending on time and temperature changes. Two vials of distilled water were used as control specimens, which were dried under the same conditions and weighed to prove the purity of the distilled water. After the end of canal preparation, for complete drying of vials, they were maintained at room temperature for 4 weeks, and thereafter final weighing was done. Until final weighing, the vials were saved in a desiccator containing $CaCl_2$ (Panapolytech Co., Bangkok, Thailand) to absorb the moisture. The difference between initial weight and final weight was recorded as the weight of extruded debris.

Considering a 95% confidence interval, the data were analyzed using one-way ANOVA and Duncan's test.

Results

According to the results, all four techniques induced extrusion of debris from the apical foramen. One-way ANOVA of weighed debris indicated that there were significant differences between the four groups ($\alpha = 0.05$).

Group H had the highest mean weight of debris among the four groups. A statistically significant difference was found between group H and each of other groups ($P < 0.001$). The lowest mean weight of debris was related to group R, which was significantly different from group F but not significantly different from group P (Table 1 and Fig. 2).

Discussion

It has been proved that debris extrusion occurs in all instrumentation techniques, and therefore an attempt should be made to find a system that results in minimal extrusion of debris.

In various investigations, even with usage of the same techniques, the weight of extruded debris varies due to differences in the type of irrigants, instruments, teeth and method of collection, and the weighing of debris in addition to root canal size. The type of teeth utilized plays a very important role. Fairbourn et al. (5) used mandibular premolars, and McKendry et al. (6) used maxillary central incisors, canines and second premolars in addition to mandibular canines and premolars, which have obvious morphologic differences. Other previous investigations have not mentioned the type of teeth. In this study, mandibular single-canal premolars were used because of the wide frequency between extracted teeth. Additionally, application of only one kind of tooth can help to increase the similarity between the specimens. The type of irrigants is also important. Fairbourn et al. (5) used tap water and McKendry et al. (6) used 2.5% NaOCl, whereas al-Omari et al. (7) and Beeson et al. (3) used distilled water. Because of the importance of accurate measurement, distilled water that is completely pure was chosen for this study to reduce the chance that particulate matter, indwelling in other irrigants, might possibly skew the final values. In accordance with this, the weight of control vials in both situations (without distilled water and after drying) was similar. Another important factor was instrument type. Martin and Cunningham (8) used K files and concluded that they cause more extruded debris than the endosonic technique. Fairbourn et al. (5) used K-Flex files for the step-back technique, and concluded that it caused more extruded debris than ultrasonic or endosonic technique. Similarly, al-Omari et al. (7) used Flexofile and concluded that filing with push and pull motion increases the extrusion of debris. In this study, for creating material similarity between hand files and rotary instruments, NiTi files were used.

In this study, it was noted that in all specimens, debris extrusion was created, in agreement with Ruramelin (9). The Race rotary system induced less extrusion of debris and the manual step-back technique caused most extrusion of debris from the apical foramen. Although rotary systems created much less extruded debris than the conventional

Table 1 Mean weight of extruded debris and SD with the four different systems

Instrument type	Mean(g)	SD
NiTi Flex	0.0021	0.0007
Profile	0.0003	0.0002
Race	0.0002	0.0001
FlexMaster	0.0005	0.0005

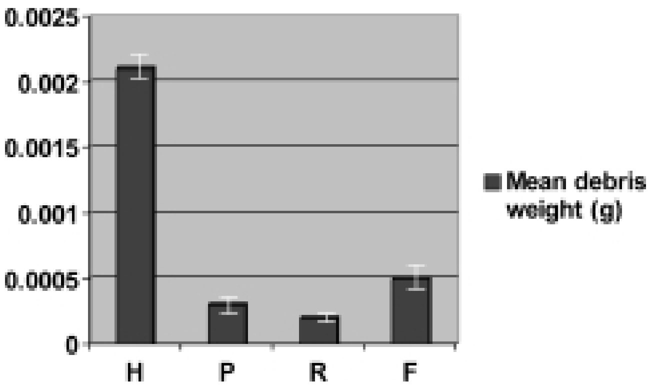

Fig. 2 Bar diagram for comparison between mean debris weights in the four groups.

technique, it should be noted that the potential for flare-up due to every amount of extruded debris (9) is clinically important. According to Reddy et al. (4), the step-back technique induced more extrusion of debris than the Profile rotary system, in agreement with this investigation. Also according to Ferraz et al. (10), the Profile 0.04 system induced less extruded debris than the manual technique, which was in agreement with this investigation.

Because this study was an *in vitro* study, different results may be achieved by *in vivo* models because periapical tissues play the role of a bridge and thus prevent extrusion of debris from the apical foramen. Therefore it is proposed that *in vivo* studies should be done to compare the results with this *in vitro* study. Additionally, other investigations should be done to assess other techniques, such as the effect of anatomic variations, multiple foramina, and various irrigants, on the amount of extruded debris.

This study showed that although all of the techniques for canal preparation caused extrusion of debris, because of the decreased amount of extruded debris, the application of rotary systems, chiefly the Race system, is considered to decrease the incidence of flare-ups.

Acknowledgments

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