The Influence of Instrument Application Frequency on Apical Extrusion of Debris in Three Instrumentation Techniques

M.H. Zarrabi DDS MSc*, M. Bidar DDS MSc*, H. Jafarzadeh DDS**, A. Talati DDS MSc***

ABSTRACT

Introduction: Various kinds of hand-held or rotary techniques are used for mechanical preparation of the canal. The purpose of this study was to assess the influence of the number of applications on apical extrusion of debris in conventional and two rotary instrumentation techniques (Profile, Flex Master).

Methods and Materials: In this in vitro study, 75 extracted single-rooted human mandibular premolars with curvature between 0-10 degrees were selected and divided into three groups of 25 teeth each. All teeth were shortened to length of 15 mm by cutting the crown. Group H was prepared by hand step back technique, group P was prepared by profile system and group F was prepared by Flex Master system. The number of applications was according to manufacturer recommendation. For collection of debris, vials of distilled water were used that were weighed before preparation by 0.0001 weighing machine. At the end of canal preparation, vials were completely dried and weighed again. The difference between the weights of vials in two stages was the weight of debris extruded from apical foramen. The mean weight of debris in various numbers of applications within each system was compared by one–way variance analysis.

Results: Comparing the various numbers of applications in each system, it was noted that only in profile group, with increasing the number of applications, the quantity of debris extrusion was reduced.

Discussion: Unused profile instruments induce more extrusion of debris from apical foramen, rather than used ones.

Key Words: Canal Preparation, Application Number, Debris Extrusion.

[Dental Research Journal (Vol. 3, No. 2, Autumn-Winter 2006)]

Introduction

The most important objective of canal preparation is the complete cleaning and elimination of irritant factors for maintenance of health in periapical tissues.

Various investigations have proved that in all instrumentation techniques, debris can be extruded apically and enter periapical tissues. These studies have noted that rotary systems are effective in canal preparation and they reduce the quantity of extruded debris from apical foramen [1]. Therefore, finding the appropriate technique and application number that minimizes the extrusion of debris can help to reduce the incidence of flare-ups in endodontics.

Seltzer and Bender [2] in 1968 noted that if canal preparation is confined to the canal

* Associated Professor, Endodontics Department, School of Dentistry and Dental Research Center, Mashad University of Medical Sciences, Mashad, Iran.
** Endodontist
*** Assistant Professor, Endodontics Department, School of Dentistry and Dental Research Center, Mashad University of Medical Sciences, Mashad, Iran.

space or extend beyond the apical foramen, in both situations, periapical reaction would be seen.

Brady and Himel [3] in 1985 emphasized that in over instrumented cases, the presence of dentinal debris in periapical area would suppress the production of bone and cementum and decrease the healing rate.

Ruiz-Hubard and Gutmann [4] in 1987 proved that in straight or curved canals, Crown-down pressureless technique induced less extrusion of debris in comparison with step back technique.

Myers and Montgomery [5] in 1991 compared canal master rotary system with hand step back technique and concluded that step back technique up to apical foramen created less extrusion of debris.

Beeson and Hartwell [6] in 1998 compared hand step back technique and series 29 rotary profile system and showed that step back technique created more extrusion of debris.

Hinrichs et al [7] in 1998 compared the light speed system, 0.04 taper series 29 profile, Niti files, and balanced force technique (using Flex-R instruments) regarding the debris extrusion and concluded that there was no significant difference among them but they noted that there was a relationship between the volume of irrigating solution and quantity of extruded debris; however, factors such as the length and curve of canal and also the size of apical foramen had no effect on the quantity of extruded debris.

Reddy and Hicks [8] in 1998 showed that both profile and light speed techniques induced less extrusion of debris compared to hand technique.

Bidar et al [9] in 2000 concluded that step back technique induced significantly more debris extrusion than 0.04 taper series 29 profile.

Some investigations have been done about the number of applications regarding each system and some recommendations have been proposed. There are many differences in various numbers of instrument applications in recutting efficiency, shaping ability, creating of smear layer, instrument fracture, and forcing of debris to periapical tissues.

The purpose of this in vitro study was to assess the influence of number of applications on apical extrusion of debris in conventional and two rotary instrumentation techniques (Profile, Flex Master).

Methods and Materials

For this in vitro study, 75 human extracted single-rooted intact mandibular premolars with mature apices and curvature between 0-10 degrees were selected. For determination of canal curvature, we used Schneider's method by taking buccolingual radiographs and application of AutoCad software. For removal of soft tissues and attached elements, surface mechanical preparation was done by periodontal curettes followed by placement of teeth in 5.25% NaOCl for 1 hour. To ensure the similarity between specimens, all teeth were shortened to the length of 15 mm by cutting the crown with diamond burs. Then the teeth were randomly divided into three groups of 25 teeth each. Pulpal remnants were extirpated by broach and then, working length of each canal was determined by a No.15 K-file in the manner that was subtracted as 0.5 mm from the length that was determined at the time of viewing the tip of the file from apical foramen.

All instruments were used according to the manufacturer recommendation. In rotary groups, Endo IT Control electromotor (VDW, Germany) was used that has the ability of automatic setting of speed and torque for each selected file. For canal irrigation, 1cc of distilled water was applied after using each instrument by passive rinsing with a 28-gauge needle. To be sure about the purity of distilled water, two vials of distilled water were used as control groups that dried and weighed in similar conditions to the specimen vials.

Group H was prepared by hand step back technique using NiTi files (Maillefer, Switzerland). They were used in Push and Pull motion until the file was passive in the

canal and then the next file was applied. Apical preparation was continued up to No.35 file and after completion of this stage, step back technique was used by diminishing 1 mm for each next file. Preparation of coronal part of the canal was done by circumferential filing up to No.60.

Group P was prepared by profile system (0.04, 0.06, O.S) (Maillefer, Switzerland) with recommended speed of 300 rpm. For coronal preparation in crown down technique, 0.S#4 and O.S#3 were used respectively and then 0.06/30, 0.06/25, 0.04/30, and 0.04/25 were used. For apical preparation 0.04/25, 0.04/30, and 0.06/25 were used respectively.

Group F was prepared by Flex Master system (VDW, Germany) with recommended speed of 280 rpm. File application sequence was as 0.06/25, 0.06/20, 0.04/30, 0.04/25, 0.02/20, 0.02/25, and 0.02/30 respectively.

Every kit of NiTi hand files was used in 5 canals so the first number of hand file application was named "A" up to fifth number which was named "E". Every kit of profile system and also every kit of Flex Master system, was used in 6 canals. In these rotary groups, the first number of file application was named "A" up to sixth number which was named "F".

For collection of debris, Myers and Montgomery [5] technique was used. Debris extruded from apical foramen, were collected in vials containing distilled water that were mounted in glass flasks (figure 1). Before each procedure, the weight of each vial was marked by a 0.0001 sartorius weighing machine (Sartorius Analytical, Germany). To balance the air pressure of inside and outside of the flask, a 25-gauge needle was used in the vial cap.

After the end of canal preparation, for complete drying of vials, they were maintained in the room temperature for 4 weeks and after that, final weighing was done. Until final weighing, vials were saved in desiccator (containing $CaCl_2$) to prevent moisture absorption. The difference between initial and final weight was recorded as the weight of extruded debris. The data were analyzed using One-way ANOVA and Duncan tests.

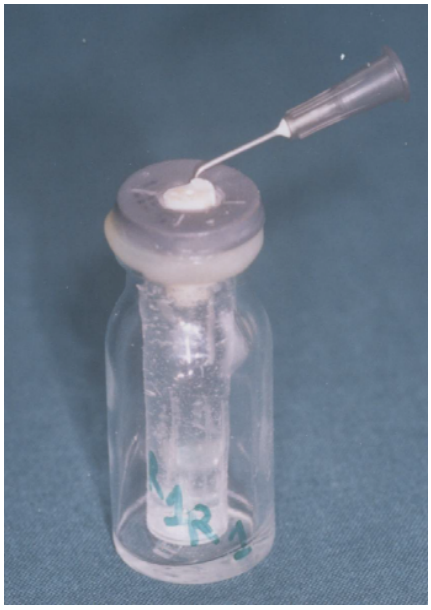

Figure 1: System of mounted tooth debris in flask.

Results

According to the results, all three techniques and all numbers induced extrusion of debris from apical foramen (table 1).

In group H, the comparison among the weight of extruded debris in five numbers of application of each kit showed that there is no significant difference in debris extrusion among five applications (P>0.05).

In group P, the comparison among the weight of extruded debris in six numbers of application of each kit, showed that there is significant difference in debris extrusion among six applications. Comparison among subgroups indicated that E and F subgroups (last numbers of instrument application) had significant differences with subgroup A (first number of instrument application); subgroup A had maximum and E and F had minimum mean weights of debris extrusion.

In group F, the comparison among the weight of extruded debris in six numbers of application of each kit, showed that there is no significant difference in debris extrusion among six applications (P>0.05).

It should be noted that first weights of control vials were similar to final weights of them.

Table 1: Mean weight of extruded debris in subgroups of three different systems.

Group	Subgroup	Mean	SD
H	A	0.0021	0.0010
	B	0.0020	0.0007
	C	0.0021	0.0009
	D	0.0021	0.0008
	E	0.0020	0.0007
F	A	0.0008	0.0005
	B	0.0008	0.0011
	C	0.0006	0.0002
	D	0.0004	0.0000
	E	0.0003	0.0000
	F	0.0003	0.0000
P	A	0.0006	0.0001
	B	0.0004	0.0001
	C	0.0003	0.0002
	D	0.0003	0.0001
	E	0.0002	0.0001
	F	0.0002	0.0002

Discussion

Siqueira [10] has noted that apical extrusion of debris is one of the most important causes of flare-ups.

In various investigations, even in usage of the same techniques, the weight of extruded debris differs that may be due to differences in factors such as the type of irrigators, instruments, teeth, method of collecting and weighing of debris, and root canal size.

Type of used teeth has a very important role. Fairbourn [11] used mandibular premolars, McKendry [12] used maxillary central incisors, canines, and second premolars in addition to mandibular canines and premolars that have obvious morphologic differences with each other. Other investigations have not mentioned the type of teeth. In this study, mandibular single canal premolars have been used.

Type of irrigators is also important. Fairbourn [11] used tap water and concluded that K-Flex files caused more debris extrusion than ultrasonic or endosonic techniques. McKendry [12] used 2.5% NaOCl and concluded that no significant difference was demonstrated between endosonic and step back filing techniques. al-Omari [13] used distilled water and concluded that most debris extrusion occurred with the step back technique with circumferential and antecurvature filing and the least extrusion with the balanced force and crown down pressureless techniques. Beeson [6] also used distilled water and concluded that K-files used to the apical foramen extruded significantly more debris than the 0.04 taper series 29 profile. Because of the importance of accurate measurement, completely pure distilled water was used in this study to reduce the chance of that possible suspended particles in other irrigators might skew the final values.

Another important factor is instrument type. Martin and Cunningham [14] used K files, Fairbourn [11] used K-Flex files, and al-Omari [13] used Flexo file. In this study, we used NiTi files to maintain material similarity of hand files and rotary instruments.

The method of debris collection and its weighing is very critical. The collected debris must be due to canal preparation; also it should be emphasized that its moisture should be completely eliminated to obtain true weight of debris. In some investigations various ways have been proposed for this object. Al-Omari and Dummer [13] maintained the specimens in the room temperature for 1 month and after that, weighed them. Other investigators [11, 12] placed the collecting vials in the incubator and then in desiccator containing CaSo4 [11] or CaCl2 [12]. Fairbourn [11] has noted that placement of collecting vials in the room temperature may cause moisture absorption that may increase the weight of specimens.

In this study, it was noted that in all specimens, debris extrusion is created that is in agreement with Ruramelin. [1].

In present study, comparing the number of instrument applications in each system, only in profile group the quantity of debris was decreased with increasing the application number; perhaps because of decrease in efficacy of dentin cutting in each

application (file kits applied in first times, caused the most extrusion of debris, whereas the files used for some instances had less extrusion of debris). Application number had no significant influence on hand and Flex Master groups.

It should be emphasized that up to now, there has been no published study with similar objective to this study to investigate the influence of number of applications on apical debris extrusion in conventional and rotary instrumentation techniques, so this study is the first investigation in this manner.

Yared et al in an in vitro study in 1999 indicated that the taper 0.06 profile NiTi rotary instruments, sizes 15-40, could be safely used, in the instrumentation of the mesial canals of human mandibular molars, up to 10 times [15] whereas in an in vivo study in 2000 they concluded that the taper 0.06 profile NiTi rotary instruments, size 15-40, could be used safely in crown down instrumentation of canals up to four human molars [16].

In vivo conditions have obvious differences. In these models, different results may

be obtained, as compared with in vitro studies because periapical tissues may be as a natural barrier and prevent extrusion of debris [7]. Also, because of positive or negative pressure at the apex, the results may be different, so the effect of this barrier should be proved. Vande visse and Brilliant have shown that in cases without periapical lesion, normal PDL can control apical or lateral penetration of irrigating solutions but in necrotic specimens, irrigating solutions spread out over the periapical tissue [17].

In the future, other investigations should compare other techniques, effect of anatomic variation, effect of various irrigating solutions, and other parameters to help dentists to know better about canal preparation process and for the best evaluation of various systems.

Acknowledgement

This work was supported in part by Dental Research Center and Vice Chancellor for Research of Mashad University of Medical Sciences (2005).

References

1. *Ingle J, Bakland L. Endodontics.5th ed. London: Mosby; 2002. p. 470-558.*
2. *Seltzer S, Soltanoff W, Sinai I, Goldenberg A, Bender IB. Biologic aspects of endodontics part III. periapical tissue reactions to root canal instrumentation. 1968. J Endod. 2004 Jul;30(7):491-9; discussion 489-90*
3. *Brady JE, Himel VT, Weir JC. Periapical response to an apical plug of dentin filings intentionally placed after root canal overinstrumentation. J Endod. 1985 Aug; 11(8) :323-9.*
4. *Ruiz-Hubard EE, Gutmann JL, Wagner MJ. A quantitative assessment of canal debris forced periapically during root canal instrumentation using two different techniques. J Endod. 1987 Dec;13(12):554-8.*
5. *Myers GL, Montgomery S. A comparison of weights of debris extruded apically by conventional filing and canal master techniques. J Endod. 1991 Jun;17(6):275-9..*
6. *Beeson TJ, Hartwell GR, Thornton JD, Gunsolley JC. Comparison of debris extruded apically in straight canals: Conventional filing versus Profile 0.04 taper series 29. J Endod. 1998 Jan;24(1):18-22.*
7. *Hinrichs RE, Walker WA 3rd, Schindler WG. A comparison of amounts of apically extruded debris using handpiece-driven nickel-titanium instrument systems. J Endod. 1998 Feb;24(2):102-6.*
8. *Reddy SA, Hicks LM. Apical extrusion of debris using two hand and two rotary instrumentation techniques. J Endod. 1998 Mar;24(3):180-3.*

9. Bidar M, Rastegar AF, Ghaziani P, Namazikhah MS. Evaluation of apically extruded debris in conventional and rotary instrumentation techniques. J Calif Dent Assoc. 2004 Sep;32(9):665-71.
10. Siqueira JF Jr. Microbial causes of endodontic flare-up. Int Endod J. 2003 Jul;36(7):453-63.
11. Fairbourn DR, McWalter GM, Montgomery S. The effect of four preparation techniques on the amount of apically extruded debris. J Endod. 1987 Mar;13(3):102-8.
12. Mckendry DJ. Comparison of balanced forces endosonic and step back filing instrumentation techniques: Quantification of extruded apical debris. J Endod. 1990 Jan;16(1):24-7.
13. al-Omari MAO, Dummer PMH. Canal blockage and debris extrusion with eight preparation techniques. J Endod. 1995 Mar;21(3):154-8.
14. Martin H, Cunningham WT. The effect of endosonic and hand manipulation on amount of root canal material extruded. Oral Surg Oral Med Oral Pathol. 1982 Jun;53(6):611-3.
15. Yared GM, Bou Dagher FE, Machtou P. Cyclic fatigue of Profile rotary instruments after simulated clinical use. Int Endod J. 2000 May;33(3):204-7.
16. Yared GM, Bou Dagher FE, Machtou P. Cyclic fatigue of Profile rotary instruments after simulated clinical use. Int Endod J. 2000 May;33(3):204-7.
17. Vande Visse JE, Brilliant JD. Effect of irrigation on the production of extruded material at the root apex during instrumentation. J Endod. 1975 Jul;1(7):243-