Title	Influence of Prior Cervical Enlargement on Apical Cleaning Using Single File.
Author(s)	Piotto Leonardi D, Alfredo Schramm C, Fernando Giovanini A, Mariane Silveira C, Sens Fagundes Tomazinho F, Baratto-Filho F.
Journal	Bulletin of Tokyo Dental College, 56(2): 85-91
URL	http://hdl.handle.net/10130/5671
Right	
Description	

Bull Tokyo Dent Coll (2015) 56(2): 85–91

Original Article

Influence of Prior Cervical Enlargement on Apical Cleaning Using Single File

Denise Piotto Leonardi, Celso Alfredo Schramm, Allan Fernando Giovanini, Cibelli Mariane Silveira, Flávia Sens Fagundes Tomazinho and Flares Baratto-Filho

Department of Dentistry, Positivo University, Rua Professor Pedro Viriato Parigot de Souza, 5300, Campo Comprido, 81280-330, Curitiba, Brazil

Received 14 November, 2014/Accepted for publication 15 January, 2015

Abstract

The goal of this study was to compare the apical cleaning capabilities of single files from 3 different rotary systems in the presence or absence of prior cervical preparation based on a histological analysis. A total of 84 human single-rooted mandibular permanent incisors were divided into 6 groups (14 canals each). Cleaning and shaping was performed under the following protocols: Group I, F2 ProTaper at working length; Group II, SX ProTaper and F2 ProTaper; Group III, size 25, .06 taper Mtwo at working length; Group IV, SX ProTaper and size 25, .06 taper Mtwo; Group V, size 25, .06 taper BR3 BioRace at working length; and Group VI, SX ProTaper and size 25, .06 taper BR3 BioRace. After cleaning and shaping, the root canals were evaluated by histological analysis. The percentage of remaining debris was evaluated using a cross-hatched grid superimposed over each image. Data were assessed using the Shapiro-Wilk and ANOVA tests. Statistically significant differences were observed between groups ($p = 0.0001$) with respect to amount of remaining debris; use of SX in conjunction with F2 ProTaper yielded a significantly lower mean percentage of debris. It was concluded that cleaning ability improves when root canal preparation with F2 ProTaper is complemented by prior cervical enlargement.

Key words: BioRace — Continuous rotating motion — ProTaper — Root canal preparation

Introduction

Ideally, endodontic treatment should include complete removal of all pulp tissue, necrotic dentin, and microorganisms, to be achieved by enlarging the root canal to obtain a clean, deformation-free area ready for posterior filling with endodontic sealer and gutta percha points[3,18]. Currently, this is not possible, however, as no available preparation technique will allow the root canal to be completely cleaned, particularly in the anatomical region of the apical third. This means that the clinical success of the endodontic treatment may be undermined[10,12].

Several types of endodontic rotary instrument have been developed with a view to optimizing such treatment, which has led

Table 1 Groups according to root canal preparation protocol

Group	Protocols for preparation
I	F2 (ProTaper, Dentsply Maillefer, Ballaigues, Switzerland) at WL of 19 mm
II	SX (ProTaper) at WL of 12 mm and F2 at WL of 19 mm
III	Mtwo 25, .06 (Mtwo, VDW, Munich, Germany) at WL of 19 mm
IV	SX at WL of 12 mm and Mtwo 25, .06 at WL of 19 mm
V	BR3 25, .06 (BioRace, FKG Dentaire, La Chaux-de-Fonds, Switzerland) at WL of 19 mm
VI	SX at WL of 12 mm and BR3 25, .06 at WL of 19 mm

WL: working length

to the gradual replacement of manual with mechanical instruments[10,17,22]. Such rotary instruments are designed to facilitate faster, higher-quality root canal preparation, reducing stress on both the professional and the patient during endodontic therapy[4,7,28]. These instruments first came onto the market in the mid-1990s, since which they have undergone constant refinement thanks to new manufacturing processes[14–16]. These changes in manufacturing have allowed variation in taper format, cross-section, and cut angle design. Such refinements have improved cutting ability and resulted in a gradual decrease in the number of instruments required during endodontic treatment[6]. Therefore, recent studies have proposed protocols that recommend the use of a single file for root canal preparation[13,29].

Although the recent focus has been on the use of simplified techniques using only one file, no consensus has been reached on the comparative cleaning efficiency of each type of instrument[8,9,29]. The purpose of the present study was to compare the apical cleaning capabilities of single files from 3 different rotary systems in the presence or absence of prior cervical preparation based on a histological analysis. The hypothesis tested was that prior cervical preparation would increase cleaning efficiency.

Materials and Methods

1. Specimen selection

The study protocol was approved by the Ethics Committee of this institute (approval no: 147/2010). A total of 84 single-rooted freshly extracted human mandibular permanent incisors with fully formed apices were randomly selected from the Teeth Bank at the Dental School of Positivo University. All teeth were stored in aqueous 0.1% thymol solution at 9°C prior to use. Radiographs were taken in the buccolingual and mesiodistal projections to select those with only one root canal.

2. Root canal preparation

The incisal edge of each tooth was ground with a bur to obtain a standard length of 20 mm. The root canal was then accessed and negotiated using a #10 K-file (Dentsply Maillefer, Ballaigues, Switzerland) to obtain a working length of 19 mm. Two specimens (n = 2) were used for the negative control group, which comprised uninstrumented and unirrigated root canals. The specimens were then randomly assigned to one of 6 groups (n = 14 per group) and the following protocols undertaken by a single operator (Table 1).

The SX ProTaper was used in a brushing motion at a working length of 12 mm and the F2, size 25, .06 taper Mtwo, and 25, .06 taper BR3 BioRace at a working length of 19 mm.

During the procedure, each instrument was cleaned with gauze to remove debris and reinserted 5 times to the working length. The root canals were irrigated with a total of 20 ml of 2.5% NaOCl solution delivered using a syringe with a 27-gauge needle (Ultradent, South Jordan, USA) at 2 mm from the working length. Each instrument was used only once in a VDW Silver electric motor (VDW, Munich, Germany) at a speed of 300 rpm and a torque of 2 N·cm. On completion of instrumentation, each root canal was irrigated with 2 ml of 17% EDTA solution.

3. Histological preparation of specimens

After cleaning and shaping, the root canals were dried with paper points. The samples were then fixed in 10% buffered formalin for 48 hr and sent to a histopathology laboratory for analysis. Each specimen was decalcified in 20% formic acid and sodium citrate over 20 days, after which they were washed with tap water, dehydrated, diafanized, and embedded in paraffin. The specimens were hemi-sectioned perpendicularly to the long axis of the tooth to obtain a representative portion of the third apical region, which measured 3 mm vertically. Serial sections of 4 μm were obtained using a microtome RM2155 (Leica Microsystems GmbH, Nussloch, Germany) and stained with hematoxylin and eosin to facilitate histomorphological and histomorphometric evaluation. Approximately 100 histological slices were obtained from each sample and analyzed using the BX-51 light microscope (Olympus, Tokyo, Japan) at 10 $\times$ magnification.

4. Histomorphological and histomorphometric evaluation

The percentage of remaining debris was evaluated using a cross-hatched grid superimposed over each image. Using the Image Tools 3.0 software (UTHSCSA, San Antonio, USA), the quadrants superimposed onto the root canal area were scored *via* a tag and count tool. Only those quadrants superimposed onto areas containing debris in the root canal were counted to establish debris percentage and cleaning capability.

5. Statistical analysis

Data were assessed with SPSS Statistics version 20.0.0 (IBM Corporation, Armonk, USA) using the Shapiro-Wilk test. Once a normal distribution had been confirmed, the data were evaluated using a single-factor ANOVA followed by the Tukey test. In all tests, $p<0.05$ was deemed to indicate statistical significance.

Results

The remaining debris can be observed in Fig. 1. The negative control group is shown in Fig. 1A. Table 2 expresses the results. No file deformation or breakage was observed.

Discussion

The purpose of this study was to determine whether cervical preflaring influenced apical cleaning when using only one instrument in this region. The results showed a statistically significant difference when prior cervical preparation was performed in association with the ProTaper F2. The proposed hypothesis was partially confirmed, as among most groups no statistically significant difference was observed in efficiency of apical cleaning.

If the initial apical file fits the apical third, then a larger master file can be used, thus allowing greater root canal enlargement and irrigant volume, which in turn influences the degree of cleanliness that can be obtained. To determine the appropriate master apical file size, cervical preflaring should be performed before choosing the initial apical file, as an appropriate fit is important in facilitating root canal enlargement[24]. It is important to verify whether the appropriate size of file has been chosen when using the single file technique, and whether cervical preflaring would improve its performance in the apical area.

In this study, the ProTaper F2 yielded better results when used after the SX. The

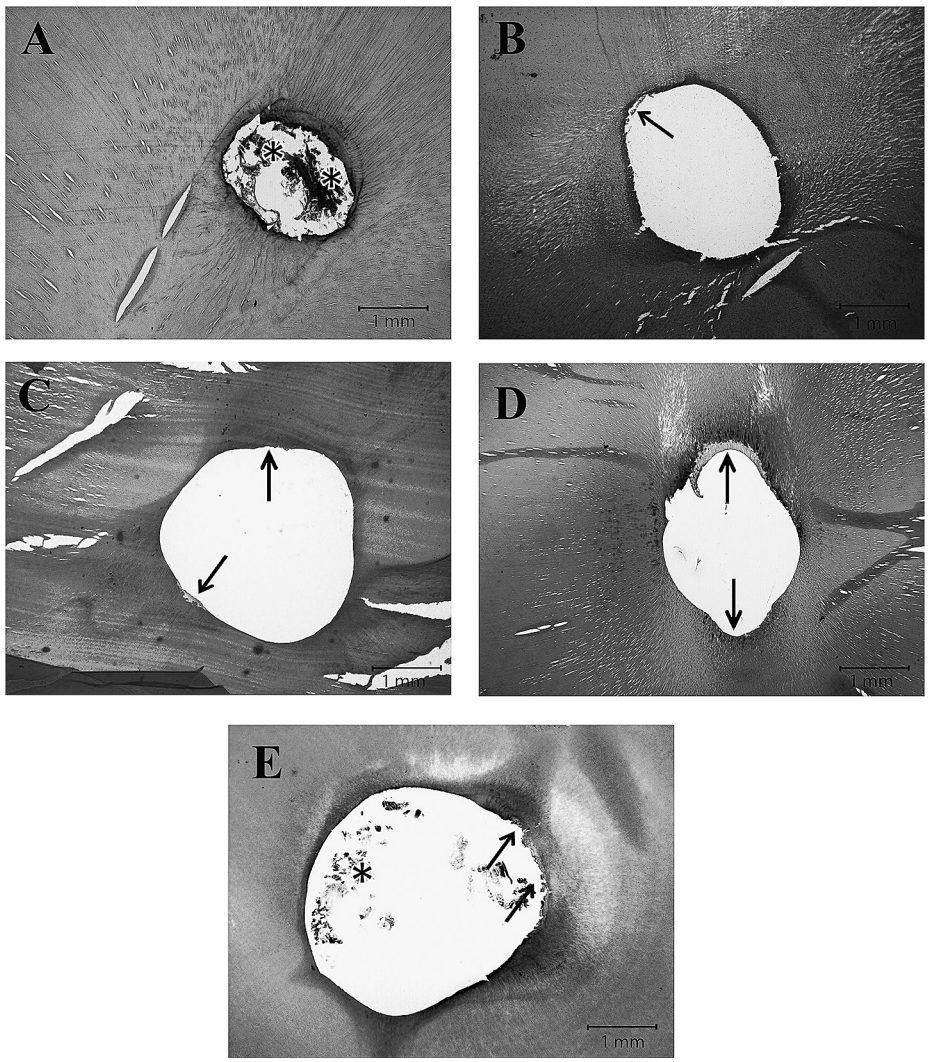

Fig. 1 A: Negative control group showing apical third full of debris (asterisks); B: Apical third with dentinal surface non-instrumented (arrow); C: Apical third with dentinal surface non-instrumented (arrows); D: Apical third with dentinal surface non-instrumented (arrows); E: Apical third with presence of debris (asterisk) and dentinal surface non-instrumented (arrows) — (H.E. — 10× magnification)

use or non-use of the SX in the ProTaper groups made a difference to the results. No significant difference was observed with its use, however, in any of the other groups. This may be explained by the design features of the F2, such as its 8% taper from D1 to D3, while the Mtwo and BR3 both have a 6% constant taper. The results for the Mtwo and BioRace groups may also have been influenced by the use of a second instrument immediately after using another instrument from the same system in the apical third, which constitutes part of that system's complementation design. Moreover, the results exhibited by the ProTaper F2 group do not represent optimum cleaning conditions, as some debris still remained. In this study, the root canals were prepared with ProTaper

Table 2 Percentage of remaining debris (mean and standard deviation) in apical third prepared using single file in presence or absence of prior cervical enlargement (n = 14)

Group	Debris mean (SD)
I: F2	(4.5 ± 2.2%)[b]
II: SX + F2	(2.6 ± 1.4%)[a]
III: Mtwo 25, .06	(5.4 ± 1.5%)[b]
IV: SX + Mtwo 25, .06	(4.3 ± 1.2%)[b]
V: BR3 25, .06	(5.0 ± 2.2%)[b]
VI: SX + BR3 25, .06	(3.2 ± 1.1%)[b]

a: groups with letters "a" were not significantly different by Tukey test ($p>0.05$)
b: groups with letters "b" were not significantly different by Tukey test ($p>0.05$)

F2 according to the protocol of Yared[29]. Preparation with larger files may have yielded a higher degree of cleanliness. However, the apical size that must be obtained to ensure optimal cleanliness remains to be determined[2,29].

As previously stated, it has been reported that cervical preflaring improves cleaning ability[24]. However, cervical preflaring may not be the only factor which determines apical cleaning capacity; for optimal results, it may be necessary to use the full conventional rotary system sequence, exactly as the manufacturer recommends, or even a single file, since that is what they are designed for[8]. It may not always be possible to clean the root canal efficiently, even when using a rotary system in full sequence, and at such times it may be necessary to employ hybrid instrumentation (rotary/manual)[25]. On the other hand, oval-shaped canal instrumentation tends to leave unprepared surfaces with remaining debris, demonstrating the influence of the original root canal shape on the debridement quality, regardless of the preparation technique used[8,19,26].

Instrument movement is as important as the preparation method. In this study, the ProTaper F2 was used with a rotary motion, in accordance with the manufacturer's instructions and its design. Other studies, on the other hand, have employed clockwise and counterclockwise movement or a reciprocating movement[9,29]. Reciproc and WaveOne nickel-titanium files are designed to allow complete preparation and cleaning of root canals with only one instrument. They were designed to be used with counterclockwise movements only, while a reciprocation working motion consists of both counterclockwise (when the instrument cuts) and clockwise movements (when the instrument is released); the angle of the counterclockwise cutting direction is greater than the angle of the reverse direction[5,20]. Thus, considering that the ProTaper file was initially designed to cut in a clockwise motion, it may be relevant to investigate whether instrument movement variation can influence cleaning efficiency, as well as the number of files used.

Another point is the use of irrigant to complement traditional methods of cleaning and shaping[1,11,23]. The irrigant requires time to play its role, so the fastest preparation does not always mean the most effective cleaning. Thus, cleanliness does not just rely on the method of preparation. The properties of each type of irrigant should also be investigated, together with the effects of concentration and technique when using a single file[30]. It is possible that passive ultrasonic irrigation may improve the cleaning ability of single-file instrumentation techniques, as previously reported[21,27].

In this study, we approximated clinical conditions by using extracted human teeth selected in a standardized manner. Nevertheless, the findings should be extrapolated to a clinical situation with care. As stated, traditional cleaning and shaping methods may require more time, and adequate root canal preparation must be achieved, regardless of the technique and number of instruments used.

The results of this study suggest that cleaning capability improves when root canal preparation using ProTaper F2 is complemented by prior cervical enlargement. When other instruments were used in the presence or absence of cervical third preparation, no

significant difference was observed in degree of cleanliness.

References

1) Aranda-Garcia AJ, Kuga MC, Vitorino KR, Chávez-Andrade GM, Duarte MA, Bonetti-Filho I, Faria G, Só MV (2013) Effect of the root canal final rinse protocols on the debris and smear layer removal and on the push-out strength of an epoxy-based sealer. Microsc Res Tech 76:533–537.
2) Bartha T, Kalwitzki M, Löst C, Weiger R (2006) Extended apical enlargement with hand files versus rotary NiTi files. Part II. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 102:692–697.
3) Bier CA, Shemesh H, Tanomaru-Filho M, Wesselink PR, Wu MK (2009) The ability of different nickel-titanium rotary instruments to induce dentinal damage during canal preparation. J Endod 35:236–238.
4) Bonaccorso A, Cantatore G, Condorelli GG, Schäfer E, Tripi TR (2009) Shaping ability of four nickel-titanium rotary instruments in simulated S-shaped canals. J Endod 35:883–886.
5) Bürklein S, Hinschitza K, Dammaschke T, Schäfer E (2012) Shaping ability and cleaning effectiveness of two single-file systems in severely curved root canals of extracted teeth: reciproc and WaveOne versus Mtwo and ProTaper. Int Endod J 45:449–461.
6) Câmara AS, de Castro Martins R, Viana AC, de Toledo Leonardo R, Buono VT, de Azevedo Bahia MG (2008) Flexibility and torsional strength of ProTaper and ProTaper Universal rotary instruments assessed by mechanical tests. J Endod 35:113–116.
7) Cheung GS, Liu CS (2009) A retrospective study of endodontic treatment outcome between nickel-titanium rotary and stainless steel hand filing techniques. J Endod 35:938–943.
8) De-Deus G, Barino B, Zamolyi RQ, Souza E, Fonseca A Jr, Fidel S, Fidel RA (2010) Suboptimal debridement quality produced by the single-file F2 ProTaper technique in oval-shaped canals. J Endod 36:1897–1900.
9) De-Deus G, Brandão MC, Barino B, Di Giorgi K, Fidel RA, Luna AS (2010) Assessment of apically extruded debris produced by the single-file ProTaper F2 technique under reciprocating movement. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 110:390–394.
10) Fornari VJ, Silva-Sousa YT, Vanni JR, Pécora JD, Versiani MA, Sousa-Neto MD (2010) Histological evaluation of the effectiveness of increased apical enlargement for cleaning the apical third of curved canals. Int Endod J 43:988–994.
11) Hohscheidt GL, Böttcher DE, Fatturi Parolo CC, Montagner F, Grecca FS (2013) Response of *E. faecalis* biofilms to different associations of auxiliary substances during root canal preparation: a confocal laser microscopy analysis. Microsc Res Tech 76:658–662.
12) Interliche R, Marchesan MA, Silva SR, Pécora JD, Silva-Sousa YT, Sousa-Neto MD (2011) Influence of Hero Apical instruments on cleaning ovoid-shaped root canals. Braz Oral Res 25:314–318.
13) Jin SY, Lee W, Kang MK, Hur B, Kim HC (2013) Single file reciprocating technique using conventional nickel-titanium rotary endodontic files. Scanning 35:349–354.
14) Kramkowski TR, Bahcall J (2009) An *in vitro* comparison of torsional stress and cyclic fatigue resistance of ProFile GT and ProFile GT Series X rotary nickel-titanium files. J Endod 35:404–407.
15) Larsen CM, Watanabe I, Glickman GN, He J (2009) Cyclic fatigue analysis of a new generation of nickel titanium rotary instruments. J Endod 35:401–403.
16) Lopes HP, Ferreira AA, Elias CN, Moreira EJ, de Oliveira JC, Siqueira JF Jr (2009) Influence of rotational speed on the cyclic fatigue of rotary nickel-titanium endodontic instruments. J Endod 35:1013–1016.
17) Moore J, Fitz-Walter P, Parashos P (2009) A micro-computed tomographic evaluation of apical root canal preparation using three instrumentation techniques. Int Endod J 42: 1057–1064.
18) Moradi S, Disfani R, Baziar H, Daneshvar F, Jafarzadeh H (2013) Use of fluid filtration method to evaluate the effect of master cone size on the apical seal of severely curved root canals. J Oral Sci 55:93–98.
19) Moura-Netto C, Palo RM, Camargo CH, Pameijer CH, Bardauil MR (2013) Micro-CT assessment of two different endodontic preparation systems. Braz Oral Res 27:26–30.
20) Pedullà E, Grande NM, Plotino G, Gambarini G, Rapisarda E (2012) Influence of continuous or reciprocating motion on cyclic fatigue resistance of 4 different nickel-titanium rotary instruments. J Endod 39:258–261.
21) Rödig T, Sedghi M, Konietschke F, Lange K, Ziebolz D, Hülsmann M (2010) Efficacy of syringe irrigation, RinsEndo and passive ultrasonic irrigation in removing debris from irregularities in root canals with different

apical sizes. Int Endod J 43:581–589.
22) Sadeghi S (2011) Shaping ability of NiTi rotary versus stainless steel hand instruments in simulated curved canals. Med Oral Patol Oral Cir Bucal 16:e454-e458.
23) Schilder H (1974) Cleaning and shaping the root canal. Dent Clin North Am 18:269–296.
24) Schmitz Mda S, Santos R, Capelli A, Jacobovitz M, Spanó JC, Pécora JD (2008) Influence of cervical preflaring on determination of apical file size in mandibular molars: SEM analysis. Braz Dent J 19:245–251.
25) Siqueira JF, Araujo MC, Garcia PF, Fraga RC, Dantas CJ (1997) Histological evaluation of the effectiveness of five instrumentation techniques for cleaning the apical third of root canals. J Endod 23:499–502.
26) Taha NA, Ozawa T, Messer HH (2010) Comparison of three techniques for preparing oval-shaped root canals. J Endod 36:532–535.
27) Vinhorte MC, Suzuki EH, de Carvalho MS, Marques AA, Sponchiado Júnior EC, Garcia Lda F (2014) Effect of passive ultrasonic agitation during final irrigation on cleaning capacity of hybrid instrumentation. Restor Dent Endod 39:104–108.
28) Whipple SJ, Kirkpatrick TC, Rutledge RE (2009) Cyclic fatigue resistance of two variable-taper rotary file systems: ProTaper universal and V-Taper. J Endod 35:555–558.
29) Yared G (2008) Canal preparation using only one Ni-Ti rotary instrument: preliminary observations. Int Endod J 41:339–344.
30) Zehnder M (2006) Root canal irrigants. J Endod 32:389–398.

Correspondence:
Dr. Denise Piotto Leonardi
Rua Professor Pedro Viriato Parigot de Souza, 5300,
Campo Comprido, 81280-330,
Curitiba/PR, Brazil
E-mail: dpleonardi@gmail.com