Evaluation of apical extrusion of debris during ultrasonic versus rotary instrumentation

Avaliação da extrusão apical de debris durante instrumentação ultra-sônica *versus* rotatória

Abstract

Purpose: The aim of this study was to compare the apical extrusion of debris during rotary *versus* ultrasonic instrumentation of root canals.

Methods: The sample comprised 20 mandibular premolars with similar root length. To collect the extruded material during endodontic instrumentation, acrylic resin containers were fixed on the root external surfaces. All teeth were prepared with Gates-Glidden drills at the cervical and middle thirds of the root canal. Root canal instrumentation was accomplished using ultrasound or rotary systems (n=10/group) according to the established work length. The resin containers were weighed before and after instrumentation, and the weight difference was considered the amount of extruded material. Data were analyzed by Mann-Whitney test at a 0.05 level of significance.

Results: Both instrumentation techniques showed large variability of amount of extruded material with values ranging from 0.0009 to 0.0860 g. No significant difference was found between the two experimental groups ($P>0.05$).

Conclusion: It can be concluded that ultrasonic or rotary systems promoted similar apical extrusion of debris during root canal instrumentation.

Key words: Root canal preparation; tooth apex; waste products

Resumo

Objetivo: O objetivo deste estudo foi comparar a extrusão apical de debris durante a instrumentação rotatória *versus* ultra-sônica de canais radiculares.

Metodologia: A amostra constituiu-se de 20 pré-molares inferiores com dimensões radiculares similares. Para coleta do material extruído apicalmente durante a instrumentação endodôntica, foram fixados recipientes de resina acrílica na superfície externa das raízes. Todos os dentes tiveram os terços cervical e médio dos canais radiculares preparado com brocas Gates-Glidden. Após odontometria, a instrumentação apical foi realizada com sistema ultra-sônico ou sistema rotatório (n=10/grupo). Os recipientes de resina foram pesados antes e após a instrumentação e a diferença de peso foi considerada a quantidade de material extruído. Os dados foram analisados por teste de Mann-Whitney, ao nível de significância de 0,05.

Resultados: Houve grande variabilidade de quantidade de material extruído para ambas as técnicas de instrumentação, com valores de 0,0009 a 0,0860 g. Não houve diferença estatisticamente significante entre os dois grupos ($P>0.05$).

Conclusão: Pode-se concluir que ambas as técnicas de instrumentação testadas, com ultra-som ou sistema rotatório, apresentaram extrusão apical de debris em quantidade semelhante.

Palavras-chave: Preparo de canal radicular; ápice dentário; resíduos

Karolline Rodrigues Araquam [a]
Maria Leticia Borges Britto [b,c]
Cleber Keiti Nabeshima [a,c]

[a] Curso de Especialização em Endodontia, Universidade Cruzeiro do Sul, São Paulo, SP, Brasil

[b] Disciplina de Endodontia, Universidade Cruzeiro do Sul, São Paulo, SP, Brasil

[c] Programa de Pós-Graduação em Ciência Odontológica/Endodontia, Universidade de São Paulo, São Paulo, SP, Brasil

Correspondence:
Cleber Keiti Nabeshima
Av. Amador Bueno da Veiga, 1340
São Paulo, SP – Brazil
03636-100
E-mail: cleberkn@hotmail.com

Received: January 29, 2008
Accepted: November 11, 2008

Introduction

In Endodontics the chemical surgical preparation phase aims to provide adequate root canal shaping and sanitation. This phase may become complex when facing roots with pronounced curvature, in which iatrogenesis and accidents are not unusual. The endodontic techniques and instruments have had outstanding technological evolution regarding preparation quality and working time. For example, ultrasound has been used to improve dentin removal from the root canal walls with effective canal irrigation. Costa et al. (1) showed by means of scanning electron microscopy images that ultrasonic instrumentation provided larger dentin removal and root canal cleaning than manual instrumentation.

On the other hand, mechanic instrumentation using new rotary files, such as nickel-titanium instruments with high flexibility, is able to promote uniform preparation relative to the original root canal shape in cases of curved roots. Zmener et al. (2) simulated curved root canals and compared the ultrasonic instrumentation with K-files, ProFile® files driven by high torque engine, and manual K-files with filing movements. Their results showed that ProFile® files promoted a more centralized canal and more conical preparation than ultrasonic instrumentation, which often showed larger deviation from the original canal curvature and extrusion of debris.

In spite of the technological advances in Endodontics, the apical extrusion of debris during instrumentation still is a major concern because it can cause periapical inflammatory reaction, pain, and healing delay. Previous studies reported contradictory findings of the relationship between instrumentation technique and quantity of extruded material from the root canal. Vansan (3) showed that all four instrumentation methods, conventional, crown-down, step-preparation, and ultrasonic techniques, yielded extrusion of debris through the apical foramen. For rotary instrumentation, Lopes et al. (4) compared the step-back technique, oscillatory movements, and ProFile 0.04 system and series 29 driven by engine, and showed that ProFile 0.04 system caused the smallest material extrusion in central incisors. Conversely, Diblasi et al. (5) observed similar extrusion de debris in maxillary lateral incisors prepared by step-down, ProFile®, and K3® techniques.

Therefore, it still is not clear the advantages of one or another technique to avoid or reduce extrusion of debris. The purpose of this *in vitro* study was to compare the quantity of debris extruded apically during root canal instrumentation using the ultrasonic and Pro Taper® rotary systems.

Methods

The research protocol was approved by the Ethics Committee of the Universidade Cruzeiro do Sul (Protocol 058/06). Twenty mandibular premolars with similar anatomy were selected. Surgery access was done using round bur LN and Endo Z, and preparation of the cervical and middle thirds of the root canals was accomplished by means of #1 and #2 Gates-Glidden drills. Root canal length was measured visually for instrumentation establishing the limit of 1mm from the anatomical apical foramen. To collect the extruded material during canal enlargement 20 containers were fabricated with chemically activated acrylic resin and fixed on the root external surface with wax (Fig. 1). The specimens were randomly divided into two experimental groups according to the instrumentation technique: ultrasonic or rotary system.

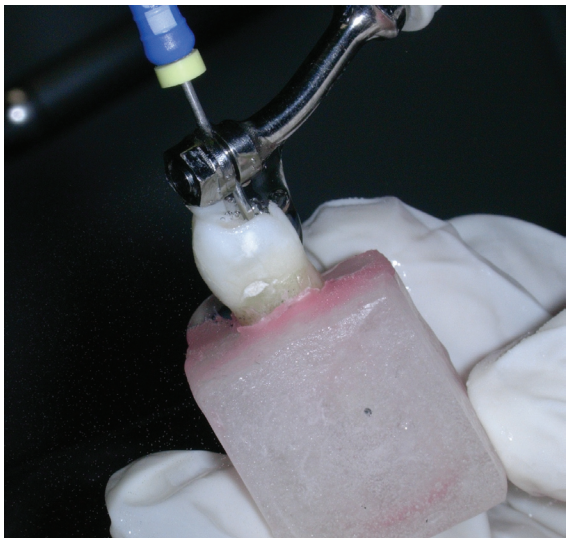

Fig. 1. Acrylic resin container fixed to the external root with wax to collect extruded material from the apical foramen during root canal instrumentation.

The ultrasonic instrumentation was performed by using the ultrasound equipment Profi III Bios® (Dabi Atlante, Ribeirão Preto, SP, Brazil) at maximum potency and with constant irrigation with 0.5% sodium hypochlorite (Fórmula & Ação, São Paulo, SP, Brazil). The sequence of files #15, 20, 25, 30, and 35 was used, and each file was replaced by a thicker file when it was completely free inside the canal walls. For each file change the root canal was filled with Endo-PTC (Fórmula & Ação, São Paulo, SP, Brazil).

The second group had canal instrumentation using the Pro Taper® rotary system (Dentsply-Maillefer, Ballainguess, Switzerland) and Pro Torque® engine (Driller, São Paulo, SP, Brazil) at 300 rpm and 3.5 torque in the cervical and middle root canal thirds and 0.6 torque in the apical third. Firstly, the file SX was used to refine the shape of the cervical and middle thirds, then the sequence of files S1, S2, F1, F2, and F3 were used up to the apical third according to the manufacturer's instructions. Each file was used 4 to 5 times to enlarge the canal with the aid of Endo-PTC and 0.5% sodium hypochlorite.

To measure the quantity of extruded material, an analytical precision balance scale BP2 10 S (Sartorius, Goettingen, Germany) was used. The acrylic resin containers were weighed completely empty before any procedure (initial weight) and after instrumentation, containing the extruded

material (final weight). The weighing procedures were done in triplicate after calibration using a standard resin block. The quantity of extruded debris was calculated by subtracting the final weight from initial weight (in grams). Data showed non-normal distribution and were analyzed by Mann-Whitney test at the 0.05 level of significance.

Results

Descriptive statistics of the quantity of extruded debris per experimental group are depicted in Table 1. A large variation of quantity of extruded material was found with values ranging from 0.0009 to 0.0860 g, and mean values were not statistically different between groups (P>0.05).

Table 1. Descriptive statistics of the quantity of extruded material (in grams) as a function of instrumentation technique (n=10/group).

	Ultrasonic	Rotary
Mean	0.0353	0.0318
Standard deviation	0.0307	0.0312
Median	0.0328	0.0229
Maximum value	0.0860	0.0851
Minimum value	0.0009	0.0055

Discussion

This study showed that apical extrusion of debris occurred using either the ultrasonic or the rotary system, but no difference of quantity of extruded material in weight was detected. The ultrasonic system was adapted to Endodontics due to the enlargement of root canal walls produced by the ultrasonic waves in addition to the efficient irrigation during instrumentation (6-8). However, this enlargement cannot be controlled and may result in an irregular canal preparation (8-16). On the other hand, systems using rotary files became more popular with the modernization of instrumentation techniques; they result in a more uniform and regular canal preparation (2,17), but the cost is still high. Previous studies showed that the apical extrusion of debris can be related to the root canal anatomy and/or the instrumentation technique (1,3,18-20), and no method is completely safe or avoid debris extrusion (1,3,5,15,19-22). The cervical-apical technique reduces the lever effect of the instrument inside the root canal because the previous preparation of the cervical and middle thirds facilitates the intracanal access, retention sites are removed, and the instrument can be inserted more freely and reach the apical region without canal deformation (14,16,23). This justifies the initial cervical rectification using Gates-Glidden drills (24) as stainless steel instruments promote greater cervical enlargement than nickel-titanium rotary files (25). Stainless steel manual files are not as flexible as nickel-titanium files, which would cause less deformation of root canal shape (23). However, in the present study flexible stainless steel files were used because the nickel-titanium files are more likely to fracture when subjected to ultrasonic waves (14).

This study showed large intra-group variability of quantity of extruded material for both instrumentation techniques. Many factors may have contributed to such variability, such as dentin hardness and permeability, microscopic anatomy, and the selection of only one type of teeth (mandibular premolars). Attempts were made to standardize root length, since longer canals seem to relate to an increased apical extrusion (18). The average root canal length was 22 mm, but it was necessary to use 31 mm files to reach the real pre-established work length because the ultrasonic tip covers some millimeters from the file.

The apical extrusion de debris varies during procedures specific to each instrumentation technique. For example, the continuous and abundant irrigation in the ultrasonic system helps the sanitation of root canals due to constant renewal of the irrigation liquid and accelerates the chemical reaction between auxiliary substances, but also can increase apical extrusion of debris and irrigation solution. Moreover, the files are replaced only when they are completely free inside the canal walls, and it is often not possible to standardize the length of work time inside de root canal. For the rotary systems, the irrigation is manual and can be affected by pressure and amount of irrigation solution, *i.e.*, there may be great individual variation according to each professional.

A limitation of the used method to measure material extrusion refers to the fact that the canal instrumentation was conducted without direct observation of the root apex, which was covered by the acrylic resin container. Therefore, it is not possible to guarantee that root canal length was kept constant during instrumentation, which could affect apical extrusion of debris and irrigation solution. However, the present findings suggest that both techniques cannot avoid apical extrusion of debris, and the professional should balance the advantages and disadvantages of each technique to better accomplish a successful treatment for a particular clinical case. Future studies may indicate the ideal moment to associate both techniques to retrieve their best operating characteristics with minor risk for apical extrusion.

Conclusions

Within the limitations of this study, the results suggest that both tested instrumentation techniques using ultrasonic or rotary system showed similar apical extrusion of debris.

References

1. Costa WF, Watanabe I, Antoniazzi JH, Pécora JD, Sobrinho AN, Lima SN. Estudo comparativo, através do microscópio eletrônico de varredura, da limpeza de canais radiculares quando da instrumentação manual e ultra-sônica. Rev Paul Odontol 1986;9:26-40.
2. Zmener O, Banegas G. Comparison of three instrumentation techniques in the preparation of simulated curved root canals. Int Endod J 1996;29:315-9.
3. Vansan LP, Pécora JD, Costa WF, Silva RG, Savioli RN. Comparative in Vitro study of apically extruded material after four different root canal instrumentation techniques. Braz Dent J 1997;8:79-83.
4. Lopes HP, Eias CN, Silveira GEL, Araújo Filho WR, Siqueira Junior JF. Extrusão de material do canal via forame apical. Rev Paul Odontol 1997; 4:34-6.
5. Diblasi F, Vilhena FS, Sassone LM, Fidel SR, Fidel RA. Análise comparativa (in vitro) da extrusão apical de debris por meio de três técnicas de instrumentação: Step down, profile e k3. UFES Rev Odontol 2003;5:46-52.
6. Bramante CM, Fernandez MC. Análise através de microscopia eletrônica de varredura de alguns dispositivos para irrigação de canais radiculares. Rev Fac Odontol Bauru 1998;6:41-6.
7. Freitas A. Relato de uma experiência de 11 anos na utilização do ultra-som em endodontia. JBC: J Bras Odontol Clin 1997; 1:66-73.
8. Langeland K, Liao K, Pancon EA. Work-saving devices in endodontics: efficacy os sonic and ultrasonic techniques. J Endod 1985;11:499-510.
9. Aragão EM, Garcia RB. Análise comparativa das técnicas de instrumentação escalonada, Oregon modificada e ultra-sônica na remoção de corante aderido ás paredes do canal radicular. Rev Odontol Univ São Paulo 1994;8:211-5.
10. Campos JM, Del Rio C. Comparison of mechanical and standard hand instrumentation technique in curved root canals. J Endod 1990;16:230-4.
11. Fernandes LM, Nascimento CM, Silveira JC, Silva FS. Instrumentos rotatórios versus instrumentação ultra-sônica no preparo de canais radiculares. Rev Assoc Paul Cir Dent 1998;52:127-33.
12. Heard F, Walton RE. Scanning electron microscope study comparing four root canal preparation techniques in small curved canals. Int Endod J 1997;30:323-31.
13. Luiten DJ, Morgan LA, Baumgartner JC, Marshall JG. A comparison of four instrumentation techniques on apical canal transportation. J Endod 1995;21:26-32.
14. Nabeshima CK; Britto ML. Avaliação da resistência de limas durante preparo químico cirúrgico no sistema ultra-sônico. Rev Assoc Paul Cir Dent 2007;61:473-8.
15. Ribeiro AF. Avaliação da limpeza do terço apical, do aumento da área foraminal e da extrusão apical de detritos após preparo químico-mecânico de canais radiculares realizados por diferentes técnicas e instrumentos [dissertação]. Rio de Janeiro (RJ): Universidade do Rio de Janeiro; 2000.
16. Zanaroli MC. Estudo da deformidade da região apical de canais artificiais preparados com a técnica cérvico-apical e ENAC [monografia]. Santos (SP): Associação dos Cirurgiões Dentistas de Santos e São Vicente; 1998.
17. Miranzi BA. Avaliação in vitro das distorções promovidas em canais radiculares artificiais curvos comparando o preparo cervical com limas de níquel titânio acionadas a motor e brocas de Gates-glidden. Rev odonto ciênc 2005;20:245-50.
18. Deonizio MD, Gavini G, Pontarolo R. Avaliação de duas metodologias de quantificação da extrusão de "debris" apicais. Rev Odontol UNICID 2002; 14:15-23.
19. Favieri A, Gahyya SM, Siqueira JJ. Extrusão apical de detritos durante instrumentação com instrumentos manuais e acionados a motor. JBE: J Bras Endo/Perio 2000;1:60-4.
20. Ribeiro MA. Avaliação da quantidade de extrusão de debris quando do preparo químico-cirúrgico de canais radiculares, utilizando quatro técnicas de instrumentação [tese]. São Paulo (SP): Faculdade de Odontologia, Universidade Camilo Castelo Branco; 1998.
21. Al-Omari MA, Dummer PM. Canal blockage and debris extrusion with eight preparation techniques. J Endod 1995;21:154-8.
22. Reddy SA, Hicks ML. Apical extrusion of debris using two hand and two rotary instrumentation techniques. J Endod 1998;24:180-3.
23. Garcia MM. Análise comparativa da deformidade de canais simulados com curvaturas acentuadas preparados pelas limas Flexofile X Nitiflex [monografia]. Santos (SP): Associação dos Cirurgiões Dentistas de Santos e São Vicente; 1998.
24. Machado ME. Análise morfométrica comparativa, à luz da computadorização em canais artificiais, de duas técnicas propostas para o preparo de canais radiculares curvos [tese]. São Paulo (SP): Faculdade de Odontologia, Universidade de São Paulo; 1993.
25. Franco AB, Jeronymo RD, Raldi DP, Lage-Marques JL, Habitante SM. Análise do desgaste após preparo cervical de canais mésio-vestibulares em molares superiores. Rev odonto ciênc 2008;23:182-6.