Comparison of the Cleaning Efficacy of Self-Adjusting File and Rotary Systems in the Apical Third of Oval-shaped Canals

Marcus Vinícius de Melo Ribeiro, MS, Yara Terezinha Silva-Sousa, PhD,† Marco Aurélio Versiani, PhD,* Alessandro Lamira, Dr med dent,† Liviu Steier, Dr med dent,‡ Jesus Djalma Pécora, PhD,* and Manoel Damião de Sousa-Neto, PhD**

Abstract

Introduction: Cleaning and shaping of root canals are essential steps for the success of endodontic therapy. The purpose of this study was to evaluate the tissue debridement efficacy of the self-adjusting file (SAF) protocol in the apical third of oval-shaped canals of mandibular incisors in comparison with a nickel-titanium rotary system preparation. **Methods:** Twenty-six single-rooted human mandibular incisor teeth were selected and assigned to a control (n = 4) and 2 experimental groups (n = 11) according to 1 of 2 instrumentation techniques, SAF and nickel-titanium rotary systems. After root canal preparation, the apical thirds of the specimens were submitted to histologic processing and analyzed by optical microscopy regarding the percentage of debris and uninstrumented root canal walls. The data were statistically compared by using unpaired *t* test with Welch's correction, and the level of significance was set at 5%. **Results:** The percentage of remaining debris and uninstrumented canal perimeter was significantly lower in SAF group (2.18 ± 2.71 and 12.33 ± 7.85, respectively) than in rotary group (13.11 ± 12.98 and 53.54 ± 15.95, respectively) ($P < .05$). In the SAF group most of specimens were completely free of debris, whereas in the rotary group 53% of the canals presented debris. **Conclusions:** SAF had significantly more contact to the dentin walls and removed more debris than rotary instrumentation in the apical third of mandibular incisors. *(J Endod 2013;39:398–401)*

Key Words

Canal cleaning, nickel-titanium, oval-shaped canals, root canal preparation, self-adjusting file

From the *Department of Endodontics, School of Dentistry, University of São Paulo, Ribeirão Preto, São Paulo, Brazil; †Department of Endodontics, School of Dentistry, University of Ribeirão Preto, Ribeirão Preto, São Paulo, Brazil; and ‡Department of Endodontics, Warwick Dentistry, University of Warwick, Coventry, United Kingdom.

Address requests for reprints to Prof Dr Manoel Damião de Sousa-Neto, Rua Célia de Oliveira Meirelles 350, 14024-070 Ribeirão Preto, SP, Brazil. E-mail address: sousanet@forp.usp.br

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Preparation of the root canal system is recognized as being one of the most important stages in root canal treatment. It includes the removal of vital and necrotic tissues from the root canal system, along with infected root dentin, which gives the canal system a shape that allows easy debridement and predictable placement of locally used medicaments and a permanent root filling of high technical quality (1). The introduction of nickel-titanium (NiTi) rotary file systems has resulted in significant progress being made in the mechanical preparation of the root canal space (2–4). However, the rotary motion of these files tends to prepare the main root canal space into a circular shape, leaving unprepared buccal and lingual extensions, which favors the retention of tissue and bacterial remnants, especially in oval-shaped canals (3–7). Thus, although many advances have been made in endodontics in the last decades, canal preparation is still adversely influenced by highly variable root canal anatomy (8).

The self-adjusting file (SAF) (ReDent-Nova, Ra'anana, Israel) has been devised with the purpose of sidestepping some of the limitations of NiTi rotary instruments (9, 10). Initial reports of the SAF system in oval-shaped root canals sound promising (11–16). During its operation, the file is designed to adapt itself three-dimensionally to the shape of the root canal. Rather than machining a central portion of the root canal into a round cross section, the SAF is claimed to maintain a flat canal as a flat canal with slightly larger dimensions (10).

Thus, the present study was designed to evaluate the tissue debridement efficacy of SAF protocol in the apical third of oval-shaped canals of mandibular incisors in comparison with a NiTi rotary system preparation.

Materials and Methods

Selection of Teeth

After ethics committee approval (protocol 2009.1.972.58.4, CAAE 0072.0.138.000-09), twenty-six vital single-rooted freshly extracted human mandibular incisor teeth with fully formed apices were selected and stored in 9°C aqueous 0.1% thymol solution until further use. Each root was radiographed in buccolingual and mesiodistal projections to categorize them and to detect any possible obstruction. When the buccolingual diameter was 4 or more times larger than that of the mesiodistal diameter, the canals were classified as flattened. All teeth presenting isthmus, lateral, accessory, apical curvature, or 2 canals were excluded from the study. After being washed in running water for 48 hours, the root canal was accessed by using high-speed diamond burs. Coronal flaring was accomplished with #2 and #3 Gates Glidden burs (Dentsply Maillefer, Ballaigues, Switzerland) in a low-speed contra-angle handpiece, which was placed to 2–4 mm below the cementoenamel junction by irrigation with 5 mL 2.5% NaOCl delivered in a syringe with a 27-gauge needle (Endo Eze; Ultradent Products Inc, South Jordan, UT). Subsequently, apical patency was determined by inserting a size 10 K-file into the root canal until its tip was visible at the apical foramen, and the working length (WL) was set 0.5 mm short of this measurement. A glide path was confirmed at least to a size #20 K-file. Specimens were then randomly assigned to a control (n = 4) and 2 experimental groups (n = 11) according to the instrumentation technique, SAF and NiTi rotary system. In addition, to achieve a certain degree of uniformity and reduce interoperator variables, all experimental procedures were conducted by the same operator.

Control Group

The negative control group (n = 2) included uninstrumented and unirrigated root canals. In the positive control group (n = 2), root canals had no mechanical preparation; instead, irrigation with distilled water was performed so that the specimens were exposed to the same volume of irrigant (20 mL) for the same length of time (4 minutes) of the experimental groups.

Root Canal Instrumentation with the SAF

A 1.5-mm-diameter SAF was operated for 4 minutes by using a trans-line (in-and-out) vibrating handpiece (Gentle-Power Lux 20LP; KaVo, Biberach, Germany) adapted with a RDT3 head (ReDent-Nova) at a frequency of 83.3 Hz (5000 rpm) and amplitude of 0.4 mm. The instrument was used with a manual in-and-out motion to the WL. Continuous irrigation with 2.5% NaOCl was applied throughout the procedure at 5 mL/min by using a special irrigation apparatus (VATEA; ReDent-Nova).

Root Canal Instrumentation by Using the NiTi Rotary System

The coronal and middle thirds were serially enlarged with NiTi rotary instruments sizes 25/.12, 25/.10, and 25/.08 (K3; SybronEndo, West Collins, CA) in a crown-down manner by using gentle in-and-out motion toward the apex. The following sequence was used to the WL at 300 rpm driven by a torque-controlled motor (X-Smart; Dentsply Maillefer): 25/.02, 25/.04, 30/.02, 30/.04, 35/.02, 35/.04, and 40/.02 instruments. To avoid fracture, the instruments were withdrawn when resistance was felt and changed for the next instrument. Also, 2 canals were instrumented with 1 set of instruments. Passive ultrasonic irrigation was performed between each instrument by using a size #20 K-file mounted on a piezoelectric handpiece (JetSonic Four; Gnatus, Ribeirão Preto, SP, Brazil) at a power setting of 3, which was activated for 10 seconds at the WL. Each canal was irrigated with a total of 20 mL 2.5% NaOCl. In all groups after root canal preparation, a final rinse with 3 mL bi-distilled water was performed. Then, teeth were immersed in 10% buffered formalin for 48 hours.

Histologic Preparation and Analysis

The teeth were washed in running water for 1 hour and decalcified in 10% trichloroacetic acid for 15 days. The apical thirds of the decalcified roots were cut perpendicularly to their long axis with a scalpel at 5 mm from anatomic apex and embedded in paraffin. Care was taken to avoid contamination during the sectioning process. Serial sections (10 semi-serial sections of each specimen), with the microtome set at 6-μm thickness, were stained with hematoxylin–eosin and examined under an optical microscope (Eclipse E 600; Nikon, Shinagawa-ku, Tokyo, Japan), coupled to a computer, at $\times$40 magnification. Before viewing the sections, any identification on the slide was masked, and the slides were randomized, which allowed blinded evaluation that was undertaken by 2 trained observers. The percentage of interagreement should be more than 95%; if this percentage was lower than 95%, a consensus should be reached. The images were recorded as a tagged image file format and evaluated for the percentage of debris and uninstrumented root canal walls. The percentage of debris was calculated by placing an integration grid (Image J; National Institutes of Health, Bethesda, MD) over the cross-section images to allow counting the points in the root canal that coincided with either clean areas or areas containing debris. The percentage of uninstrumented root canal walls was determined by calculating the length of the canal outline that was not touched by the instruments in relation to the total length of the canal outline by using Image J software. The action of the instruments on the root canal walls was assessed on the basis of the following criteria: surface regularity, abrupt change on the continuity of root canal wall, and partial or total predentin removal (Fig. 1). The prepared root canal outline was traced in a different color to differentiate it from the uninstrumented canal.

Statistical Analysis

Preliminary tests were performed to determine the sample distribution (Shapiro-Wilk test). The mean percentages of remaining debris and uninstrumented root canal perimeter at the apical third were statistically compared by using unpaired *t* test with Welch's correction. Statistical analysis was performed at the 0.05 level of significance by using SPSS software version 17.0 (SPSS Inc, Chicago, IL).

Results

The results of the analysis of the root canal cleanliness are detailed in Table 1. All experimental groups revealed significantly less debris and uninstrumented root canal walls than negative and positive control groups ($P < .05$). The percentage of remaining debris and uninstrumented canal perimeter was significantly lower in the SAF group (2.18 ± 2.71 and 12.33 ± 7.85, respectively) than in the rotary group

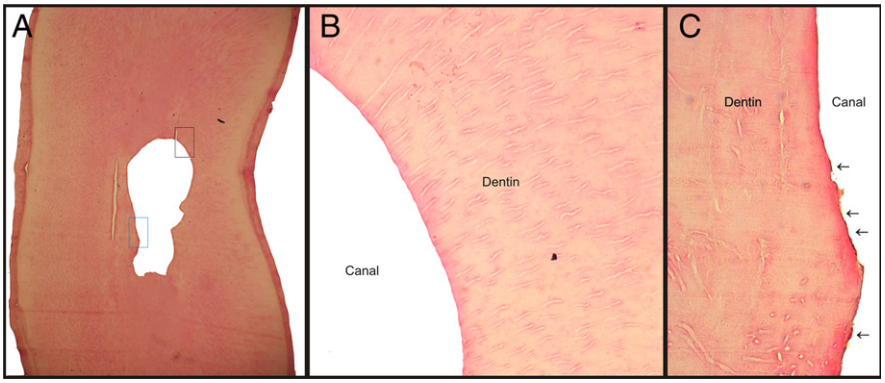

Figure 1. Criteria used for histologic evaluation of the dentin walls after root canal preparation. (*A*) Photomicrograph at apical level of mandibular incisor showing a root canal free of debris after biomechanical preparation (hematoxylin–eosin; original magnification, $\times$400). (*B*) Instrumented root canal walls: higher magnification of (*A*) (area outlined in *black*) showing the surface regularity of the root canal walls with a complete predentin removal (hematoxylin–eosin; original magnification, $\times$4000). (*C*) Uninstrumented root canal walls: higher magnification of (*A*) (area outlined in *blue*) showing the abrupt change on the continuity of the root canal walls, the irregularity of the dentin walls, and the incomplete predentin removal (*arrows*) (hematoxylin–eosin; original magnification, $\times$4000).