

Micro-computed Tomographic Analysis of Apical Microcracks before and after Root Canal Preparation by Hand, Rotary, and Reciprocating Instruments at Different Working Lengths

Bruna Paloma de Oliveira, DDS, MSc,* Andréa Cruz Câmara, DDS, MSc, PhD,*
Daniel Amancio Duarte, MSc,[†] Richard John Heck, MSc, PhD,[‡]
Antonio Celso Dantas Antonino, MSc, PhD,[‡] and Carlos Menezes Aguiar, DDS, MSc, PhD*

Abstract

Introduction: This study aimed to compare apical microcrack formation after root canal shaping by hand, rotary, and reciprocating files at different working lengths using micro-computed tomographic analysis. **Methods:** Sixty mandibular incisors were randomly divided into 6 experimental groups ($n = 10$) according to the systems and working lengths used for the root canal preparation: ProTaper Universal for Hand Use (Dentsply Maillefer, Ballaigues, Switzerland), HyFlex CM (Coltene-Whaledent, Allstetten, Switzerland), and Reciproc (VDW, Munich, Germany) files working at the apical foramen (AF) and 1 mm short of the AF (AF – 1 mm). The teeth were imaged with micro-computed tomographic scanning at an isotropic resolution of 14 μm before and after root canal preparation, and the cross-sectional images generated were assessed to detect microcracks in the apical portion of the roots. **Results:** Overall, 17 (28.3%) specimens presented microcracks before instrumentation. Apical microcracks were present in 1 (ProTaper Universal for Hand Use), 3 (Hyflex CM), and 2 (Reciproc) specimens when the instrumentation terminated at the AF. When instrumentation was terminated at AF – 1 mm, apical microcracks were detected in 3 (ProTaper Universal for Hand Use) and 4 (Hyflex CM and Reciproc) specimens. All these microcracks detected after root canal preparation were already present before instrumentation, and no new apical microcrack was visualized. For all groups, the number of slices presenting microcracks after root canal preparation was the same as before canal preparation. **Conclusions:** Root canal shaping with ProTaper Universal for Hand Use, HyFlex CM, and Reciproc systems, regardless of the working length, did not produce apical microcracks. (*J Endod* 2017; **■**:1–5)

Key Words

Dentinal crack, HyFlex CM, micro-computed tomography, ProTaper, Reciproc, root canal preparation

A cracked tooth represents a diagnostic and restorative challenge to clinicians (1). Clinically, microorganisms may proliferate in crack lines, leading to the establishment of biofilms on the root surface (2). Additionally, the propagation of a microcrack may lead to a vertical root fracture and, ultimately, tooth loss (3, 4).

Root canal shaping has been suggested as a contributing factor to the induction of dentinal defects (5–7). Additionally, instrumentation to the apical foramen (AF) has been speculated to increase the risk of producing defects in apical root dentin (8–10). There are other claims that the smoothing out of fins and sharp edges may lead to a decrease in fractures (11, 12). However, reports from research data have been inconsistent concerning the incidence of root cracks after canal preparation with hand, rotary, and reciprocating files, often generating confusion and uncertainty on the part of practitioners who are seeking a safer instrument.

Most of the studies on the incidence of dentinal cracks have been based on the root sectioning method in which, after root canal instrumentation, the specimens are sectioned at various levels from the apex, and the resulting slices are observed through a stereomicroscope (13). The major shortcoming of this method is the impossibility of reliably evaluating defects previously present in the root dentin before canal preparation (14). In addition, the sectioning procedures can damage the dentin, inducing false-positive results (15).

In recent years, micro-computed tomographic (micro-CT) imaging has emerged as a highly accurate method of imaging widely used in endodontic research (16, 17). With this technology, it is possible to obtain a high-resolution, 3-dimensional image of

Significance

This study highlighted the importance of using nondestructive methods to provide a better understanding of the factors related to the induction of dentinal defects. Micro-CT analysis showed that, independent of the techniques or working lengths, no apical microcracks were generated.

From the *Department of Prosthodontics and Oral and Maxillofacial Surgery, Dental School and [†]Department of Nuclear Energy, Federal University of Pernambuco, Recife, Pernambuco, Brazil; and [‡]Department of Land Resource Science, University of Guelph, Guelph, Ontario, Canada.

Address requests for reprints to Dr Bruna Paloma de Oliveira, Av Prof Moraes Rego s/n, Cidade Universitária, Recife, PE, Brazil 50670901. E-mail address:

bruna_paloma@msn.com

0099-2399/\$ - see front matter

Copyright © 2017 American Association of Endodontists.

<http://dx.doi.org/10.1016/j.joen.2017.01.017>

Basic Research—Technology

teeth before and after canal preparation without sectioning the samples, enhancing the internal validity of *in vitro* experiments (18, 19).

To date, no studies have investigated the influence of the root canal preparation technique and instrumentation length on the occurrence of apical microcracks using a nondestructive methodology. Therefore, the aim of this study was to compare apical microcrack formation after root canal shaping by hand, rotary, and reciprocating files at different working lengths using micro-CT analysis. The null hypothesis tested was that neither the root canal preparation technique nor the instrumentation length has an effect on apical microcrack formation.

Materials and Methods

Sample Selection and Preparation

This study was submitted to and approved by the ethics committee of the Federal University of Pernambuco, Recife, Pernambuco, Brazil. Freshly extracted human mandibular incisors with mature apices and single straight root canals ($<5^\circ$) (20) were selected. The specimens had been extracted for reasons unrelated to this study and stored in purified filtered water until use. All roots were inspected under a stereomicroscope (Stemi 2000-C; Zeiss, São Paulo, Brazil) with $12\times$ magnification to exclude those with any external dentinal defect. Radiographs were taken from the mesiodistal and buccolingual planes to confirm the presence of a single root canal. Teeth with previous endodontic treatment, internal/external resorption, or root caries were discarded. To ensure standardization, the coronal portions of the teeth were sectioned approximately 13 mm from the apex using a low-speed saw (Isomet; Buehler Ltd, Lake Bluff, IL) under water cooling. For all teeth, the canal width near the apex was compatible with a size #10 K-file (Dentsply Maillefer, Ballaigues, Switzerland). Using these criteria, we selected 60 specimens.

Subsequently, the specimens were imaged with a micro-CT scanner (XTH225ST; Nikon, Tokyo, Japan) at an isotropic resolution of $14\ \mu\text{m}$. X-rays were generated at 70 kV and $114\ \mu\text{A}$ and filtered with a 1-mm-thick aluminum filter. An air calibration of the detector was performed before the scans to reduce ring artifacts and minimize the beam hardening effect. Images of each specimen were reconstructed with CT Pro 3D v.XT3.1.3 software (Nikon Metrology NV, Tring, UK). VGStudio MAX v.2.2 software (Volume Graphics, Heidelberg, Germany) was used to smooth the images using a Gaussian filtering application and to provide cross sections of the internal structure of the roots.

Root Canal Procedure

The distance between the reference plane and the AF of roots was determined by inserting a size #10 K-file (Dentsply Maillefer) into the canal until the tip of the file became visible at the AF. To simulate the periodontal ligament space, the surfaces of the roots were coated with a thin film of silicone-based impression material and embedded in acrylic resin (21).

The teeth were numbered and randomly divided into 6 experimental groups ($n = 10$) according to the technique and working length used for the root canal preparation. The following hand, rotary, and reciprocating files were tested: ProTaper Universal for Hand Use (Dentsply Maillefer), HyFlex CM (Coltene-Whaledent, Allstetten, Switzerland), and Reciproc (VDW, Munich, Germany). The instrumentations were terminated at the following levels: AF, instrumentation finished at the AF, and AF – 1 mm, instrumentation finished 1 mm short of the AF.

The glide path was performed using a size #15 K-file (Dentsply Maillefer) up to the working length. ProTaper Universal for Hand Use files were used in the following sequence: SX prepared the coronal portion of the canal, and, subsequently, S1, S2, F1, and F2 (25/0.08)

were used until the working length was reached. HyFlex CM files were used in a crown-down sequence using 25/0.08 (two thirds of the working length), 20/0.04, and 25/0.04 (the full working length) files. An R25 Reciproc instrument (25/0.08) was used in a reciprocating slow in-and-out pecking motion of approximately 3 mm in amplitude with a light apical pressure until the working length was reached.

Instrumentation with HyFlex CM and Reciproc files was performed with a low torque motor (X-Smart Plus, Dentsply Maillefer) according to instructions set by the manufacturer of each system. All root canal preparations were performed by a single operator, and each instrument was used to prepare 4 canals only. Composite resin was used to fix the rubber stoppers and avoid their displacement during instrumentation. Irrigation was performed using a total of 15 mL 1% sodium hypochlorite (Farmácia Escola Carlos Dumont de Andrade, Recife, Brazil) per canal administered with a syringe and a 30-G needle between the use of each instrument or after 3 pecking motions. The final irrigation was performed using 5 mL distilled water. After instrumentation, specimens were imaged again with a micro-CT scanner (postinstrumentation scan) using the aforementioned parameters.

Microcrack Evaluation

Micro-CT cross-sectional images generated before and after the root canal preparation ($N = 34,320$) were blindly evaluated by 3 examiners who were endodontic specialists to detect the presence of microcracks in the 4-mm apical portion of the roots. A microcrack was defined as any incomplete crack (line extending from the canal wall into the dentin without reaching the outer surface of the root), complete crack (line extending from the root canal wall to the outer surface), or craze line (other lines that did not reach any surface of the root or extend from the outer surface into the dentin but did not reach the canal wall) observed in the root dentin (5). If a microcrack line was detected in the postinstrumentation image, the preinstrumentation corresponding cross-sectional image also was inspected to verify the preexistence of a dentinal defect (22). The images were reassessed after an interval of 4 weeks. In case of discrepancy among the observations, the slices were examined again, and the examiners discussed the findings until they reached an agreement.

Results

Apical microcracks were detected in 17 (28.3%) specimens. Instrumentation terminated at the AF showed 1 (10%), 3 (30%), and 2 (20%) specimens presenting dentinal microcracks when canals were prepared with ProTaper Universal for Hand Use, Hyflex CM, and Reciproc, respectively. When instrumentation was terminated at AF – 1 mm, dentinal microcracks were presented in 3 (30%), 4 (40%), and 4 (40%) specimens prepared with ProTaper Universal for Hand Use, Hyflex CM, and Reciproc, respectively. All these microcracks detected after root canal preparation had already existed before instrumentation (Fig. 1). Thus, independent of the technique or working length used for the root canal preparation, no new apical microcrack was generated.

From a total of 34,320 slices obtained, 2586 (7.53%) showed some dentinal defect. The distribution of slices presenting microcracks in each group is summarized in Table 1. For all groups, the number of slices in which microcracks were detected after root canal preparation was the same as has been verified before canal preparation. Therefore, the longitudinal length of the preexisting microcracks was not modified. Because there were no new microcracks, statistical analysis was not performed.

Download English Version:

<https://daneshyari.com/en/article/5640796>

Download Persian Version:

<https://daneshyari.com/article/5640796>

[Daneshyari.com](https://daneshyari.com)