Influence of Cervical Preflaring on the Incidence of Root Dentin Defects

Álvaro Henrique Borges, DDS, MSc, PhD, Monique Sobral Damião, DDS, MSc,* Thiago Machado Pereira, DDS, MSc,* Gilberto Siebert Filho, DDS, MSc,* Fabio Luis Miranda-Pedro, DDS, MSc, PhD,* Welligton Luiz de Oliveira da Rosa, DDS, MSc, PhD,† Evandro Piva, DDS, MSc, PhD,† and Orlando Aguirre Guedes, DDS, MSc, PhD**

Abstract

Introduction: This study evaluated the influence of cervical preflaring on the incidence of root dentin defects after root canal preparation. **Methods:** Extracted human maxillary central incisors were selected and allocated to 1 control group and 12 experimental groups (n = 15). Teeth in the control group were left unprepared, whereas the others were prepared using 2 reciprocating single-file systems (Reciproc and WaveOne [WO]), 3 full-sequence rotary systems (ProTaper Universal, ProTaper Next [PTN], and ProFile), and K-files driven by an oscillatory system, with and without cervical preflaring. Roots were then horizontally sectioned at 4, 8, and 12 mm from the apex, stained with 1% methylene blue, and viewed through a stereomicroscope at ×25 magnification. Slices were inspected and the absence/presence of defects (fractures, partial cracks, and craze lines) recorded. Data were analyzed using Kolmogorov-Smirnov and Levene tests followed by the Tukey post hoc test at a significance level of $P < .05$. **Results:** No root dentin defects were observed in the control group. WO was associated with a significantly higher number of defects than K-files, ProFile, and PTN ($P < .05$), but was not significantly different from Reciproc or ProTaper Universal ($P > .05$). Cervical preflaring significantly reduced the incidence of fractures and other defects in the WO and PTN groups ($P < .05$). **Conclusions:** All instruments caused root dentin defects, regardless of the enlargement or not of the cervical portion. Cervical preflaring was associated with a lower incidence of defects, mainly in root canals prepared with WO and PTN. *(J Endod 2017;■:1–6)*

Key Words

Cervical preflaring, coronal flaring, dentin microcracks, root dentin defects, vertical root fracture

Significance

Cervical preflaring played an important role in reducing fractures and the formation of other defects during root canal preparation with instruments in continuous rotation, reciprocation, or oscillatory movement.

Preflaring (PF) has proved to be a strategic and important operative step for successful endodontic therapy, as it minimizes the occurrence of operative accidents (1), reduces apical extrusion of debris (2), and allows better cleaning and shaping of the apical third of root canals (3).

In view of the need to obtain a well-defined, conical preparation, tapering toward the apex, the size chosen for PF instruments is greater than that of the main file used during root canal preparation (1, 4, 5). The use of larger tapered instruments results in more wall contact and hence more friction and stress concentration (6). Such stress is transmitted through the root and may damage the dentin (7), resulting in incomplete cracks or craze lines that may develop into vertical root fractures, an undesirable complication with a negative influence on the long-term survival of endodontically treated teeth (8).

Even though several studies have demonstrated the development of root dentin defects in association with different root canal procedures (9–13), only 1 study (6) has focused on the effect of using different PF instruments on crack formation. In that previous study (6), the authors performed PF with Gates-Glidden drills, ProTaper Universal (SX), Endoflare, Revo-S, and HyFlex and found the following rates of root cracks: 50%, 22%, 16%, 27%, and 27%, respectively. To the best of our knowledge, no studies have evaluated the effect of using LA Axxess burs for PF (SybronEndo) or the influence of performing or not performing PF before instrumentation, on the occurrence of root dentin defects.

Therefore, the purpose of this *ex vivo* study was to assess the influence of PF on the incidence of root fractures and other dentin defects after root canal preparation with several instruments. The null hypothesis tested was that there would be no significant differences in root dentin defects produced (1) by different instruments and (2) with or without PF.

Material and Methods

Tooth Selection

A total of 195 extracted human single-rooted maxillary central incisors with fully formed apices and straight root canals ($r < 5^{\circ}$) (14) were selected and stored in distilled water until use. Buccopalatal and mesiodistal radiographs were taken and only teeth with a

From the *Department of Oral Sciences, University of Cuiabá, Cuiabá, Mato Grosso, Brazil; and †Department of Restorative Dentistry, Biomaterials Development and Control Center, Federal University of Pelotas, Pelotas, Rio Grande do Sul, Brazil.

Address requests for reprints to Prof Dr Álvaro Henrique Borges, University of Cuiabá, School of Dentistry, Avenida Manoel José de Arruda, 3100, Jardim Europa, Cuiabá, MT 78065-900, Brazil. E-mail address: alvarohborges@gmail.com

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single canal, no calcifications, no internal or external root resorption, no prosthetic crowns or dental posts, no prior endodontic treatment, or aberrant root canal morphology were included in the study. All the teeth were inspected under a stereomicroscope at ×20 magnification (Expert DN; Müller Optronic, Erfurt, Germany) to exclude the possibility of preexisting defects on their external surfaces. To further increase standardization, only teeth with lengths between 20 and 22 mm, which were confirmed with a millimeter ruler (Dentsply Maillefer, Ballaigues, Switzerland), and with comparable buccopalatal and mesiodistal canal widths, which were measured 9 mm from the apex on both radiographic examinations (13), were selected.

This study was approved by the Research Ethics Committee of the University of Cuiabá, Brazil (CAAE 27230214.6.0000.5165).

Specimen Preparation

Standard access cavities were made using round diamond burs (#1011, #1012; KG Sorensen, Barueri, SP, Brazil) mounted on a high-speed handpiece under air water spray cooling. The apical patency of all root canals was confirmed using a #10 K-file (Dentsply Maillefer). Any specimen showing patency > ISO 15 was discarded. Working length (WL) was determined using a #15 K-file (Dentsply Maillefer), which was introduced into the root canal until it became visible at the apical foramen. WL was determined 1 mm short of this measurement. The surface of the roots was covered with silicone impression material (Aquasil; Dentsply Maillefer) to simulate the periodontal ligament space (15). All the roots were then randomly allocated to 1 control group and 12 experimental groups of 15 teeth each, prepared using 2 reciprocating single-file systems (Reciproc [RC] and WaveOne [WO]), 3 full-sequence rotary systems (ProTaper Universal [PTU], ProTaper Next [PTN], and ProFile [PRF]), and K-files (KF).

Specimens in the control group were left unprepared. In each subgroup allocated to PF, #35/0.06 stainless steel LA Axxess burs (SybronEndo, Orange, CA) were used to enlarge the cervical and middle thirds of teeth. LA Axxess burs driven by Intramatic 2068 and Intramatic 181DBN (both from Kavo Ind. Com. Ltda., Joinville, SC, Brazil) motors operating at 5000 rpm were used until resistance to penetration was detected. Final PF depth ranged from 12 to 14 mm.

The root canal preparation protocol used for each of the 6 instruments tested (combined or not with PF, at a total of 12 groups) is described as follows.

ProTaper Universal (PTU-PF and PTU). ProTaper Universal (Dentsply Maillefer) files F1 (#20/0.07), F2 (#25/0.08), F3 (#30/0.09), and F4 (#40/0.06) were used.

WaveOne (WO-PF and WO). The large WO file #40/0.08 (Dentsply Maillefer) was used.

Reciproc (RC-PF and RC). The R40 RC file (#40/0.06) (VDW, Munich, Germany) was used.

ProTaper Next (PTN-PF and PTN). PTN (Dentsply Maillefer) instruments X1 (#17/0.04), X2 (#25/0.06), X3 (#30/0.07), and X4 (#40/0.06) were used.

K-File (KF-PF and KF). KFs (Dentsply Maillefer) #15/0.02, #20/0.02, #25/0.02, #30/0.02, #35/0.02, and #40/0.02 were used.

ProFile (PRF-PF and PRF). PRF (Dentsply Maillefer) files #15/0.04, #20/0.04, #25/0.04, #30/0.04, #35/0.04, and #40/0.04 were used.

PTU, WO, RC, PTN, and PRF instruments were all driven by X-Smart Plus (Dentsply Maillefer), observing the standards set by the manufacturer of each system. KFs were driven by oscillatory kinematic using a TEP SUPER-NSK reduction contra-angle (Nakanishi, Tochigi-ken, Japan) coupled to an Intramatic 181DBN (Kavo) motor. At each instrument change or after 3 pecks (reciprocating files), 2 mL 1% sodium hypochlorite (NaOCl; Pharm, Phloraceae, Cuiabá, MT, Brazil) was used as irrigant. The irrigation needle (NaviTip 31-gauge needle; Ultradent, South Jordan, UT) was placed at 1 mm short of the WL.

After completion of root canal preparation, canals were irrigated with 3 mL 17% EDTA (Biodinâmica, Ibiporã, PR, Brazil) for 3 minutes and then rinsed with 2 mL distilled water. Patency was reassessed using a #10 KF. A single operator (endodontist with 10 years of experience) performed all root canal preparations. Each instrument was used to prepare one root only. All roots were stored in distilled water throughout the experimental procedures to avoid dehydration.

Root Canal Sectioning, Staining, and Examination

The silicone impression material was removed, and all roots were horizontally sectioned at 4, 8, and 12 mm from the apex with the aid of a double-faced diamond disc (4-inch diameter × 0.012-inch thickness × 1/2 inch; Arbor; Extec, Enfield, CT, USA) and a precision saw (Isomet 1000; Buehler, Lake Bluff, IL, USA) at low speed with water-cooling. Slices were stained with 1% methylene blue (Pharm, Phloraceae, Cuiabá, MT, Brazil), to aid in the detection of defects (16), rinsed with distilled water, dried with absorbent paper, and viewed through a stereomicroscope (Expert DN; Müller Optronic, Erfurt, Germany) at ×25 magnification. All slices were then photographed with a digital camera attached to the stereomicroscope. Digital images were inspected and the presence of defects recorded as follows: no defect, fracture, and other defects (17). "No defect" was defined as root dentin devoid of any lines or cracks, where both the external surface of the root and the internal root canal wall had no defects. "Fracture" was defined as a line extending from the root canal space to the outer surface of the root. "Other defects" included all other lines observed that did not extend from the root canal to the outer root surface (eg, partial crack: line extending from the root canal wall into the dentine without reaching the outer surface, or craze line: line extending from the outer surface into the dentine without reaching the canal lumen). A total of 90 images were examined in each experimental group. A single, previously calibrated examiner blinded to group allocation analyzed all images. The same examiner read the images twice, with a 1-week interval between the readings.

Statistical Analysis

Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 15.0 for Windows (SPSS Inc., Chicago, IL). Comparisons between means were realized by analysis of variance, using Kolmogorov-Smirnov and Levene tests followed by Tukey *post hoc* test at a significance level of $P < .05$. Intraexaminer agreement was assessed by kappa statistics in 10% of the sample.

Results

Intraexaminer agreement was excellent (kappa = 0.89). A total of 1170 slices were examined. No defects were observed in the control group (unprepared teeth). Fractures and other defects (partial cracks and craze lines) were observed in all experimental groups, with statistically significant differences between the instruments ($P < .05$). WO was associated with a significantly higher number of fractures, partial cracks, and craze lines than KF, PRF, and PTN ($P < .05$) but was not significantly different from RC or PTU ($P > .05$) (Fig. 1*A* and *B*). PF was associated with a reduced incidence of root dentin defects. However, statistically significant differences were observed only for WO when considering fractures, and for PTN when considering other defects (Fig. 2*A* and *B*). Regarding the different sections, more defects were observed in coronal (12 mm) and middle sections (8 mm) when compared with apical (4 mm) sections. However, this difference was