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Effects of four instruments on coronal pre-enlargement by using cone beam computed tomography

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Abstract

Introduction: This ex vivo study used cone beam computed tomography to evaluate the amount of dentin removal from the distal wall of the mesial canal of human mandibular first molars caused by 4 instruments used to flare the cervical third. **Methods**: Thirty-two mesial roots were divided into 4 groups prepared by using ProTaper, K3, Gates-Glidden, or LA Axxess. The dentin thickness of the distal cervical wall of mesial canals was measured before and after the preparation by using computed tomography and Adobe Photoshop software. **Results**: There was no statistically significant difference between the study groups (P > 05). **Conclusions**: All the instruments used for cervical preparation seemed to be safe and did not damage the dentin struc- ture of the distal wall of mesial root canals of mandib- ular molars.

Introduction

The cervical preparation of curved root canals should ensure straight access to the canals and their apical curvature (1). The cervical third should be safely prepared to maintain the integrity of the canal walls without risking the perforation or the production of thin walls that are described as anticurvature filing by Abou- Rass et al (2). Furthermore, an adequate coronal pre-enlargement accurately defines what initial apical instrument should be used (3–5), and it results in a more precise anatomical diameter at working length. However, mesial roots of mandibular molars and mesiobuccal roots of maxillary molars have thinner distal walls in cases of bifurcation or trifurcation. Damage to this area might conduct the instrument and perforate the periodontal junction of the furcal region. Mahran and EboEl-Fotouh (6) recently used multislice computed tomography (CT) to compare the effect of ProTaper, Hero Shaper, and Gates-Glidden on the cervical dentin thickness of the distal wall of mesiobuccal canals of mandibular molars during instrumentation. They found that ProTaper removed significantly less cervical dentin from the distal wall (risk zone) than the Hero Shaper and Gates-Glidden burs.

Because of the importance of cervical preparation and its consequences, this ex vivo study used CT to evaluate the amount of dentin removal produced by 4 instruments during the preparation of the distal wall of mesial canals of human mandibular first molars.

Material and Methods

This study was approved by the Research Ethics Committee of the Passo Fundo University, Passo Fundo, Brazil.

Thirty-two unrestorable human permanent mandibular first molars, extracted because of extensive coronal tissue destruction, were radiographed and stored in 10% formaldehyde. Teeth were excluded from the study if they exhibited a distance greater than 3 mm between the cementoenamel junction and the root bifurcation, previous endodontic manipulation, incomplete root formation,

calcification, internal or external resorption, or curvature greater than 40 degrees.

All the crowns were sectioned at the cementoenamel junction, and specimens were then cross-sectioned 2 mm below the bifurcation of the mesial root with a double face diamond disk. The mesial root was separated from the distal one so that the cervical area of mesial roots could be reached.

The roots were stored in alginate hydrogel (Jeltrade; Dentsply, Petro´polis, RJ, Brazil) poured in plastic containers. All the roots of each specimen were embedded in the alginate gel, leaving out the first 2 mm of the cervical third.

After the alginate solidified, 3-dimensional x-ray images (i-CAT Cone Beam, Hatfield, PA) were obtained. The exposure time was 40 seconds, operating at 12 Kvp and 3– 8 mA. The CT unit provided 0.3-mm axial cuts and image reconstruction with high inten- sity of projection. The beam incidence was on the cervical portion of the device used to fasten the specimens. The reconstruction of axial cuts was performed after CT scans of all teeth were obtained. The longest possible time for this reconstruction was about 30 minutes. The images were saved in a computer for later comparison.

The specimens were then removed from the alginate bed and fastened to a morse (Neboluz, Sa˜ o Paulo, Brazil) to keep them immovable during preparation. The cervical third of the canals (4–5 mm) was explored with #10 Flexofile (Dentsply-Maillefer, Ballaigues, Switzerland).

The specimens were then randomly distributed in 4 groups of 8 teeth (8 mesiobuccal and 8 mesiolingual canals).

Group GG (Gates-Glidden)

The specimens were prepared with #1 and #2 Gates-Glidden burs (Dentsply-Maillefer, Ballaigues, Switzerland) by using a micro-motor (12,000 rpm). The burs

were pushed into the root canal, rotating in a clockwise direction until they reached the cervical enlargement length; they were then pulled out while still in movement.

Group PT (ProTaper)

Preparation was made with the S1, SX, and S2 of ProTaper Universal (Dentsply-Maillefer) instrument system, with paintbrush movements along all the cervical enlargement length at a speed of 300 rpm and torque of 3 N/cm.

Group K3 (K3 System)

The cervical thirds of each mesial root canal were prepared with 25/.08 and 25/.10 instruments of the K3 system (SybronEndo, Glendora, CA), with push-and-pull movements along all the cervical enlargement length at a speed of 300 rpm and torque of 3 N/cm.

Group LA (LA Axxess Instruments)

The specimens were prepared with 20/.06 and 35/.06 LA Axxess instruments (SybronEndo) on a micro-motor (12,000 rpm). The files were used in clockwise rotation to the cervical enlargement length, and they were pulled out while still in movement.

All the preparations used anticurvature techniques, which means that all the instruments were used with mesial forces.

After the cervical preparation of the specimens, the canals were irrigated again with 2.5% NaOCI (Farmácia Calêndula) for cleaning dentin debris.

The specimens were then placed on the CT scanner and radiographed again in the same position as they were before preparation. The images obtained before and after preparation were cross-sectioned at the beginning of the cervical third and exported to Adobe Photoshop software (Adobe Systems Inc, San Jose, CA). The dentin area was standardized at 32 tones of gray, and the images were converted

to 8-bit RGB (256 colors). The software was used to bring together the images obtained before and after preparations. For this purpose, the image obtained after preparation was changed into an 80% clear layer.

The images were amplified until 1 pixel was visualized. The distance between the distal wall of the mesiobuccal and mesiolingual canals to the outer tooth surface (dangerous zone) was measured, and the amount of dentin removal produced during the preparations was expressed in millimeters (Fig. 1).

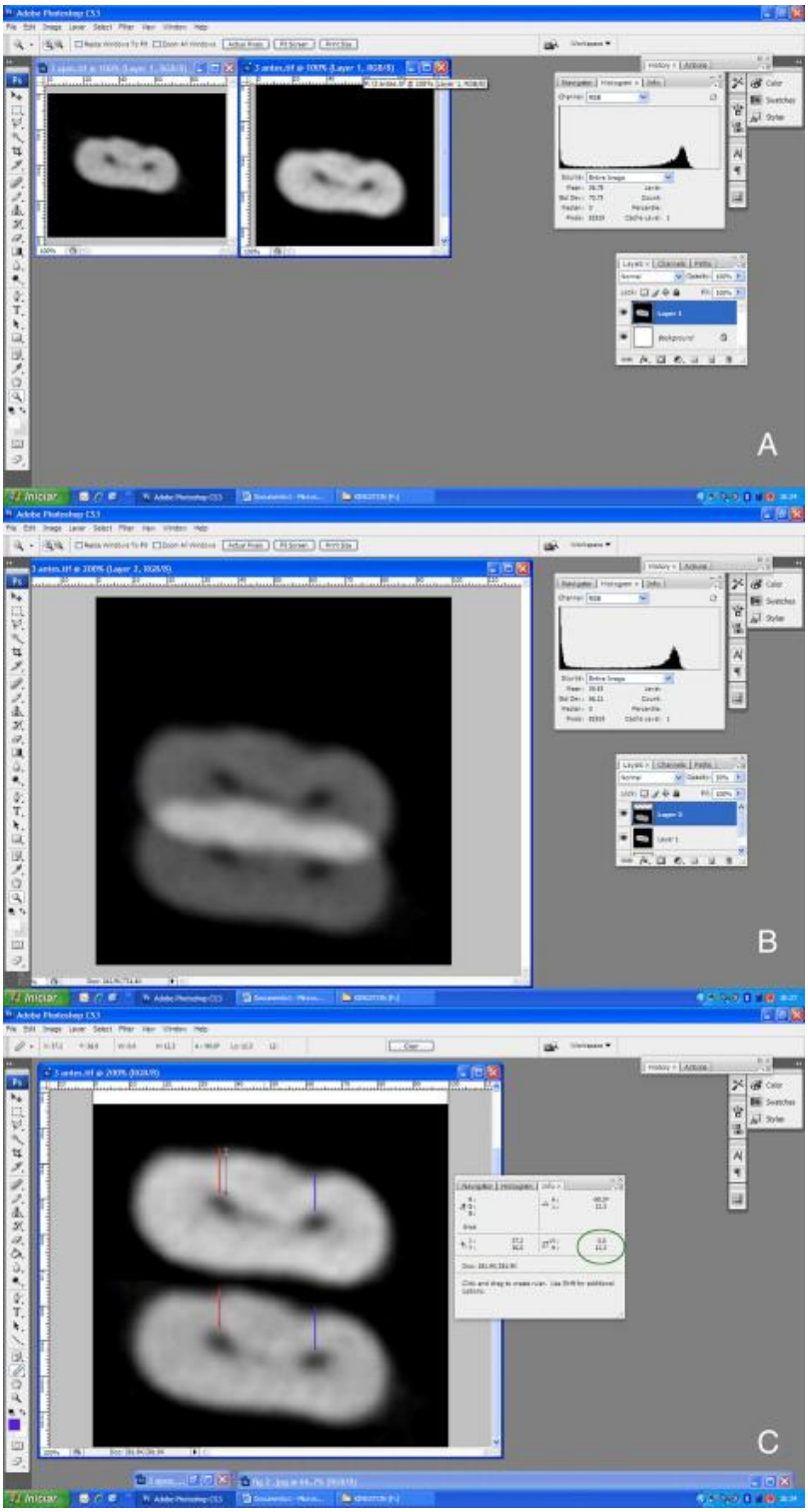

Figure 1. (*A*) Image obtained before and after cervical preparation. (*B*) Image obtained after preparation pasted as a new layer over the initial and had the

opacity set at 50%. (*C*) Measurements of the distance between the distal wall of the mesiobuccal and mesiolingual canals to the outer tooth surface.

The same observer read the distances twice for each canal at a 1-week interval. A *t* test was used to analyze agreement between readings and to compare measurements before and after treatment in each group. The Kruskal-Wallis test was used. The level of significance was set at 5%.

Results

The *t* test showed statistically significant differences between the measurements before and after coronal pre-enlargement in each group (Table 1). The nonparametric Kruskal-Wallis test revealed no statistically significant differences between the study groups at a 5% level of significance (Table 2).

Table 1. Mean and Standard Deviation of the Measurements before and after Coronal Pre-enlargement in Each Group

	Group GG		**Group PT**		**Group K3**		**Group LA**	
	Before	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**
Mean	6.63	5.93	6.75	6.02	6.85	6.08	7.38	6.55
Standard deviation	1.14	1.10	1.03	0.97	1.56	1.20	1.36	1.20

GG, Gates-Glidden; K3, K3 System; LA, LA Axxess Instruments; PT, ProTaper.

Table 2. Mean and Standard Deviation of Percent Reduction in Each Group

	Mean	**Standard deviation**	**n**
Group GG	8.79[a]	5.82	16
Group PT	11.10[a]	6.26	16
Group K3	10.25[a]	7.20	16

	Mean	Standard deviation	n
Group LA	10.61[a]	7.18	16

a GG, Gates-Glidden; K3, K3 System; LA, LA Axxess Instruments; PT, ProTaper.

Mean values followed by the same superscript letter had no statistically significant differences. a = .05.

Discussion

Cone beam CT and specialized software (i-CAT Cone Beam) were successfully used for measurements before and after instrumentation of root canals and for the calculations of amount of dentin removed during cleaning and shaping of the root canals. The use of this methodology was based on the study of Hartmann et al (7), which showed it to be reliable, without destructive sectioning of the specimens or loss of the root material during sectioning. Besides this, cone beam CT can be used as a good method for initial identification of dental internal morphology (8).

In this study we made the option of eliminating the dental crown before the cervical preparation, aiming at the sample standardization because the specimens presented crowns in good conditions, restored, and some even absent. However, if the dental crown was present, it could influence the cervical pre-enlargement, because it could interfere in the straight-line access to the canal, increasing the risk of accidents, such as stripping and furcal perforation.

Our comparisons did not reveal any statistically significant differences between the 4 groups because the mean percent of the amount of dentin removal was similar in the canals, as shown in Table 2. This finding showed that there was no cervical root perforation of the distal wall of the mesial canals on the inferior molars. This might be explained by the anticurvature movement of all instruments, according to Abou-Rass et al (2).

Progressive and continuous tooth formation creates dentin projections that narrow the canal diameter, especially in the cervical third. Adequate root canal access

increases the efficacy of irrigants, the control of instruments, and the quality of root canal sealing (4). Most dangerous for even experienced clinicians is the increased potential for structural loss during shaping or actual strip perforation while trying to create adequate root canal access.

The largest percent reduction was 11.10% for ProTaper, followed by 10.61% for LA Axxess; 10.25% for K3, and 8.79% for the Gates-Glidden burs, but differences were not statistically significant. This is in disagreement with the results of Mahran and EboEl-Fotouh (6), who found less amount of dentin removed from the distal wall of mesiobuccal canals when using the Pro Taper system than when the Gates-Glidden burs were used. These burs are relatively inflexible, which has been shown to contribute to the development of furcal thinning and critical dentin thickness in the cervical region [9] and [10]. However, these authors used Gates-Glidden no. 3, which, according to Estrela (10), might cause stripping, particularly when used by inexperienced operators or when the direction in which the instrument is moved is not carefully observed. We believe that in the present study there was no difference between the GG Group and the others because of the use of a Gates-Glidden no. 2, which has a diameter of 0.70 mm, and also because of the instrument direction to the mesial wall (anticurvature).

Because of its progressive nature, ProTaper and K3 should be used with caution in the coronal region, especially toward furcation (11). Zhang et al (12) reported that the Pro Taper shaping files have an increasing taper (from 3.5% at D0 to 19% at D9) and superelasticity, and that they safely flare the coronal part of the canal without transportation.

The results of the present study show that the instruments used to prepare the cervical third are safe. The coronal pre-enlargement allows a direct access of the endodontic instrument to the apical third, making the cleaning and shaping of the root canal in this portion easier (13).

Conclusions

Our results showed that all the instruments used for cervical preparation were safe and did not cause extensive damage to the distal wall of mesial root canals of mandibular molars.

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