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The dentin thickness remaining in the risk zone of mandibular molars after cervical preflaring with four methods

A espessura da dentina remanescente na zona de perigo após o pré-alargamento com quatro métodos

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Resumo

Introdução: O preparo cervical é uma etapa importante da instrumentação do sistema de canais, mas pode levar ao alargamento excessivo ou rasgo da raiz. **Objetivo:** Avaliar, em tomografia computadorizada cone beam, da espessura remanescente de dentina cervical da raiz mesial de molares inferiores, após o preparo com diferentes técnicas: *Gates-Glidden* (ordem crescente); *Gates-Glidden* (ordem decrescente); *LA Axxess* e *Easy Pro-Design*. **Material e método:** Foram selecionadas 40 raízes mesiais de molares inferiores, que foram escaneadas em tomógrafo cone beam antes e após o preparo. Das imagens tomográficas foram obtidos cinco cortes com intervalo de 1 mm a partir da furca e, então, mensurada a variação da espessura entre o canal radicular até a porção externa da raiz em *software* de análise. **Resultado:** Avaliação dos diferentes níveis demonstraram ausência de significância dentro do mesmo grupo para o grupo das *Gates-Glidden*. Por outro lado, foi notada diferença para *LA Axxess* (p=0,002) e para *Easy Pro-Design* (p=0,005). Na avaliação entre os grupos, foi observada diferença em todos os níveis, sobretudo, para *Gates-Glidden* na ordem crescente (ANOVA e Tukey). **Conclusão:** Considerando as limitações desse estudo, concluiu-se que o protocolo que apresentou maior desgaste da área de perigo cervical foi o da *Gates-Glidden* em ordem crescente, sendo que os demais grupos foram equivalentes (p>0,05).

Descritores: Instrumentos odontológicos; preparo de canal radicular; tomografia computadorizada de feixe cônico.

Abstract

Introduction: Cervical preflaring is an important step of the canal system instrumentation, but can lead to excessive enlargement or root perforation. **Objective:** Evaluate the remaining dentin thickness in the mandibular molars of mesial roots using cone beam computed tomography: *Gates-Glidden* (crown-down); *Gates-Glidden* (step-back); *LA Axxess* and *Easy Pro-Design*. **Material and method:** Were selected 40 lower molars mesial roots, which were scanned in a cone beam CT scanner before and after preparation. Were obtained five sections of the CT images with an interval of 1 mm from the furcation, and measured the thickness variation between the root canal to the root external portion in analysis *software*. **Result:** The evaluation of the different levels showed no significance within the same group for the *Gates-Glidden* group. On the other hand, were observed difference for *LA Axxess* (p=0.002) and *Easy Pro-Design* (p=0.005). In the intergroup analysis, were observed difference in all levels, especially for *Gates-Glidden* in the ascendant order (ANOVA and Tukey). **Conclusion:** Within the limitations of these study, is possible to conclude that the protocol with greater wear in the cervical risk area was the *Gates-Glidden* in step-back sequence, as the other groups were equivalent (p>0.05).

Descriptors: Dental instruments; root canal preparation; cone beam computed tomography.

INTRODUCTION

The main goals of the endodontic therapy are cleaning, disinfecting and shaping, which are achieved by the associated action of the instruments on the canal wall and with aid of the chemical solutions used during the preparation. Shaping must keep the canal in the conical format in the apical direction, free of obstructions and foramen in the original format and position[1,2].

Ideally the canal created after the treatment must fully incorporate the original canal in the three dimensions, meaning that all surfaces of the root canal were mechanically repaired with proportional dentin removal in all surrounding walls, creating a uniform debriding and avoiding excessive wear of the root structure in determined areas[2].

The preparation method currently recommended follows the crown-down principle, in which instruments are used to reduce the cervical interference and allow the instruments to move more freely and safer in the root canal due to the reduction of friction with the walls[3,4]. The cervical preflaring is also recommended to favor the work length determination, the apical diameter, as well as to facilitate canals irrigation and filling[5-9].

The first rotating instruments developed for cervical preflaring were *Gates-Glidden* (GG) drills[1], with a GG tip diameter # 2 of 0.70 mm, considered safe for lower molars mesial canals[9-11]. On the other hand, as they were made of stainless steel and had limited flexibility, their use leads to risks especially in the lower molars mesial root, as its excessive enlargement may lead to wear of lateral perforation of the root, named "Strip Perforation"[10,11]. This accident may affect the treatment prognosis since it may reduce the treatment success rates[12-14].

The GG is still recommended despite of the possibilities of accidents by its incorrect use. However, additional instruments were developed for cervical repair, such as *LA Axxess* (SybronEndo, Orange, CA, USA) drills and *Easy Pro-Design* files (EasyEndo, Belo Horizonte/MG, Brazil). The *LA Axxess* are made of stainless steel treated with titanium nitride. They are found in the market in three nominal diameters (D1 #20, D1 #35 and D1 #45), they have 12 mm active sharp edges, inactive tip and must be used in low rotation[15,16]. *Easy Pro-Design* (#35.10, #20.07) are made of nickel-titanium alloy and have a cordiform transverse section with three cutting edges, constant tapering and semiactive tip. They must be used in the straight portion of the root canal between 750 and 900 rpm and 3 to 4 Ncm[17].

The evaluation of the remaining dentin thickness in the risk area of the lower molars mesial roots after the cervical preparation is justified by the features and relative lack of studies exploring these instruments actions, especially the *Easy Pro-Design* instruments.

MATERIAL AND METHODS

This study was approved by the Ethics Committee of the Hospital Universitário Pedro Ernesto/UERJ (Protocol: 38139). Lower molars with two mesial root canals were selected after the approval. Teeth were cleaned, disinfected with 2.5% sodium hypochlorite and radiographed in the ortorradial direction for evaluation of root canal length, angle and curvature radius.

Teeth were then sectioned at 2 mm from the cementoenamel junction in using *IsoMet Low Speed Saw (*Buehler, Illinois, USA) and 0.3 mm diamond disc to minimize the coronary interference. The coronary access was obtained and the canals exploration with type K-10 files (Dentsply-Maillefer, Ballaigues, Switzerland) was made until permeability and for selection of mesial canals of similar initial diameter. Finally, we selected 40 teeth, which were paired per length, radius and curvature angle ($p>0.05$) and divided in four groups per the preparation method (n=10). Samples were included in epoxy resin *FR Plus* (Alpha Resiqualy Indústria e Comércio de Resinas Ltda, São Paulo) (Figure 1) for stabilization.

Initial scanning was performed in the cone beam computed tomography (CBCT) *3D Accuitomo* (J Morita MFG Corporation, Kyoto, Japan), with 60-80 Kvp, 1-10 mA and 0.125 mm voxel, calibrated for 1 mm.

After initial scanning, all root canals were negotiated with #10 and 15 type K files until D_{16} (≈ #47) reach the canal opening to standardize it with 0.47 mm diameter. For instrumentation, group 1 was prepared with *Gates-Glidden* drills in crown-down sequence #4, 3, 2 e 1 (Maillefer Instruments, Ballaigues, Switzerland); group 2 with *Gates-Glidden* in step-back sequence #1, 2, 3 e 4 (in both groups with mild apical pressure and limiting the instrument depth to the canal straight portion); group 3, *Line-Angle Axxess* drills in the step-back sequence #1 and 2 (Sybron Dental Specialities, USA); and group 4 used titanium nickel files *Easy ProDesign* #35.10 and #20.07 in the crow-down direction (Easy Endo, Belo Horizonte, Brazil). All instruments were powered by electric motor *Easy Endo System* (Equipamentos Odontológicos Ltda, Belo Horizonte, Brazil), with G1, G2 and G3 powered in the option *Gates-Glidden* (20.000 rpm) and G4 at 750 RPM and 2 N.

The final scanning was performed using same the initial parameters. The data obtained with the tomography allowed the reconstruction of the samples before and after the preparation from the apex to the cementoenamel junction using the *NRecon v.1.6.9* (Bruker-microCT, Kontich, Belgium) software (Figure 2). The tridimensional images (before and after) were overlapped in the software CTAn V.1.13 (Bruker-microCT, Kontich, Belgium). The same software was used to mark the external surface of the overlapped images and, the option "*Line*" of the "*Measure tool*" allowed the measurement of the canal distance to the distal surface of each mesial root canal ("area of risk") (Figure 3). The program CTan was used to determine the furcal position, considered a "0" point and, from that, were performed measurements on four millimeters from the furcation, corresponding to the beginning of curvature[5] (Figure 4).

The dentin thickness variation results before and after the preparation after tested systems were tabulated, analyzed with the Analysis of Variance (ANOVA) and the Turkey test when necessary, with a significance level of 5%.

Figure 1. Sample included in epoxy resin for stabilization during preparation and tomography scanning.

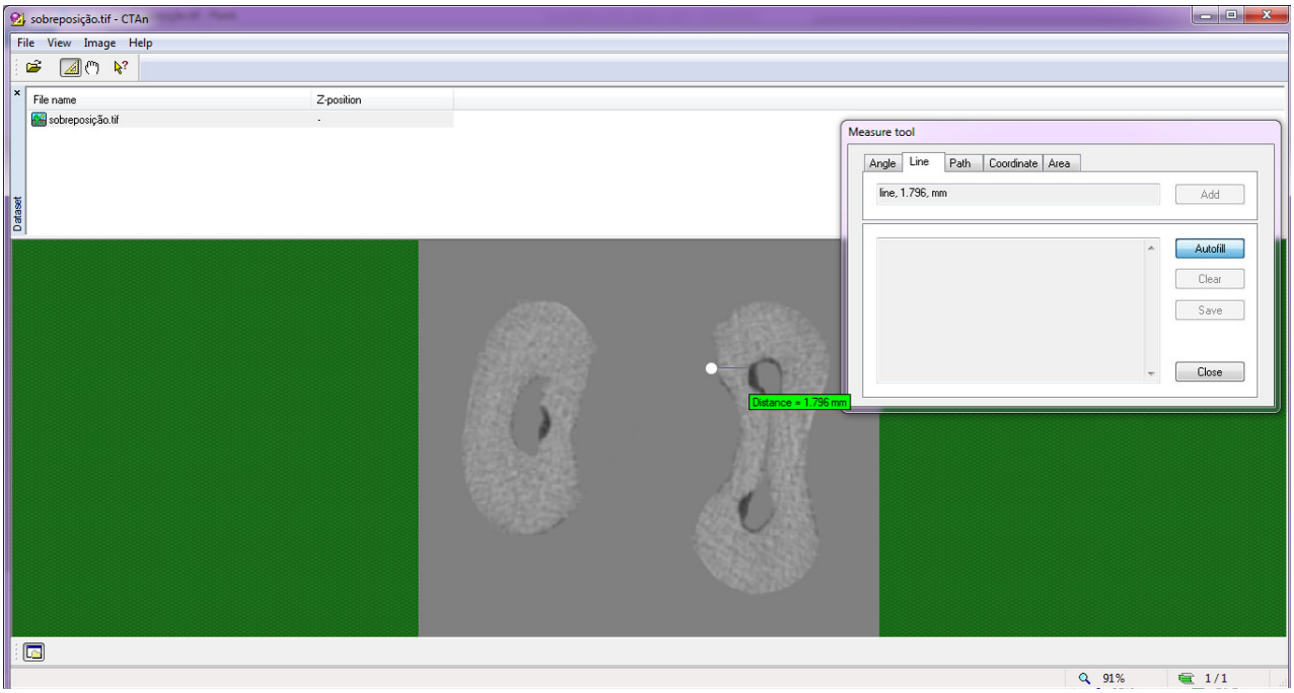

Figure 2. Samples representative images in the program CTan V.1.13.

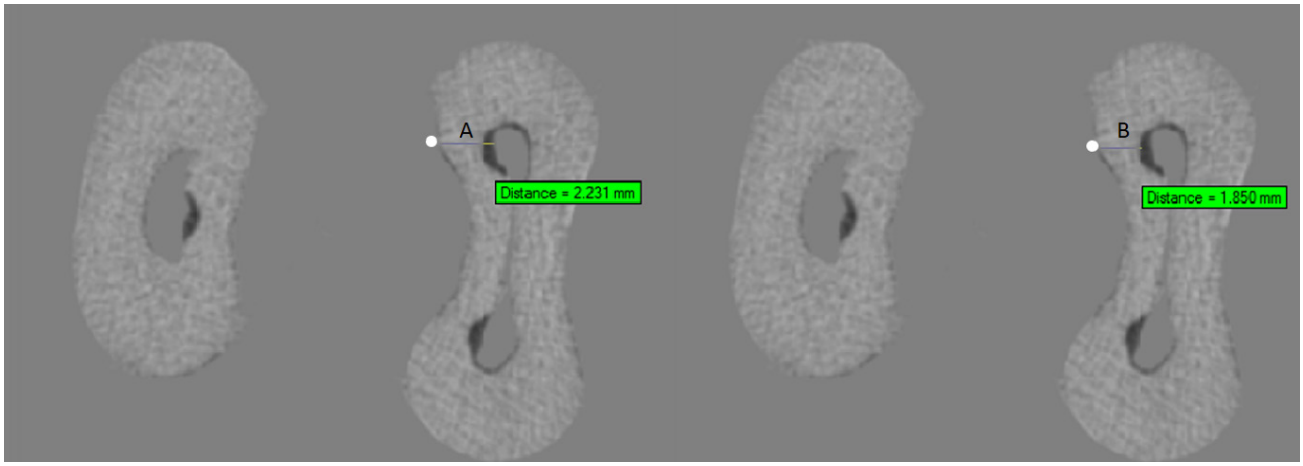

Figure 3. Representation of the dentin thickness measurement before and after preparation, using CTan V.1.13 sofware. (A) before preparation; (B) after preparation.

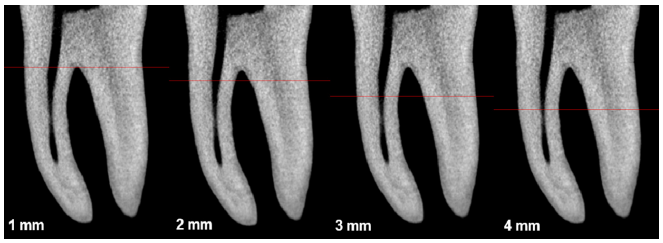

Figure 4. Levels of areas of risk from furcal region, assessed using CTan V.1.13 software.

RESULTS

The dentin thickness variation analysis within the same group showed no significant differences for step-back (p=0.21) or crown-down (p=0.07) GG between the evaluated levels. The *LA-Axxess* group showed difference (p-0.002), with the Tukey test, which showed significance between levels 1 compared to 3 and 4 mm. The *Easy ProDesign* group also revealed significance (p=0.005), and the Tukey test showed differences between levels 3 compared to 0 and 1 mm. Regarding the intergroup analysis, were observed significant difference in 1, 2, 3 and 4 mm (Student-Newman-Keuls, $p<0.05$) only when *Gates-Glidden* in step-back sequence was compared to all other methods; on the other hand, no difference was found when comparing the other groups. Table 1 shows the mean and standard deviation of dentin thickness variation data in the cervical area of risk of the mandibular molars.

Overall, was observed that all systems wore out the area of risk, however, in the evaluated levels, the remaining thickness was equal or lower that 0.50 mm in 50% of the roots prepared with GG in step-back and 14% in GG crown-down sequence, 12% with *LA Axxess*, on the other hand, were not found thickness lower that 0.75 mm for *Easy ProDesign* group (Table 2).

Table 1. Mean ± standard deviation of remaining cervical dentin in the assessed levels, in mandibular molars after cervical preflaring. Intra and intergroup analysis

Group	Cervical level evaluated (mm)				
	0	1	2	3	4
GG step-back	$0.31 \pm 0.14^{a\Omega}$	$0.42 \pm 0.19^{a\Omega}$	$0.37 \pm 0.16^{a\Omega}$	$0.29 \pm 0.16^{a\Omega}$	$0.26 \pm 0.17^{a\Omega}$
GG crown-down	$0.22 \pm 0.11^{a\Omega}$	$0.16 \pm 0.10^{a\Delta}$	$0.23 \pm 0.12^{a\Delta}$	$0.16 \pm 0.10^{a\Delta}$	$0.11 \pm 0.06^{a\Delta}$
LA-Axxess	$0.27 \pm 0.16^{a\Omega}$	$0.22 \pm 0.12^{b\Delta}$	$0.15 \pm 0.13^{a\Delta}$	$0.09 \pm 0.08^{b\Delta}$	$0.06 \pm 0.08^{b\Delta}$
Easy	$0.21 \pm 0.09^{b\Omega}$	$0.20 \pm 0.11^{b\Delta}$	$0.12 \pm 0.08^{a\Delta}$	$0.07 \pm 0.07^{b\Delta}$	$0.11 \pm 0.09^{a\Delta}$

Different letters in the same line (a,b) indicate intragroup significant difference; different characters in the same column (Ω, Δ) indicate intergroup significant difference.

Table 2. Dentin thickness in the cervical area of risk of the lower molars mesial root after preparation with different methods

Thickness (mm)		Number of samples (%) by remaining dentin thickness			
		GG step-back	GG crown-down	LA AXXESS	EASY
≤	**0.25**	6	0	0	0
≤	**0.50**	44	14	12	0
≤	**0.75**	22	46	48	52
≤	**1.00**	16	22	26	24
≤	**1.25**	12	8	4	18
≤	**1.50**	0	6	2	6
≤	**1.75**	0	2	8	0
≤	**2.00**	0	2	0	0

DISCUSSION

The cervical preflaring is a step of the endodontic therapy that reduces the canal curvature, minimizes interferences, optimizes irrigation, allows access to the apex, in addition improves root canal filling[4,10,18]. Despite the advantages, when excessive, the enlargement may cause accidents that may affect success, such as perforation or weakening of the furcal wall, especially in lower molars mesial roots[11,19].

Several methods may be used to evaluate the cervical preparation, such as resin blocks[20,21], scanning electron microscopy[18], X-rays[4] and computed tomography[22,23]. Thus, this work aimed to determine, through CBCT, the variation of the cervical dentin thickness after preparation with different systems. This non-destructive method allows the evaluation of pre and post-instrumented samples[3,24], but can also be performed by computed microtomography, which is a slow and expensive process that is not always readily available[24].

The present study reveals that all systems wore the cervical area of risk of lower molars, among the levels evaluated, but there were significant differences to 1, 2, 3 and 4 mm from the furcal region ($p<0.05$) when using *Gates-Glidden* drills in step-back sequence compared to the other groups, but the comparison among the other groups did not show significant differences. Such data agree with previous studies[4,17,19].

Although the *LA Axxess* drill is also made of stainless steel, it was less aggressive to the area of risk than the ascending *Gates-Glidden* drills in step-back sequence, maybe because these instruments have the conical working part similar to the canal shape, while the *Gates-Glidden* drills are cylindrical[2,4,8,15]. The present study found similar rates of dentin removal compared to previous studies[4,9-15,24].

Was also observed that the *Easy ProDesign* system showed a lower wear ($p>0.05$), however the data could not be compared as the literature due to the lack of information regarding on the system behavior during cervical preflaring. Still, the literature considers that, due to the alloy and design features of instruments made of nickel-titanium, the centralization in the canal long axis is maintained, allowing proportional wear of dentin in risk area since the instrument does not tend towards the area of risk[4,19,21,23,24].

The wearing results caused by the instruments may be linked to the vector effect that leads the GG drills to the furcal direction, since as shown by Wu et al.[4], the anticurvature movement does not reduce the perforation risk by these drills, in addition, in this study, the *LA Axxess* and GG were powered at 20.000 rpm, increasing the cutting action, while *Easy ProDesign* was used at 750 rpm, as shown in previous studies comparing the GG and nickel-titanium rotating systems[22,24].

Considering the critical remaining dentin thickness (less than 0.50 mm)[21,25], the present results showed that *Easy ProDesign* system was safer, had better performance, with no thickness results bellow 0.50 mm, represented no risk of root wall perforation. On the other hand, step-back GG showed the worst performance, with results

lower than 0.25 mm or lower, with in 50% chance of perforation and promoted the higher dentin wear than compared to other tested systems.

Thus, it is possible to highlight that the balance between cervical preflaring and dentin thickness must be achieved. Therefore, it seems viable to recommend the use of the *Easy ProDesign*, *LA Axxess* systems, or even GG in crown-down sequence for cervical preparation of mandibular molars mesial canals.

CONCLUSION

According to the used method and results obtained in this study, it is possible to conclude that all systems caused wearing of the cervical area of risk in lower molars mesial roots, however, the *Gates-Glidden* drills (step-back sequence) was more aggressive compared to the other systems in all levels, and despite the absence of significant differences, the *Easy ProDesign* systems seemed conservative.

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CONFLICTS OF INTERESTS

The authors declare no conflicts of interest.

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