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Evaluation of Wear Promoted by Post Preparation Drill Using CBCT Images

Avaliação do Desgaste Promovido Pela Broca Post Preparation Utilizando Imagens de TCCB

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ABSTRACT
Objective: To evaluate, *in vitro*, the residual dentin thickness in the palatal root of premolars after preparation of the post space with Post Preparation drill and to compare with the Gates-Glidden and Largo drills by means of cone beam computed tomography. *Methodology:* 21 premolars were selected and randomized into 3 groups: G1 - Post-preparation drills; G2 - Gates-Glidden drills nº 2 and nº 3; G3 - Wide Drills nº 1 and nº 2. The residual dentin thickness in seven cuts for the mesial, distal, buccal and palatal points was measured in three stages: initial (not prepared), after instrumentation for apical file nº 35 and after preparation powders with Kodak CS 9000C 3D Extraoral Imaging System and CS 3D Image v. 3.4.3. Software. The root canal area was analyzed in three stages using VRMesh Reverse v. 7.6.1. Software. Statistical significance was set at 5%. Linear and area measurements data were analyzed using the Kruskal-Wallis test. *Results:* Post-preparation drills performed similarly to other drills in linear and area analysis. *Conclusion:* Post-preparation drills showed similar performance to Gates-Glidden and Largo drills in the analysis of residual dentin thickness for the preparation of the pin space.

DESCRIPTORS
Cone-Beam Computed Tomography. Endodontics. Root Canal Therapy.

RESUMO
Objetivo: Avaliar, *in vitro*, a espessura de dentina residual na raiz palatina de pré-molares após preparo para pino com broca Post Preparation e comparar com as brocas Gates-Glidden e Largo por meio de tomografia computadorizada cone beam. *Metodologia:* 21 pré-molares foram selecionados e randomizados em 3 grupos: G1 – Broca Post Preparation; G2 – Broca Gates-Glidden nº 2 e nº 3; G3 – Broca Largo nº 1 e nº 2. A espessura de dentina residual em sete cortes das paredes mesial, distal, vestibular e palatina foi medida em três momentos: inicial (sem preparo), após a instrumentação até a lima **nº 35 e** após preparo para pino por meio do equipamento Kodak CS 9000C 3D Extraoral Imaging System e software CS 3D Image v. 3.4.3. A **área** dos condutos radiculares nos três momentos foi analisada por meio do software VRMesh Reverse v. 7.6.1. O nível de significância estatística foi estabelecido em 5%. Os dados das medidas lineares e da **área** da dentina remanescente foram analisados pelo teste de Kruskal-Wallis. *Resultados:* A broca Post Preparation demonstrou comportamento semelhante **às** outras brocas na análise linear e de **área**. *Conclusão:* Broca Post Preparation apresentou desempenho semelhante **às** brocas Gates-Glidden e Largo na análise da espessura de dentina residual durante o preparo para retentor intrarradicular.

DESCRITORES
Tomografia Computadorizada de Feixe Cônico. Endodontia. Tratamento do Canal Radicular.

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The cementation of intraradicular retainers aiming prosthetic reconstruction is one of the treatment options when wanting to reestablish the function and esthetics of the dental reminiscent[1-4]. The loss of dentinal structure due to the preparation for the retainer may fragilize the dental element, weakening the radicular dentin, increasing the risk of perforations and of a less favorable diagnostic[5]. Cavities, external and internal radicular morphology, curves, pulp chamber access, thickness of residual dentin and excessive root canal widening are factors that influence as much the prosthetic reconstruction as the localization and direction of vertical root fractures[6,7]. The variability of root diameter in vestibular-lingual and mesial-distal accentuate the complexity of curvatures, conicities and proximal invaginations[2]. However, at the end of the endodontic treatment, the intraradicular anchorage may become inevitable due to the loss of a significant part from the dentinal structure[8]. Facing this, the studies suggest that the preparation for retainers in the vestibular canal of superior premolars should be avoided[9,10].

During the planning for cementing a intraradicular retainer, the length, diameter and anatomy of the tooth envolved must be considered. The space for the future retainer is obtained by removing part of the root canal obturation, usually using rotatory instruments, like Gates-Glidden, Largo, Peeso and ParaPost[1,5,11,12]. The use of drills while preparing a retainer require extreme caution, as there is a correlation between the increase of root canal diameter after preparing it and the decrease of thickness in the reminiscent dentin[5]. Also, the potential of fracture from teeth presenting endodontic treatment rises proportionally to the amount of dentin removed due to the weakening of dental structure[9].

At the end of preparation for a intraradicular retainer, the residual dentin should present a minimum thickness of 1 mm around the root canal[13]. In the studies that evaluated the thickness of residual dentin after the preparation to retainers in maxillary premolars, the drills ParaPost[9] and Gates-Glidden and Peeso[12] removed more dentin that the recommended. In relation to the new drill Post Preparation, it aims the removal of guta-percha and the formatting of the root canal to receive and glass fiber or metallic cone. This helicoidal drill is made of surgical steel, has a 32mm length and a 10mm active part. This instrument is of easy acquisition and can't be found with any retainer system. It wasn't found in the literature a study that analyzed this drill.

After what was exposed, the goal of this study was to evaluate the thickness of remaining dentin in the palatal root of maxillary premolars after the preparing them for a retainer with the new Brazilian drill Post Preparation and comparing it with the drills Gates-Glidden and Largo using CBCT.

METHODOLOGY

This study was submitted and approved by the Committee of Ethics in Research of the Federal University of Santa Maria (UFSM), Santa Maria, Rio Grande do Sul, Brazil (Certificate of Presentation for Ethic Appreciation: 38799014.3.0000.5346).

Twenty-one maxillary premolars were selected from the Teeth Bank of the Dentistry Course from UFSM, radiographed and analyzed as to the eligibility criteria. The elements that presented two canals, length between 19 and 21mm, complete rhizogenesis, no cavities, big restorations and obstructions in the root canal were included in the sample. The teeth

with internal and/or external dental resorption, previous endodontic treatment and localized bifurcation in a most apical region than the medium one-third of root were excluded. The specimen were immersed in sodium hypochlorite 5,25% during 30 minutes for their disinfection and afterwards stored in a physiological solution between 10 to 15 days. After they were dried with paper towels a small amount of utility wax (Lysanda Produtos Odontológicos, Sao Paulo, Brazil) was inserted at the apical region, isolating the foramen from the external environment. The teeth were numerated from 1 to 21 and positioned in acrylic cubes with 2,2cm height using uncolored acrylic resin (Vipi Flash: VIPI Produtos Odontológicos, Pirassununga, São Paulo, Brazil), standardizing the position of the elements.

The elements were evaluated with CBCT on a Kodak CS 9000C 3D Extraoral Imaging System (Carestream Health, Inc.: Rochester, New York, USA) tomographer. Nine specimens were positioned in the interior of an expanded polyethylene disc (Metalúrgica MOR S.A, Santa Cruz do Sul, RS, Brazil) with 5cm of internal diameter. Markings were made regarding the axis as to ensure the same position of the teeth in the initial and final takes. The scanning was made in the clinic CROM (Centro de Radiologia Odontológica Medianeira, Santa Maria, Brazil), according the following parameters: voxel size of 75µm, acquisition time of 20s and FOV 50x37mm. The images were filed in the DICOM (Digital Imaging and Comunications in Medicine) format.

The coronary opening was made from a conventional way, using round shaped drills in high rotation 1012 (KG Sorensen: Cotia, São Paulo, Brazil) and the roof of the pulpar chamber was removed with Endo-Z drills (Dentsply Maillefer, Ballaigues, Suíça). The provisory working length (PWL) was determined after measuring the the apparent length of the teeth (ALT) in the initial tomography and subtracting 1mm of this value. The palatine canals were explored with a type K file #10 (Dentsply Maillefer, Ballaigues, Suíça) and prepared with manual instruments type K (Dentsply Maillefer, Ballaigues, Suíça) until the file #35[12]. The instrumentation of the canals was made only with files, discarding the use of drills of cervical preparation. This way, the analysis of the thickness of residual dentin after the preparation for intraradicular retainer wasn't influenced by the dentinal wear promoted by drills in cervical preparation. At each change of instrument, the canal was irrigated with 2ml of sodium hypochlorite 5,25% (Farmácia de Manipulação Nova Derme, Santa Maria, RS, Brazil). At the end of preparation, the canals were irrigated with 5ml of physiological solution (Farmácia de Manipulação Nova Derme, Santa Maria, RS, Brazil) and 3ml of EDTA 17% (Biodinâmica Química e Farmacêutica Ltda: Itaporã, Paraná, Brazil) during 3 minutes for the removal of smear layer and dried with absorbent paper cones (Dentsply Maillefer, Ballaigues, Suíça).

After the scanning, the maxillary pre-molars were randomized in a stratificated way in 3 groups: G1 – Post Preparation drill (Helse, Indústria e Comércio Ltda, Santa Rosa de Viterbo, São Paulo, Brazil); G2 – Gates-Glidden nº2 and 3 (Dentsply Maillefer, Ballaigues, Suíça); G3 – Largo drills nº 1 and 2 (Dentsply Maillefer, Ballaigues, Suíça). The teeth with simmilary length were distributed in the groups on a way that all of them included the same number of specimens with the same dimensions. In the preparation for the retainer of the specimens, rubber cursors were fixated in each groups respective drills with cyanoac-

rylate (Super Bonder: Henkel Ltda, São Paulo, Brazil) and the length of the preparation for the retainer was set subtracting 5mm from the ALT. This way, the distance between the end of prepare for the retainer and the end of the endodontic treatment was standardized. The preparation for the retainer was made in low rotation in about 3 minutes. The samples were repositioned in the expanded polyethylene disc and reevaluated for the third time using CBCT. All the laboratorial procedures were made by the same operator with experience in the endodontic field and trained for the execution of the technical sequence in dental elements discarded from the sample.

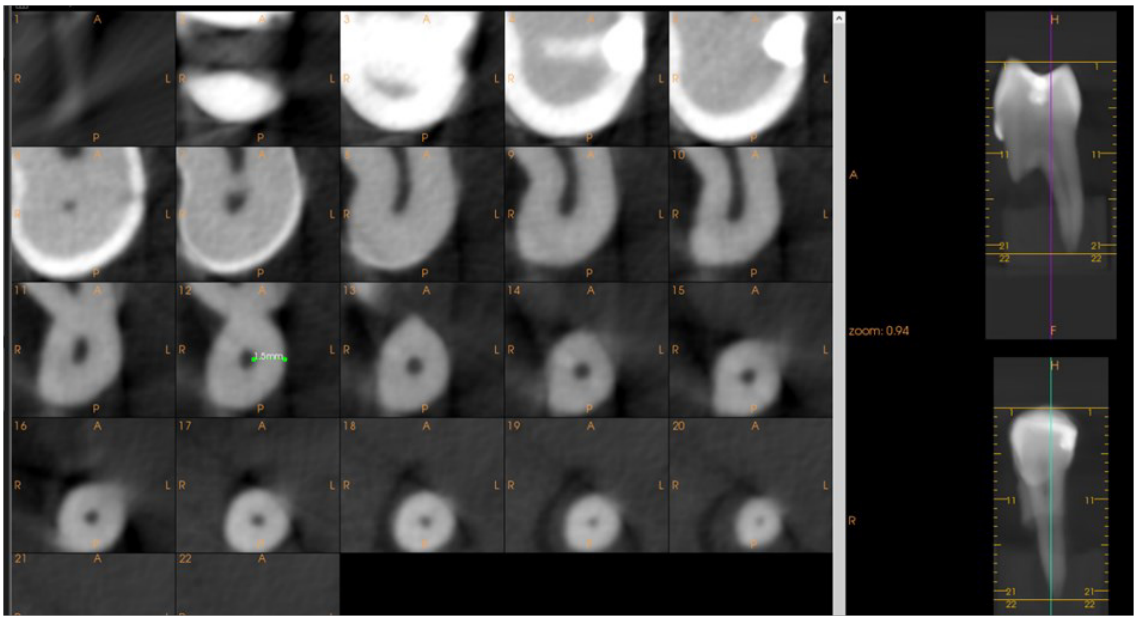
Linear Analysis

The tomographic images stored in a DICOM format were reconstructed using the CS 3D Imaging v. 3.4.3. (Carestream Health, In.: Rochester, Nova Iorque, EUA) software. Each file of the block of teeth was segmented and elements were individualized and saved in independent files according with the number correspondent to the tooth and moment (initial, endodontic post preparation and retainer post preparation). Afterwards, axial cuts were made from the apical portion to the coronal with 75 µm of thickness and 1 mm of space between cuts. The five apical millimeters not prepared with the drills were discarded from the analysis. This way, seven sections were evaluated and the thickness of the residual dentin from the vestibular, palatin, mesial, distal walls and palatin distal roots were measured in millimeters with the tood “ruler” from the software (Figure 1).

Area Analysis

The topographical images archived in

Figure 1. Sequential cuts of the dental element and measurement of thickness of reminiscent dentin through the tool “rule” from the software.



the format DICOM were tranfered to the software InVesalius 3.0 (CTI – Centro de Tecnologia da Informação Renato Archer: Campinas, São Paulo, Brazil) and converted to the format STL (stereolitographic) allowing the exportation of data to other image programs. Following that, the STL archives were imported to the software VRMesh Reverse v. 7.6.1. (VirtualGrid: Bellevue, Whashington, EUA), allowing the segmentation of the block of teeth and the individualization of the elements at the three moments (initial, endodontic post prepare and retainer post prepare). The images of three moments from each tooth were aligned in manual way (command "fine two objects") following the parameter established (300 interactions and 800 points of superposition). The images of teeth at the initial moment were cut at the cemento enamel junction (CEJ) level and the cuts from all other moments were realized based on the initial cut line. The crown o the samples was discarded from the analysis as to minimize the amount of artifacts and discard possible structural variations from the fillings and coronary fractures. Using the software, the dentin was removed from the images and the pulpar chamber and root canals were isolated for the analysis of the dentinary wear. The area of the canals at the initial, endodontic post prepare and retainer post prepare moments was obtained and the wearied area was calculated by subtracting the data generated by the software (Figure 2).

Statistical Analysis

The data were analyzed using the test Kruskal-Wallis at the significancy level of 5%. The reliability of the measures was evaluated by the interclass correlation coefficient and pointed to an excellent concordance (CCI 0,9).

RESULTS

At the linear analysis, related to the wear, the drill Post Preparation presented a similar behavior to the drills Gates-Glidden and Largo at the level of significance of 5% (p>0,05). Using the Kruskal-Wallis test in the different cuts was possible to analyze the linear differences in the moment before and after the use of the drill of preparation for the retainer wasn't significative for the drills Post Preparation X Gates-Glidden and Post Preparation X Largo for each one of the drills (p>0,05 – Dunn test). However, the difference before and after the use of Gates-Glidden and Largo drills was statistically significant. And the Gates-Glidden drill promoted a bigger wear when compared to the Largo drill.

In the analysis of the total area (Table 1), the medium amount of reminiscent dentin was alike for the three drills (p=0,8971) at the level of significance of 5%.

DISCUSSION

The preparation for inter-radicular retainers in teeth with significant loss of structural dentin means to reestablish the function and aesthetics of the reminiscent and wear the least amount of residual dentin from the palatin root of maxillary pre-molars after the prepare for a retainer with the new drill Post Preparation and compared it with the drills Gates-Glidden and Largo using CBCT.

Through time, different methods for the analisys of the dentinary wear were used[1,11,13,14]. The cone-beam computed tomography (CBCT) is an tridimensional image exam (3D), precise and trustworthy. This tool helps the diagnostic in a non destructive way[15-17], allowing the measurement of alterations in the root canal in a accurate way with reduced

Figure 2. Analysis of the area after the endodontic preparation and retainer preparation.

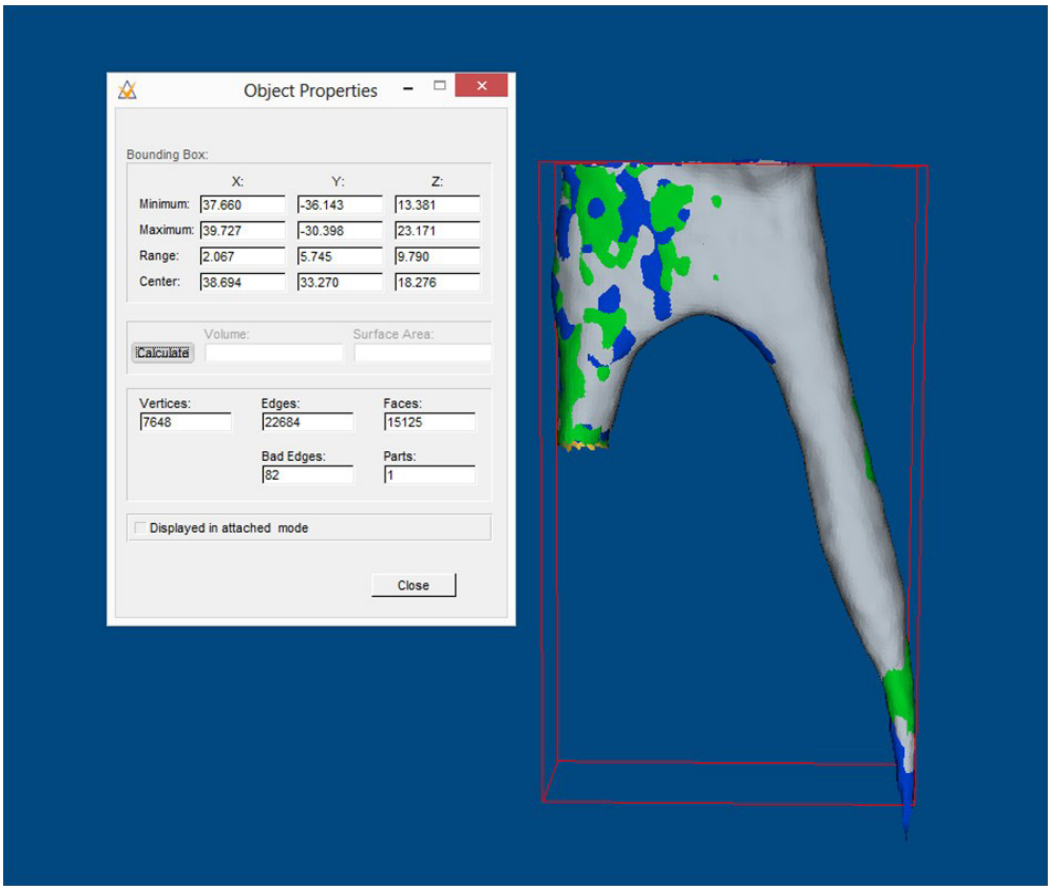


Table 1. Average and pattern deviation of the area of removed dentin for the three groups.

Group	Average ± Pattern deviation
Gates-Glidden	9,7957 ± 2,8438
Largo	10,3543 ± 6,9506
Post Preparation	11,3643 ± 9,0706

distortions[18]. The CBCT is a technology available to the clinic and a satisfactory method for the analysis of internal morphology of dental elements[19-21].The analysis of the dentinal wear was made using CBCT, because is an efficient method for the analysis of the internal dental morphology and of the instrumentation technique of root canals without the loss or destruction of the specimen[15,19]. The CBCT presents several advantages in comparison

to the computed microtomography, because this last one is slower, presents a high cost and is of difficult access[14]. Although the size of the voxel, the CBCT presents a satisfactory special resolution, enabling the analysis of the anatomic alterations, root canals and the variation of the amount of dentin after the endodontic instrumentation and preparation for a retainer.

The crown of pre-molars was kept during the laboratorial procedures aiming to simulate, in the best way possible, the clinical practice and minimize any interference of loss of dentinary structure. The teeth weren't filled previously to the preparation for the inter-radicular retainer. The presence of artifacts of image produced by radiopaque structures, as amalgam restorations or root fillings, influence in the interpretation of tomographical images and in the analysis of the reminiscent dentin thickness.

In the present study, the drills Gates-Glidden nº2 and 3 and Largo nº 1 and 2 were compared to the new drill Post Preparation. This choice was based on previous studies[1,5,9-12]. Besides the routinary use in clinica practice, the drills analyzed are moved by motor, made with the same metallic alloy, possess the same RPM (rotations per minute) speed and don't follow any system of inter-radicular retainers. The clinical use of a conic drill may present some disadvantages as the resistance of use throughout the preparation for the retainer, generation of heat that may cause damage in the periodontal tissue and rip the dentinary structure, mainly in the region of furcation of the dental element. In counterpart, the use of a single drill like the Post Preparation reduced the clinic time due to a less number of drills to be used and proportioned a greater safeness to the operator because of the smaller risk of rupture and conformation of the instrument when compared to the drills used in this research. In the linear analysis the thickness of residual dentin of the four walls in seven cuts, 9,69%, 7,14% e 13,77% of the locals prepared respectively with the drills Post Preparation, Gates-Glidden and Largo showed a thickness smaller than 1mm, recommended by Wu et al. (2005).

The instruments evaluated present different sizes and designs in the active part. The Gates-Glidden drills 2 and 3 possess 1,5mm od active part in the format of flames and extremity diameter of 0,70 and 0,90mm, respectively. The Largo drills 1 and 2 presented 10mm of active part, extremity diameter of 0,70 and 0,90 mm and are parallels. In relation of the tested drill, the Post Preparation, this one possess 10mm of active part, in conic shape and variating diameter of 0,60mm at it's tip until 1,70 mm in the end of the active part. Even though, in relation of the wear, the drill Post Preparation presented a similar behavior to the drills Gates-Glidden and Largo at the linear analysis and of area.

CONCLUSION

According to the methodology used and based in the results exposed, the drill Post Preparation showed a behavior similar to the drills Gates-Glidden and Largo as for the dentinary wear during the preparation for a inter-radicular retainer. More studies are necessary to provide additional informations about the performance of this new Brazilian drill in the different dental groups in comparison to another rotator instruments of the same finality.

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