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Guided Endodontic Access in a Calcified Central Incisor: A Conservative Alternative for Endodontic Therapy

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ABSTRACT

Guided endodontic access is a promising method to treat teeth with pulp calcification. This report aimed to describe a case of root canal treatment performed through guided endodontic access in a calcified anterior tooth with apical periodontitis. A 23-year-old female with a history of trauma 10 years ago in the anterior maxilla was referred to the dental office. Her chief complaint was discolouration of the left central incisor crown. The tooth was sensitive to percussion and responded negatively to pulp sensitivity tests. The periapical radiography showed pulp calcification and periapical radiolucency. Cone-beam computed tomography (CBCT) was obtained to allow a more detailed view of the pulp canal and the periapical area. An intraoral scan was performed and the standard tessellation language (STL) archive was combined with digital imaging and communications on medicine (DICOM) images from CBCT in the Implant Viewer software. Subsequently, a 3D model was designed and printed to guide the endodontic access in position and appropriate angulation for dental instrumentation. The mold was positioned on the patient's tooth and the root canal treatment was performed. After two years, complete healing of periapical tissues was observed. This method facilitates the drill targeting during access, reducing the risk of deviations and perforations.

Keywords: Cone-beam Computed Tomography; Endodontics; Guided Technique; Pulp Calcification; Root Canal Treatment

Introduction

The integration of recent imaging modalities has made new paths for Dentistry, such as a conservative alternative for endodontic access in calcified teeth. Even experienced clinicians working with cone-beam computed tomography (CBCT) images and surgical microscopy with magnified images may find it difficult to locate the root canal and prepare a cavity suitable for endodontic treatment without weakening the tooth. Pulp canal calcification (PCC) is mainly associated with dental trauma, after lateral luxations (71%) followed by extrusions (61%) [1]. The elderly patients also can have teeth with calcified pulp cavities and root canals, but due to the lifelong apposition of dentine [2].

PCC is considered as a sign of pulpal healing and endodontic treatment is only indicated in the presence of acute symptoms or apical periodontitis [1, 3-5]. The occurrence of complications is common in the attempt to treat teeth with calcified canals. Root perforation, canal deviations and massive loss of tooth structure have been reported, which may ultimately result in tooth loss [6].

The implementation of the intraoral scanner (IOS) device in the dental practice coincided with the development of CAD/CAM (computer-aided design and manufacturing) technology in dentistry, with numerous advantages for practitioners [7]. These technologies, along with the three-dimensional (3D) printing, are increasingly prominent in the endodontics as auxiliary means in challenging surgical and non-surgical endodontic treatments [8]. The match of CBCT images with digital data acquisition of IOS

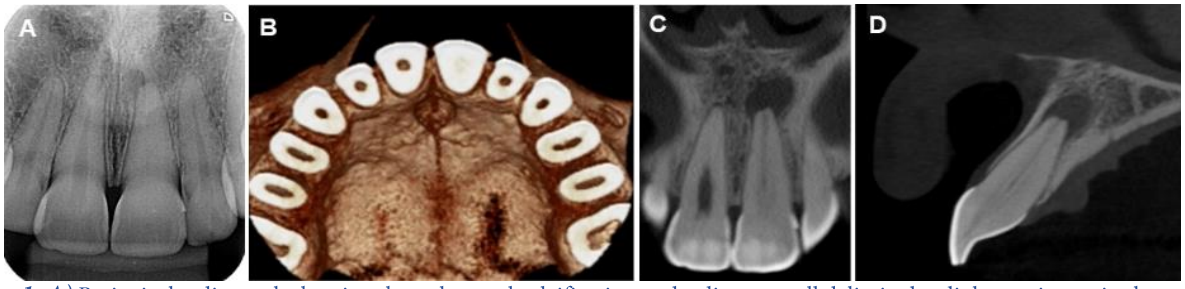

Figure 1. *A)* Periapical radiograph showing the pulp canal calcification and a discreet well delimited radiolucent image in the periapical area of the left central incisor; *B)* CBCT images showing the pulp canal calcification: volumetric reconstruction in axial view at the cervical third; *C)* Coronal reconstruction; *D)* Sagittal reconstruction of the left central incisor

enables virtual planning of minimally invasive endodontic access that could lead to a 3D template to be printed. The 'guided endodontics' method have been reported with success to root canal location and preparation of anterior and posterior calcified teeth [4, 9-12].

The purpose of this case report is to describe a guided endodontic, virtually planned with conventional palatal access, in an anterior calcified tooth presenting apical periodontitis and the outcome after two years of follow-up.

Case Report

A 23-year-old female patient was referred to a private dental clinic in May 2018 complaining of coronary browning of her upper left central incisor. She had a history of trauma in the anterior maxilla 10 years earlier. Her medical history was non-contributory. The clinical examination showed a discolored upper left central incisor. The tooth was tender to percussion and responded negatively to pulp sensitivity tests. The periapical radiograph showed a calcified pulp chamber and pulp canal. The periapical area of the left central incisor presented a discreet well delimited radiolucent image (Figure 1A). CBCT (Prexion3D Elite; Terarecon, San Mateo, USA) images were acquired with 0.1 mm of voxel size to allow a more detailed view of the pulp canal and the periapical area. In addition to apical periodontitis, CBCT images showed a reduced pulp canal lumen in all extension (Figure 1B-D). The measured length of the tooth from the incisal edge to the apex was 21.5 mm and the dimensions of the periapical lesion were 3.4 mm × 5.4 mm × 4.3 mm (height×width×depth).

After explaining the treatment process to the patient and obtaining informed consent, an intra-oral scan was performed (3Shape Trios, Holmens Kanal, Copenhagen, Denmark) and exported to ImplantViewer software (Anne Solutions, São Paulo, Brazil), used for virtual implant planning. The CBCT images and the STL file of digital data of the IOS were aligned and superimposed. The virtual drill in 1.3 mm of diameter and 20 mm in length was aligned into the root canal space making to allow conventional palatal access cavity and prevent unnecessary incisal dentin wear. The position of the drill was checked in 3 dimensions and the 3D template was designed and exported as standard tessellation language (STL) to a 3D printer (Form2, Formlabs Inc., Somerville, MA, USA) (Figure 2A-C).

The procedure was started without local anesthesia. The template was then positioned in the region of the anterior teeth for adaptation and stability check. The enamel was removed in the access area before starting the guided endodontics procedure with a diamond bur and high rotation drill (Neodent, Ref: 103179; Curitiba, Brazil) (Figure 2D). Following the virtual planning, the drill was coupled at a low-speed handpiece (10,000 RPM) and the drilling was performed with constant irrigation with saline. After drilling 10 mm inside the tooth, the access was checked with a size 10 K-file (Dentsply, Tulsa, Oklahoma, USA) and periapical radiographs with different horizontal angulation.

Working length was determinate using a combination of apex locator (Propex II; Dentsply, Tulsa, Oklahoma, USA) and radiography. Root canal preparation was performed with a Maillefer K-file (Dentsply, Tulsa, Oklahoma, USA) manually instrumentation endodontic system with the technique of constant cervico-apical progression. A solution of sodium hypochlorite (2.5%) was used for irrigation and agitated for 60 sec (Easy Dental Equipment, Belo Horizonte, MG, Brazil). The root canal was dried with paper tips and the calcium hydroxide dressing remained for 30 days. Then, obturation was done using gutta-percha and pulp canal sealer (Sybron Endo, Orange, CA, USA) (Figure 3A).

Sixty days after the endodontic treatment, the patient presented discreet pain symptomatology. Therefore, CBCT images were acquired to certify the appropriate endodontic treatment performed with the guide endodontic access. The authors believe that the presence of symptomatology may be related to the extravagated endodontic material. CBCT images showed a clearly initial healing of the apical periodontitis process (Figure 3B). The patient continues to be followed clinically and after the clinical symptoms have completely disappeared, was referred for aesthetic rehabilitation.

Periapical radiograph two years after the procedure, demonstrated complete and asymptomatic healing of the apical periodontitis process (Figure 3C).

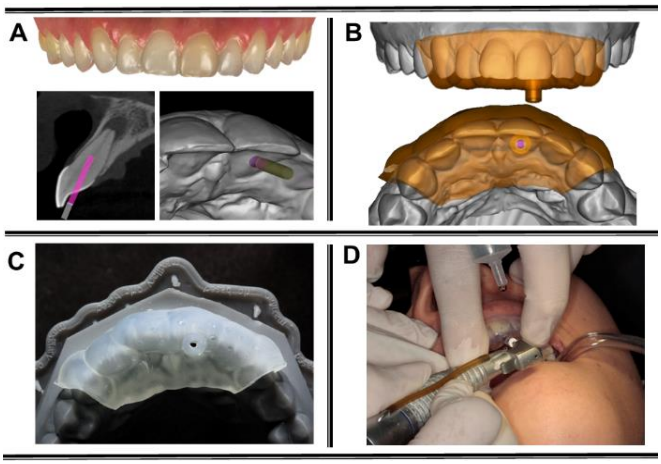

Figure 2. *A)* Maxillary arch from intraoral scan and the virtual planning for end guide assuming an conventional palatal access; *B)* The virtual 3D template ; *C)* The printed model ; and *D)* The template adapted on the patient's maxillary arcade and stabilized manually for the beginning of the longitudinal movements of the drill, under constant irrigation

Discussion

This clinical report highlights the effective result in the treatment of patients with pulp calcification using guided endodontics as a facilitator. Dentistry is surrounded by new technologies that add to the diagnosis, planning and treatment. Complementary imaging methods have evolved greatly in few years, CBCT imaging has improved its image quality, spatial and contrast resolution, providing details of small structures relevant to endodontic diagnosis. Intraoral scanning, in turn, presents a good impression of the dental crowns and gingival tissues, which ensures a satisfactory digital record of the patient's arch [13]. In addition, 3D stereolithography printers are becoming more widespread and associated with dental clinics [14]. Another relevant advancement is in the virtual navigation and planning software which is the environment used to unite the image exams and enjoy its benefits. It is interesting to note that this study is the first to use software of Brazilian origin for the virtual planning of guided access in endodontics.

A variety of methods can be used for the diagnosis of teeth with pulpal calcification. Periapical radiography is the first-choice imaging exam for initial endodontic evaluation, mainly for exposing the patient to low radiation doses. Nevertheless, the distortion and overlapping of structures inherent to the radiographs can hamper the accurate evaluation of calcified teeth. In this case report, from the periapical radiography exam, it was not possible to observe the root canal permeability, and only a discrete circumscribed periapical bone radiolucency was observed. CBCT images, on the other hand, usually add important information such as the location, morphology, degree of calcification of the root canal

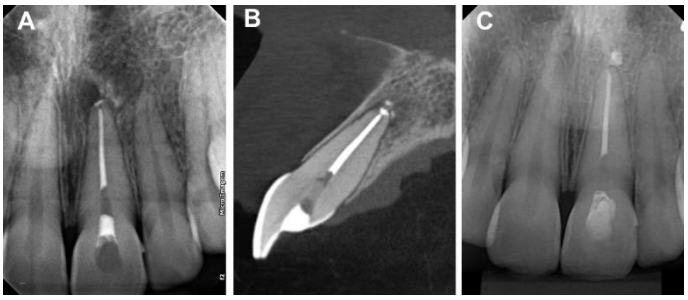

Figure 3. *A)* Postoperative periapical radiograph examination; *B)* Two-months postoperative CBCT image, sagittal reconstruction showing extravasated endodontic material and a clearly initial healing process of the apical periodontitis; *C)* Two-year postoperative periapical image showing complete healing of the apical periodontitis

and confirmation of periapical alterations [15, 16], which may affect the treatment plan. In the case presented here, CBCT images revealed the presence of root canal permeability at the level of the cervical third of the dental root, although with a significant degree of calcification. In the periapical region, CBCT images confirmed the finding of the periapical radiograph of circumscribed periapical bone radiolucency, with additional details about the integrity of the buccal cortical bone.

Even with the advantages presented by the CBCT, it is necessary to follow the justification principle for requesting this imaging modality, in order to keep the radiation dose as low as diagnostically acceptable (ALADA) [17]. However, in cases where CBCT is obtained for endodontic purposes, intraoral scanning may also be of great value. Firstly, because this will not involve exposure of the patient to radiation. Secondly, because the use of both methods will allow more information to be used for the accurate printing of 3D models and templates, which will be used during the treatment approach. Thus, the professionals can take advantage of all the benefits that the guided endodontic provides, such as minimally invasive access, facilitation of root canal location, directing instrumentation, reduction of perforation risks and less dentin wear [9, 12].

Although endodontic access using dental operating microscopy and ultrasonic tips have shown positive results for locating calcified root canals, the handling of this equipment directly involves the operator's experience. Guided endodontics allows access with greater precision and less loss of substance in teeth with calcified root canals [9, 18]. This conservative endodontic access technique is becoming increasingly common among endodontists and dental practitioners, despite the still little spread of the technique [9-12]. In addition, the proof of this methodology is related only to virtual planning softwares, the coDiagnostiX (coDiagnostiX version 9.2, Dental Wings Inc., Montreal, Canada) and the SimPlant (SimPlant Version 11; Materialise Dental, Leuven, Belgium). The high cost of virtual planning software and 3D printers for fabrication of templates is

still factor that prevents the better diffusion of this conservative alternative for endodontic access [12]. The emergence of new virtual planning softwares that present satisfactory results and, above all, easier access to dentists, will positively influence the diffusion of this recent methodology.

Initially, this approach was developed mainly for root canal treatment of anterior teeth, due to their easy accessibility for the guiding template [10]. However, recently the approach of multi-root teeth through the guided endodontic method is already possible, taking into account that patients who have limited mouth opening might have this technique as a contra-indication [11]. A previous study described the use of guided endodontics of mandibular and maxillary molars presenting calcification of all three root canals, and demonstrated that this technique is a viable and reliable alternative treatment also for complex cases [19]. In contrast, guided endodontics of teeth with marked root curvature based on this method still seems to be more challenging, and additional studies should be conducted on this topic.

Templates for guided surgery are already a reality in other fields such as implantology [20]. Although it can increase the time and cost of planning, the guided endodontic is simple, provides more reliability to the professional who will perform the endodontic access in calcified teeth, decreases the chair time and optimizes the results [9, 11]. It is important to emphasize that future studies should be conducted to customize drills and kits dedicated to endodontic accesses, once, that still use drills from guided surgery in implantology.

Conclusion

The guided endodontic method extrapolates the planning phase and directly assists the dental surgeon during endodontic treatment of calcified teeth, increasing the safety of treatment. It allows facilitates the execution of adequate instrumentation and disinfection of the root canal system. Being familiar with cutting edge technology is essential so that professionals and their patients can benefit from the appropriate treatment for the patient.

Conflict of Interest: 'None declared'.

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