Guided endodontics as an alternative for the treatment of severely calcified root canals

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ABSTRACT

Introduction: Pulp calcification is one of the factors that make endodontic treatment challenging and capable of compromising access of instruments and irrigant solutions to the entire extension of the root canal, making it impossible to disinfect it adequately. Guided endodontics makes the endodontic treatment more predictable and safer in this complex situation.
Materials and Methods: Once severe calcification requiring endodontic intervention has been found, the patient is referred to the radiology center for the planning of guided endodontics. A 3D model of the arch to be treated is obtained by means of a bench scanner, afterwards transferred to a virtual implant planning software program. The CBCT is added to this software and both are superimposed on the basis of radiographically visible structures. The Simplant software is programmed to project a physical bur used for guided endodontic access, virtually superimposed on the root canal calcification. Once the printed guide has been obtained, it is positioned in the patient's arch and the clinical procedure is performed. **Conclusion:** The guided endodontic technique is easy, predictable and clinically feasible to perform. Moreover, it may be performed by less experienced professionals, and does not require the use of an operating microscope.

Keywords: Calcification. Cone beam computed tomography. Endodontic access. Scanning.

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Introduction

The purpose of adequate cleaning and shaping of the root canal system is to control and eliminate the resident microorganisms, thus enabling the treatment and prevention of apical periodontitis.[1,2] One of the factors that make endodontic treatment challenging is pulp calcification, which is capable of compromising access of instruments and irrigant solutions to the entire extension of the root canal, making it impossible to disinfect it adequately.[3]

The American Association of Endodontists has classified the treatment of root canals with pulp calcifications and has included it in the category of procedures with a high level of difficulty.[4] Long-necked cutters and ultrasonic inserts are strategies routinely used in this type of procedure, however, they generate a high risk of failures, even when associated with visual magnification with the use of an operating microscope.[5-8] Apicectomy is another alternative for the endodontic treatment of calcified canals. Nevertheless, localization of the obliterated canal and adequate cleaning of the region contaminated after root resection is challenging, so that this surgical treatment is not the first choice.[8]

In this panorama, the tridimensional image is an extremely useful tool that opens new ranges of possibility for diagnosis and performing dental procedures.[9] In 2015, the American Association of Endodontists and the American Association of Oral and Maxillofacial Radiology,[10] met to define clinical situations in which cone beam computed tomography (CBCT) must be performed. In this context, one of the indications for is its use is the localization of calcified root canals.

Recently, tridimensional models were introduced into Endodontics with promising results for performing guided accesses and localizing the calcified root canal.[11-15] Prototype access guides, generated by means of superimposition of the CBCT and intrabucal or bench scanning images are used for precisely directing the pathway that a burr will run through the calcified tissue.[16-18]

Guided endodontics makes endodontic treatment more predictable and safer in complex situations, in addition to drastically reducing the time of performing the procedure, when compared with conventional techniques. Moreover, this does not require a long learning curve, and facilitates execution even by less experienced professionals.

Materials and Methods:

Anamnesis, clinical and radiographic exams are performed to evaluate the presence of symptomatology and/or peri-radicular changes. Once severe calcification requiring endodontic intervention has been found, the patient is referred to the radiology center for the planning of guided endodontics. A high resolution CBCT is obtained, by using a lip retractor as aid to allow a more detailed view of the dental-gingival unit. To guide the endodontic access through the calcified tissue, a CAD/CAM approach was used. A 3D model of the arch to be treated is obtained by means of a bench scanner R700 (3shape, Holmens Kanal, Copenhagen, Denmark) and the image generated is converted into an STL file, later transferred to a virtual implant planning software (Simplant, Technologielaan, Leuven, Belgium Version, 11; Materialise Dental) (Fig 1).

The CBCT is added to this software. Both the CBCT and scan of the surface of the model are superimposed on the basis of radiographically visible structures, such as the patient's soft and hard tissues, highlighted with the use of the ST-CBCT technique.[19] The Simplant software is programmed to project a physical bur used for guided endodontic access, virtually superimposed on the root canal calcification (Fig 2). The bur applied in this technique (Neodent Drill for Tempimplants, Ref: 103179; JJGC ind. E Comércio de Materiais dentários SA, Curitiba, Brazil) has a total length of 20 mm, a 12 mm working length, and is 1.3 mm in diameter. The virtual bur is inclined, thus preventing wear of the incisal edge of the tooth and conducts the trajectory so that the visible lumen of the root canal is attained. Using the previously described position of the bur, the software automatically creates a virtual model by applying its design tool. With a view to transferring the precision of the virtual planning to the surgical procedure, two fixation posts are simulated for the purpose of stabilizing the guide (Fig 3). A ring to direct the radicular access bur (3.0 mm in external diameter, 1.4 mm in internal diameter, and 8 mm long) is also virtually customized and incorporated to orient its access to the trajectory of the visible lumen in the apical third of the root (Fig 4). The model of the guide (Endoguide3D) generated is exported as an STL file and sent to a 3D printer (Object Eden 260 V, Material: FullCure 720, Stratasys Ltd., Minneapolis, MN, USA).

Figure 1. 3D Model of the maxillary arch obtained by means of a bench scanner.

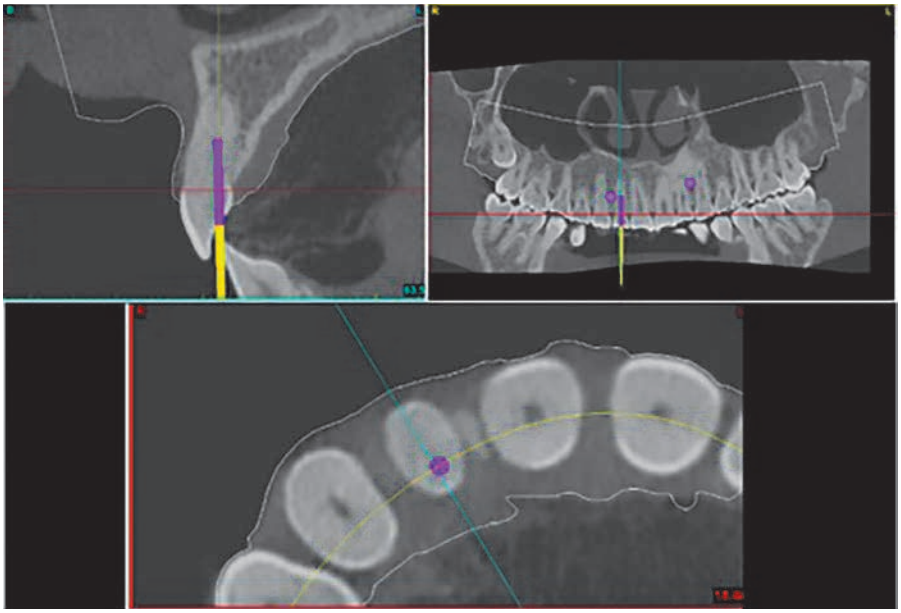

Figure 2. Virtual planning of the access guide.

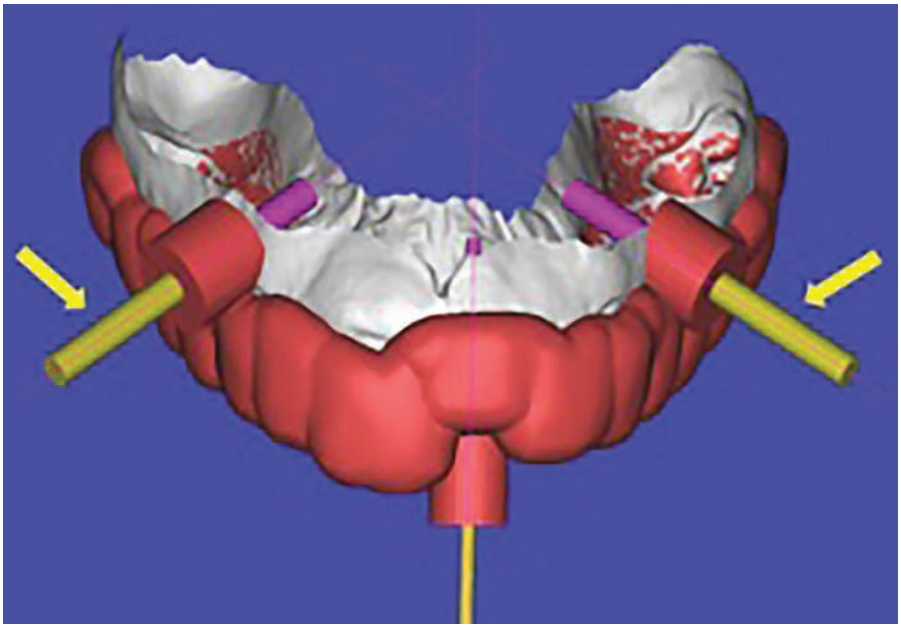

Figure 3. Virtual guide showing the representation of 3 rings. The yellow arrows pointed out the virtually planned fixation screws for stabilization.

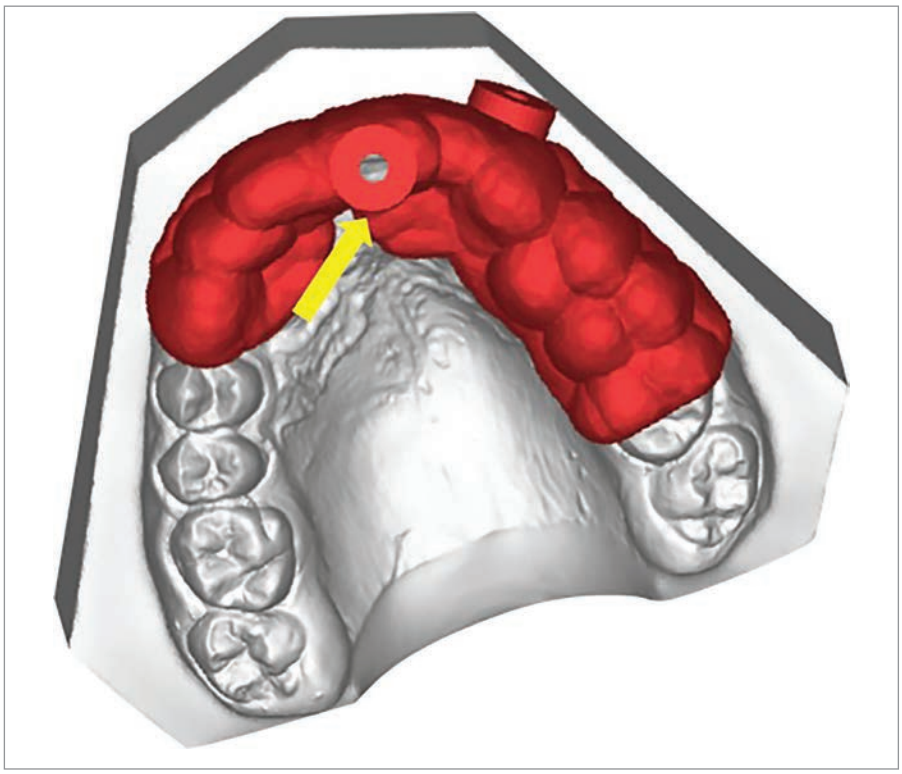

Figure 4. Virtual guide showing the representation of 2 rings. The yellow arrow pointed out the root access canal.

Once the printed guide has been obtained, it is positioned in the patient's arch to check its adaptation. Osteotomy (Bone cutting) is performed under local anesthesia, oriented by the fixation rings. After this, the screws are inserted into this trajectory created by the bur, allowing its stability without any digital support (Fig 5). Right afterwards, guided radicular access is performed using the same bur oriented by the access ring (Fig 6). To perform these procedures, a rotary motor is used at 1200 rpm and 4Ncm, under copious irrigation with physiological solution. After this, the guide is removed, and a compression with gauze is made in the area of osteotomy, to promote hemostasis without the need for sutures. From this time onwards, the endodontic treatment is concluded in the conventional manner, under absolute isolation.

Figure 5. Prototyped Guide positioned and screw retained in the maxillary arch.

Figure 6. Access guide to the canal.

Discussion

The root canal system (RCS) may be partially or completely obliterated as a result of the occurrence of several factors.[20,21] Due to dentin apposition over the course of life, elderly patients may present with severe calcification of the root canals.[22-26] The number of elderly patients and their endodontic treatment needs is increasing due to the fact that teeth remain in the oral cavity for a longer time. Orthodontic treatment as well as dental traumatism may also generate the onset of accelerated dentin deposition.[27-28] Pulp obliteration may be considered a sign of pulp cure, irrespective of the result of pulp sensitivity testing, and in this case, there is no need for endodontic treatment.[29-30] However, there is a risk ranging from 7 to 27% that the pulp of these teeth may become necrotic,[29,31,32] so that endodontic treatment is indispensable, particularly when there are symptoms of the development of apical periodontitis.[13,33]

The remaining canals of severely calcified teeth are localized in the more apical portions of progressively straighter roots, making it difficult to gain access to their entire extension.[8,27] Because this concerns a challenging stage of endodontic treatment, the localization and negotiation of calcified root canals has been related to an increase in the rate of technical failures and an unfavorable prognosis, even when the procedures have been performed by experienced professionals.[34,35] This procedure is commonly performed in a long period of time, and demands caution and professional experience, in addition to the need to have different radiographs taken for checking the root canal trajectory and the use of an operating microscope. Nevertheless, loss of orientation of the bur or ultrasonic insert may generate excessive loss of dentin structure and high risk of perforation.[2,12]

Although CBCT is known to be helpful in the treatment of severely calcified canals, it is necessary to the professional to have knowledge of dental anatomy and a precise mental map of the root canal system at the time of performing conventional access.[2]

Superimposition of the images of intraoral scanning and CBCT by means of a software, allows precise planning of penetration of the access bur. Guided endodontics may be an excellent option for the resolution of these challenging situations such as calcifications, because it is a simple, precise technique that does not demand extensive experience of the operator.[13,14,15] Furthermore, there is no need to use the operating microscope, because the way the bur is directed was created by virtual planning, oriented by the access ring in the surgical guide.[14]

For adequate precision of access, the position of the guide on the tooth surface must be checked to guarantee correct fit.[2] In addition, the bur used must penetrate the ring walls side by side to guarantee stability. Therefore, the burs used must have cylindrical stems, because if the stem were conical, it would lose stability in the guide. Because this technique was reported recently, kits of burs with characteristics advantageous to endodontics must be developed. However, accesses to roots without orientation of the bur may generate more extensive structural wear when compared with accesses made with the burs used at present.

The rings and fixation screws stabilize the guide so that no digital support will be necessary. These were reported for the first time by Lara-Mendes et al.[14] in guides for endodontic access.

After removal of the guide, it is not necessary to suture the region where osteotomy was performed for the purpose of this fixation, because only compression with gauze will be sufficient to promote hemostasis. In the post-operative period, patients reported absence of discomfort in the region, and no need to consume analgesics.

Krastl et al and Connert et al,[12,13] affirmed that the guided endodontic technique could be restricted to the anterior teeth due to the accessibility to and presence of curvatures. However, Lara-Mendes et al,[14] demonstrated that it was possible to performing the guided root access procedure in molars, as in the cited study the access guide was used in the second and third molars. Therefore, the guided endodontic technique is feasible for use in posterior teeth, provided that the patient presents no limitations in mouth opening.

Curvature of the canal may be a limiting factor for the use of this technique, however, taking into account that the majority of root calcifications are found in the cervical and middle root thirds and the curvatures, in the apical third of canals, guided endodontics have been widely used.

After performing this technique in endodontic treatment of teeth with severe calcifications, new possibilities have arisen for other challenging cases, such as those of deviations/perforation of the original trajectory of the canal, in removal of glass fiber intraradicular posts, among others.

Conclusion

The guided endodontic technique is easy, predictable and clinically feasible to perform. Moreover, it may be performed by less experienced professionals, and does not require the use of an operating microscope. Knowing about the high risk of iatrogenic errors in severely calcified root canal treatments as well as in other challenging endodontic treatments, this technique has become an important and excellent option in the art of "saving teeth".

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