Brazilian Dental Journal (2021) 32(6): 115-123
http://dx.doi.org/10.1590/0103-6440202104537

ISSN 0103-6440

Guided Endodontics in Root Canals with Complex Access: Two Case Reports

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This article reported two clinical cases in which the guided endodontics was used to perform the access to the root canals. The first case presents a 40-year-old female with a history of pain related to the left maxillary canine. After radiographic examination, the presence of severe calcification up to the apical third of the root canal, associated with a periapical radiolucency, was noted. In the second case, an 85-year-old male was referred to our service with pain upon palpation, at the right mandibular first molar. The radiographic images revealed the presence of endodontic treatment and a fiberglass post in the distal root canal, which was associated with extrusion of the filling material and a periapical lesion. The 3D-guides were planned based on cone beam computed tomography and intraoral digital scanning, which were aligned using a specific software. Therefore, implant drills could be guided up to the root canal length required for each case. In the first case, a surgical root canal was created and the patient was free of signs and symptoms after the treatment was completed. In the second case, it was observed that the fiber post was worn by the drill, allowing free access to the filling material. It was possible to perform the endodontic reintervention in a more predictable way and in less time. In both cases, the use of the guided endodontics allowed the preservation of a large part of the dental structure. The procedures were performed faster, without the occurrence of fractures and perforations.

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Key Words: Root Canal Treatment; Guided Endodontics; Calcification; Fiberglass Post.

Introduction

A proper access to the root canals is one of the most challenging and frustrating aspects of endodontic treatment, since such a procedure has a direct effect on the location, preparation, and obturation of the root canal system (1). For this reason, new instruments and operative techniques have been developed in order to increase the success rates of endodontic therapy (2). Among these innovations, the use of a 3D-printed guide that allows a safe access to highly obliterated root canals stands out (2).

The guided endodontics was inspired from surgical guides used in implantology (3). These guides accurately delimit the trajectories of the drills for implants placement (4), and currently, may be used for endodontic applications (5). Prior to the guide fabrication, a cone beam computed tomography (CBCT) and an intraoral digital scanning of the dental region, which includes the tooth to be endodontically treated, are performed (6,7). With the aid of a software which aligns the archives obtained from the CBTC and the intraoral scanning, the guide is digitally planned (8). Next, a 3D-guide of rigid material is printed, which it will fit on the tooth surface, allowing the drill to access the root canal with less risks of deviation (5).

Several studies have reported the efficacy and applicability of the guided endodontics in accessing highly obliterated root canals (9,10), teeth restored with fiber posts that require endodontic reintervention (11) and apical surgeries (8,12) .

Therefore, this article reported two clinical cases in which the guided endodontics was used. The first case describes the endodontic access of a highly obliterated root canal of a maxillary canine with the aid of the guide. In the second case, the guide was used to access the distal root canal of a mandibular molar restored with a fiberglass post.

Case Reports

The PRICE 2020 guidelines for reporting clinical cases in Endodontics were followed in the manuscript writing.

Case 1 - Primary endodontic access in a maxillary left canine with severe calcification

A 40-year-old female patient complaining of pain in the region of the upper left canine (international notation, tooth number 23) was referred to us. After clinical examination, it was noted a slight discoloration of the crown of tooth 23 (Figure 1A). The pulp sensibility test (Endo Frost spray; Roeko GmbH & Co, Langenau, Germany) was performed and the answer of the patient was negative. The patient did not report any type of pain during to the percussion and palpation stimuli. During the anamnesis, the patient reported no systemic disease and she was not under any type of medication. The tomographic examination (Figure 1B) revealed a severe calcification of the root canal of tooth 23 up to the apical third. The presence of a radiolucent lesion in the tooth periapex was also noted. The patient reported that she had finished an orthodontic treatment 3 years ago. Due to the degree of complexity of the case, a new tomographic examination was requested, in which the complete calcification of the entire root canal length was confirmed (Figure 1C).

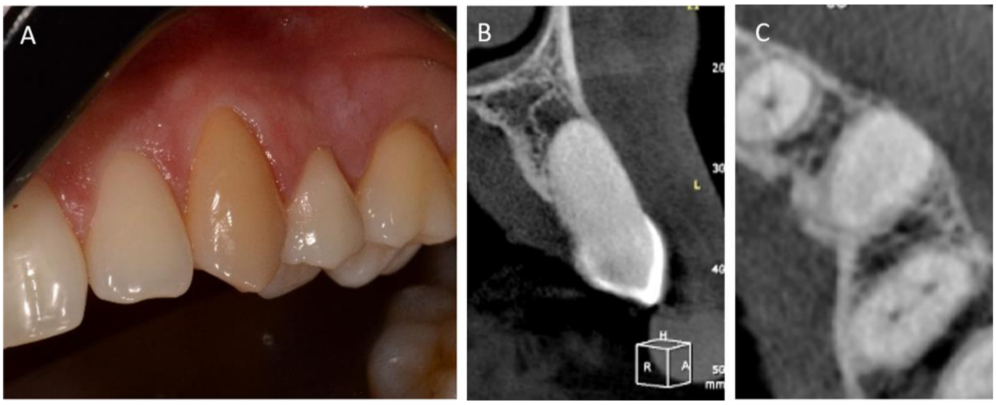

Figure 1. (A) Tooth 23 with significant discoloration of the crown (yellowing). (B, C) Images of the initial CBCT showing severe calcification of the root canal in its entire length and the presence of periapical bone rarefaction. (B) Coronal and (C) axial views showing the complete absence of the root canal image.

The diagnosis of symptomatic apical periodontitis was established for tooth 23. The patient was informed regarding the possibility of creating a surgical root canal by the guided endodontics technique. The patient was informed regarding the benefits and possible risks involving the technique and agreed with the protocol treatment.

For the guide fabrication, a Trios 3 Basic intraoral scanning (3Shape, Copenhagen, Denmark) and a CBTC examination (Instrumentarium OP 300; Kavo, Joinville, SC, Brazil) were performed and sent to the laboratory for digital planning and subsequent 3D-guide printing. According to the planning, only the palatal surface was involved during the endodontic access (Figure 2 A, B). Two guides were fabricated due to the apical incision extension that the drill would have to travel before reaching the apical foramen (Figure 2 C-E). The first guide was fabricated with the purpose of using a 1.3 mm diameter drill with 20 mm in length (ref. 103.079; Neodent, Curitiba, PR, Brazil) coupled to a contra-angle (Model Intra 500; Kavo), followed by another guide fabricated for a 1.3 mm drill with 25 mm in length (ref. 103.078; Neodent), coupled to a straight handpiece (Model Intra 500; Kavo).

Prior to performing the guided endodontics technique, a proper training of the operator was carried out to ensure the safety of the patient. With a Neosurg XT Plus (Neodent) implant motor, a well-conducted laboratory test was performed on extracted teeth to better understand how the tooth wears and how the use of long drills indicated for this case would work. According to the test, due to the sclerotic dentin resistance, the rotation selected for the drill was 10,000 RPM (9) and 5 N of torque.

Before tooth accessing, the disinfection of the oral cavity and the guide was performed with 2% chlorhexidine digluconate solution (Periogard; Colgate-Palmolive Company, São Paulo, SP, Brazil). The adaptation of the endodontic guides was tested in the oral cavity (Figure 2 C-E), and both perfectly fitted to the teeth, with great resistance for their removal, avoiding the use of fixation screws for stabilization. After local anesthesia with Mepivacaine 2% + Epinephrine 1: 100,000 (Mepivalem; Dentsply, São Paulo, SP, Brazil), the enamel surface in the area to be accessed by the implant drill was removed with a 1013 diamond spherical drill (KG Sorensen, Cotia, SP, Brazil) mounted in a high-speed hand piece (Kavo) under copious water cooling.

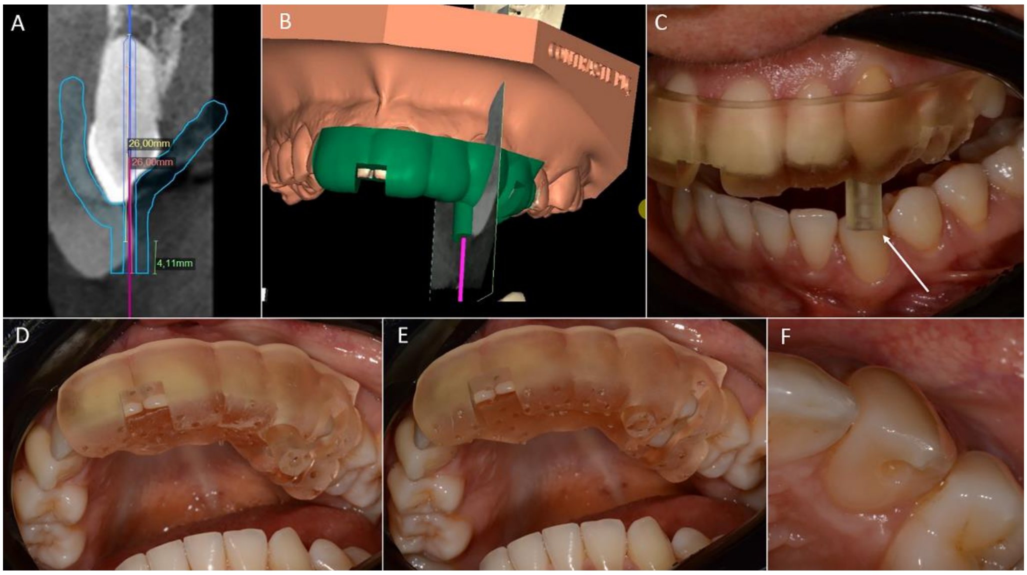

Figure 2. (A) Digital planning, with details for simulating the caliber and positioning of the drill, ensuring the integrity of the buccal and incisal surfaces of the tooth. (B) Virtual planning of the guide based on the intraoral scanning in conjunction with the tomographic examination. (C) First guide in position on the patient's arch. Note the projection of the guide (arrow), in which the drill was positioned and the artificial root canal was created. (D) Occlusal view of the first guide. (E) Note the second guide, with a shorter external projection (arrow), which allowed the drill to reach the region proposed in the digital planning. (F) Image of the tooth 23 after the initial access using a drill through the first guide.

With the guide back in position, the creation of the surgical root canal was started with the implant drill mounted on the Neosurg XT Plus engine, set at 10,000 RPM and torque of 5 N. Under copious water cooling, light and small amplitude movements were performed up to the apical direction. At each 1 mm perforated, the guide was removed and copious irrigation with 0.9% sterile saline solution (Eurofarma Laboratórios S/A, Ribeirão Preto, SP, Brazil) was performed. When the drill reached 3 mm below the limit established by the virtual planning, a periapical radiography was performed to check if there was a deviation in relation to the canal trajectory (Figure 3A). After the implant drill reached the length proposed by the planning, a new radiography was performed (Figure 3B), in which the created surgical root canal was observed. The guide was removed for rubber dam isolation (Hygienic; Coltene/Whaledent AG, Alstatten, Switzerland) of the tooth, followed by irrigation with 2.5% sodium hypochlorite (NaOCl) solution (Biodinâmica, Ibiporã, PR, Brazil) using a disposable syringe and a NaviTip needle (Ultradent, South Jordan, UT, USA). The working length was determined with a size 15 K-type file (Dentsply-Maillefer, Ballaigues, Switzerland) coupled to an electronic apex locator (Root ZX Mini; JMORITA, Tarumi-cho, Suita-shi, Osaka, Japan). The length of 20 mm coincided with the length of the digital planning. The surgical root canal was dried with paper points (Dentsply-Maillefer) and filled with calcium hydroxide intracanal dressing (Ultracal XS; Ultradent). A cotton pellet and a layer of Citodur (Dorident, Viena, Austria) were placed over the calcium hydroxide intracanal dressing. Glass-ionomer cement (GIC) (Vidrion R, SS White, Rio de Janeiro, RJ, Brazil) was used as temporary restoration. Initially, the walls of the coronary cavity were etched with polyacrylic acid for 15 seconds. Then, the cavity was washed with running water and properly dried. In the sequence, the GIC was manipulated according to the manufacturer's instructions and inserted until fulfill the entire cavity.

The patient returned after 60 days and reported reduction in tooth pain symptoms. The temporary restoration of the tooth 23 was intact, with no signs of leakage. A significant decrease of the periapical lesion extension was also observed on the follow-up radiography. After anesthesia and rubber dam isolation, as previously described, the root canal was accessed, and the calcium hydroxide intracanal dressing was removed with copious irrigation (10 mL) of 2.5% NaOCl solution.

Figure 3. (A) Trans-surgical radiographic examination to check the drill trajectory during the surgical root canal creation. (B) Access finalized, with the creation of the surgical canal, as planned. (C) Radiographic image after root canal filling with BioRoot RCS by the single cone technique. Note the presence of the apical plug made with Biodentine sealing cement. (D) One-year follow-up radiography. Observe the significant decrease in the extension of the periapical lesion.

A 2 mm-thick apical plug was fabricated (Figure 3C) with a tricalcium silicate-based repair cement (Biodentine; Septodont, Saint-Maur-des-Fossés, France). The obturation of the remaining root canal length was performed by the single cone technique with a size 90 gutta-percha cone (Dentsply-Maillefer). A tricalcium silicate-based root canal sealer (BioRoot RCS; Septodont) was used. The excess of gutta-percha and sealer were removed and a temporary restorative material (Cavitec; CaiTHEC, São José dos Pinhais, PR, Brazil) was used to seal the root canal entrance (Figure 3C). The patient was followed-up for 12 months. In order to avoid the exposure of the patient to a greater radiation dose, no CBCT analysis was performed. Only a periapical radiography was taken to assess the periapical conditions. The 1-year follow-up periapical radiography still showed an incomplete periapical repair (Figure 3D). Conversely, it was possible to notice a significant decrease in the extension of the periapical lesion and the patient did not report any type of clinical symptoms, such as tooth pain.

Case 2 - Access to the distal canal of a mandibular molar containing a fiberglass post

An 85-year-old male patient arrived for a dental consultation complaining of pain in tooth 46, which had been previously endodontically treated. The presence of filling material extrusion and a fiberglass post in the distal root canal was also observed by radiographic examination (Figure 4A). The patient reported pain after a percussion test in the distal region of the tooth. During the anamnesis, the patient reported no systemic disease and he was not under any type of medication. In the CBCT exam, a periapical radiolucency and extravasated filling material was observed in the periapical area of the distal root (Figure 4B). The diagnosis of symptomatic apical periodontitis was established for tooth 46. Due to this condition, two treatment alternatives were presented to the patient: an apical surgery, or the use of an endodontic guide for fiberglass post removal and endodontic reintervention. The second treatment option was chosen. The patient was informed regarding the risks and benefits of the technique and he agreed with the proposed treatment protocol. The radiographic and tomographic examinations revealed the presence of a radiolucent space only at the periapical area of the distal root canal. Radiographically, the mesial root canals seemed to be well obturated, with no signs of voids and/or gaps along the root canal filling material. Therefore, it was decided to perform the endodontic reintervention only in the distal root canal.

Figure 4. (A) Periapical radiography of tooth 46 with signs of filling material extravasation in the distal root canal and the presence of a fiberglass post. (B) CBCT examination showing the presence of periapical lesion and filling material extravasation.

Initially, an intraoral scanning (Trios 3 Basic; 3Shape) and a CBTC examination (Instrumentarium OP 300; Kavo) were performed, which were sent to the laboratory for digital planning and subsequent 3D-guide printing. The guide was fabricated to use an implant drill with a diameter of 1.1 mm (ref. 103.044; Neodent). The length planned by the laboratory to perform the fiberglass post removal was 15 mm (Figures 5A and 6A).

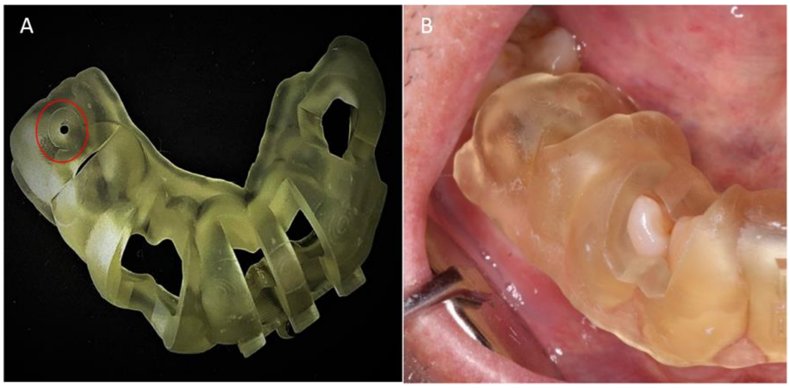

Figure 5. (A) Insertion site of the implant drill (detail). (B) Guide in position on the patient's lower arch.

After the guide and oral antisepsis with 2% chlorhexidine gluconate solution (Periogard; Colgate-Palmolive Company), the adaptation of the guide was tested on the teeth of the patient (Figure 5B), with no need for stabilization with a bone screw. The patient was anesthetized with 2% Mepivacaine + Epinephrine 1: 100,000 (Mepivalem; Dentsply) and the guide was positioned, extending from teeth 33 to 46 (Figure 5B). Endodontic access was initiated at 1200 RPM with torque of 4N. Due to the higher speed, small amplitude movements were performed up to the apical direction (1 mm), under abundant water cooling. At each three movements, the drill was removed, and the drilling hole was irrigated with 0.9% sterile saline solution (Eurofarma Laboratórios S/A). When the drill penetrated 2/3 of the planned length, the guide was removed, and the tooth radiographed. With no deviations observed, the guide was repositioned and the access was continued until the drill touched the guide (Figure 6b).

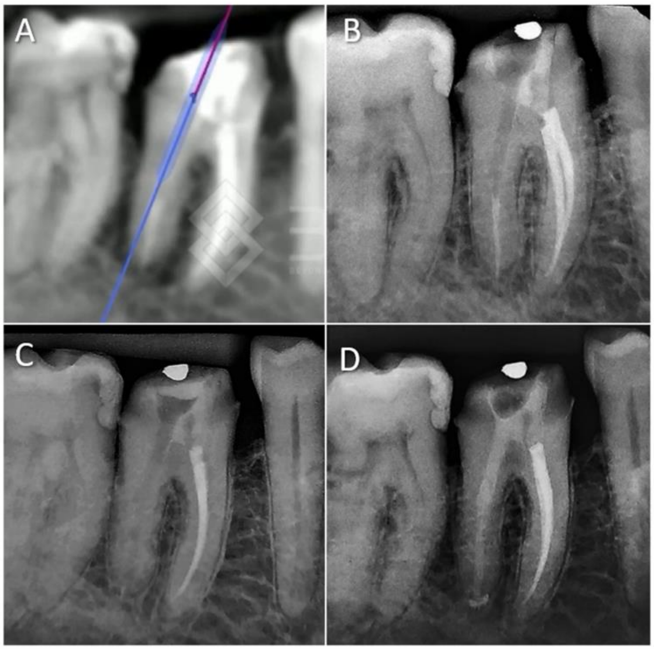

Figure 6. (A) Digital planning with details of the virtual positioning of the drill. (B) Trans-surgical radiography showing the wear caused by the implant drill. Note that there was no deviation from planning, allowing conservative access to the filling-material at the end of wear procedure. (C) Complete filling material removal. (D) Filling the entire distal root canal length with calcium hydroxide paste.

With a size 35 Hedstroem file (Dentsply-Maillefer), it was possible to remove part of the gutta-percha, indicating that the guide had reached the region of interest. The rubber dam isolation was performed (Hygienic; Coltene/Whaledent AG) and the removal of the remaining gutta-percha was completed (Figure 6C). With a size 10 K-type file (Dentsply-Maillefer), the root canal was negotiated, followed by odontometry. The re-instrumentation of the root canal was performed with the Race rotary system (FKG Dentaire, La-Cheaux-de Fonds, Switzerland) driven by an electric motor (X-mart IQ, Dentsply, Ballaigues, Switzerland). The root canal was irrigated with 2 mL of 2.5% NaOCl solution (Biodinâmica) at each instrument change, and at the end of the preparation, it was dried with sterile absorbent paper cones (Dentsply-Maillefer) and filled with calcium hydroxide intracanal dressing (Ultracal XS; Ultradent) (Figure 6D). GIC (Vidrion R; SS White) was used as a temporary restorative material.

After 2 weeks, the patient had reported no signs and symptoms and the endodontic treatment was completed. The patient was anesthetized and rubber dam isolation was performed as previously described. The pulp chamber and the root canal were flooded with 5 mL of 2.5% NaOCl solution to remove the calcium hydroxide intracanal dressing. A size 50.04 gutta-percha cone (Diadent; Burnabay, BC, Canada) was selected. The root canal was dried with sterile absorbent paper cones (Dentsply-Maillefer) and it was obturated by the single cone technique associated with an epoxy resin-based root canal sealer (AH Plus; Dentsply-Sirona, Konstanz, Germany). After the filling material excess removal, the pulp chamber was properly cleaned and the tooth was provisionally restored with a temporary restorative material (Cavitec; CaiTHEC). The 1-year postoperative follow-up revealed no signs and symptoms.

Discussion

The cases presented in this article are two examples of difficulties faced by professionals in their clinical routine. Endodontic treatment of root canals with severe calcification or containing fiberglass posts may be performed by specialists with visual magnification equipment (13). However, even the most experienced professionals, while trying to locate the root canal entrance and to properly prepare it, may promote excessive wear of the dental tissue, increasing the risks of tooth fracture (14).

On the contrary to some cases in implantology (15), the cases reported in this article did not require the use of stabilizer screws. The purpose of using stabilizer screws is to prevent any type of movement of the guide during the surgical procedures (16,17). When the adaptation tests were carried out in the mouth of the patients, in both cases, it was noted a perfect fit of the guides, with certain difficulty for their removal. Without the use of fixation screws, a series of advantages may be achieved, such as less trauma to the soft tissues and bone (18). In addition, the absence of screws allows a faster placement and removal of the guide, enhancing the irrigation process and the debris removal generated during the root canal access (19).

At each drill advance, the guide was removed, and control radiographs were taken to check the trajectory of the dental wear in relation to the long axis of the tooth. After verifying the correct trajectory, the procedure was continued until reaching the previously planned working length. Several studies have demonstrated the reliability of the method, and it may be suggested that the performance of transoperative radiographic images may not be clinically necessary (5,14). Conversely, the guided endodontics technique has a higher cost in comparison with the traditional endodontic treatment, since complementary exams, such as CBCT scans and intraoral scanning, are necessary (20). However, the higher cost of the treatment is justified by the greater safety, predictability and less final wear of dental tissue (14).

In the first case presented in this article, two surgical guides were fabricated to avoid deviations during the use of the implant drills. The different guides allowed the drills to reach the digitally planned area due to the longer extent of the root canal obliteration. Therefore, initially, a guide with a longer external projection ensured that the first drill used was maintained in a straight position along the long axis of the digitally proposed root canal during the access. Then, the second guide, with a shorter external projection, allowed the second drill to reach the region proposed by the digital planning. Because of the severe calcification of the root canal, it was necessary to create a surgical canal along the entire root canal length. The arrival to the periapex was confirmed by using an electronic apex locator. The wear created by the drill was enough to represent the preparation of the root canal and the use of additional endodontic instruments was not necessary.

It is valid to emphasize that no metallic rings were used to stabilize the drills during the access. The metallic rings available on the market were larger than both drills (1.3 mm) that had been used for the access. Our previous laboratory simulation showed that the use of rings with larger diameters could be more harmful to the clinical case than not using them. Therefore, a careful initial access, respecting the angulation of the guide, showed to be enough to maintain the drills path.

As the implant drill had the same diameter throughout its entire length, a non-conical surgical root canal was created. Because of this, the most appropriate gutta-percha cone to perform the root canal obturation was a size 90.02. Therefore, an apical plug with tricalcium silicate-based repair cement was fabricated to completely fill the apical portion and to prevent the occurrence of gutta-percha overfilling (21). Studies have shown that the fabrication of an apical plug with a mineral aggregate-based cement improves the sealing ability of this area (22).

The second clinical case reported represents a challenge when endodontic reintervention is necessary (23). Fiberglass post removal involves the use of specific drills and ultrasonic inserts (24,25). Therefore, the guided endodontics presents itself as a promising and simple treatment option, avoiding deviations and perforations of the root canal (19).

The limited occlusal space for accessing the molar teeth due to the reduced mouth opening by the patient, the acrylic projection of the guide should be shorter in this clinical case. Therefore, we decided for the fabrication of a thicker resin structure around the guide projection. Although the projection was not visible, it had an adequate internal space that allowed the drill stabilization, as the tooth had its temporary crown removed before using the guide (Figure 4A).

The fiberglass post wear was performed concurrently with the use of the implant drill, allowing the maintenance of the original trajectory of the root canal. Therefore, it was possible to perform a faster reintervention, with lesser wear of sound dental structure. Despite the simple handling of the guided endodontics in this case, laboratory and clinical studies are still needed to confirm the reliability of this device in the presence of intracanal retainers.

Based on the features displayed in this article, the use of guided endodontics may be highly recommended in cases where the location of the root canal space is considered complex. Previous studies have reported its efficacy and accuracy, especially in minimally invasive interventions (7), such as the access to obliterated root canals (2,9), removal of intracanal retainers and post space preparation (11,19) and endodontic microsurgery (12). Furthermore, today, the technology used to fabricate the 3D-printed guides is available worldwide, making its clinical applicability easy (7).

Conclusion

This article demonstrated that the guided endodontics may be an important ally in cases of greater complexity during the endodontic intervention. Both cases, presented a high risk of perforation and excessive wear of the dental structure when trying to access the root canal. However, the use of this device allowed the preservation of a large part of the dental structure. Further *in vitro* and *in vivo* studies are necessary to confirm the reliability of the guided endodontics technique to standardize and to facilitate the reproduction of operative procedures by professionals.

Disclosure statement
The authors deny any conflicts of interest related to this study.

Funding sources
This study is self-funded and has not received any external financial grants.

Resumo

Este artigo relatou dois casos clínicos em que a endodontia guiada foi utilizada para realizar o acesso aos canais radiculares. O primeiro caso apresenta uma mulher de 40 anos com história de dor relacionada ao canino superior esquerdo. Após exame radiográfico, notou-se a presença de calcificação acentuada até o terço apical do canal radicular, associada a radioluscência periapical. No segundo caso, um homem de 85 anos foi encaminhado ao nosso serviço com dor à palpação no primeiro molar inferior direito. As imagens radiográficas revelaram a presença de tratamento endodôntico e pino de fibra de vidro no canal radicular distal, que estava associado à extrusão do material obturador e lesão periapical. Os guias-3D foram planejados com base em tomografia computadorizada de feixe cônico e escaneamento intraoral digital, os quais foram alinhados por meio de um *software* específico. Desta forma, brocas de implante puderam ser guiadas até o comprimento necessário do canal radicular para cada caso. No primeiro caso, foi confeccionado um canal radicular cirúrgico e o paciente ficou sem sinais

e sintomas após o término do tratamento. No segundo caso, observou-se que o pino de fibra foi desgastado pela broca, permitindo o livre acesso ao material obturador. Foi possível realizar a reintervenção endodôntica de forma mais previsível e em menos tempo. Em ambos os casos, o uso da endodôntica guiada permitiu a preservação de grande parte da estrutura dentária. Os procedimentos foram realizados com maior agilidade, sem a ocorrência de fraturas e perfurações.

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Received: 01/06/2021
Accepted: 05/11/2021