A New Approach for Minimally Invasive Access to Severely Calcified Anterior Teeth Using the Guided Endodontics Technique

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Abstract

This article describes an endodontic treatment technique performed through a new minimally invasive approach that leads to no tooth damage at the incisal edge and uses cone-beam computed tomographic (CBCT) imaging and 3-dimensional guides. A 26-year-old patient presented with pain in the anterior region of the maxilla and reported having suffered dental trauma 13 years prior. Radiographic examination exhibited no visible root canal on tooth # 9 with a slight thickening in the apical periodontal ligament space. Pulp sensitivity tests produced no response, whereas the percussion test responded positively. CBCT imaging revealed a visible canal space limited to the apical 2-mm section of the root. Guided endodontic access was planned after intraoral scanning of the tooth surface to be used with the CBCT scan. A virtual model was created with the aid of virtual implant software for the surgical access planning in such a way as not to damage the incisal edge of the tooth. The resulting guides were printed. With guides in position over the rubber dam, a mechanical-chemical preparation was performed in the root as soon as the canal was located. Intracanal medication was left for 14 days, after which the root canal was filled gutta-percha and the access cavity sealed. Follow-up was performed 1 year after completion of the treatment. The patient was asymptomatic with periapical tissue within normal limits. The guided endodontic therapy optimized the treatment, having provided a conservative access with no tooth damage at the incisal edge in a safe and predictable way despite the presence of a severely calcified root canal. *(J Endod 2018;44:1578–1582)*

Key Words

Calcification, cone-beam computed tomography, endodontic access, intraoral scanning, tooth damage

Significance

The guided endodontic technique was used for locating and accessing canals in a calcified maxillary incisor in an attempt to minimize dental structure removal. Such an approach is also known as a minimally invasive access.

The combined use of cone-beam computed tomographic (CBCT) imaging and intraoral scanning of the target area allows the manufacturing of access guides that are extremely helpful in locating severely calcified root canals in highly complex cases, for which guided endodontic access is recommended (1–3). Guided access through root calcifications in anterior teeth has been previously performed and reported in the literature with favorable and predictable results (4, 5). The planned and guided access to calcified roots may help to preserve dental structure and avoid accidents such as deviations and perforations. This may lead to an improved long-term prognosis (3).

Except for minor modifications, traditional designs of root canal treatment of the endodontic cavity for different types of teeth have remained unchanged throughout decades (6). They promote a controlled removal of tooth structure while obtaining proper access to root canal entrances. By overcoming the access challenge, the operator will benefit from facilitated cleaning, shaping, and filling of the root canal system while avoiding procedural errors during treatment (6, 7). Some authors (8, 9) have recently changed the endodontic cavity design to minimize the removal of tooth structure. The conservative endodontic cavity concept emphasizes the preservation of dental structure, including pericervical dentin (8, 10, 11), which leads to an enhanced fracture strength under functional loads (12).

In previous studies in which guided endodontics was used to treat severely calcified anterior teeth by minimally invasive approaches, the incisal edges of teeth were always compromised by the access (3, 4, 13, 14). Aimed at avoiding major losses to such a relevant dental structure, the present case report proposes a modified endodontic access as an attempt to minimize incisal edge compromise.

Case Report

A 26-year-old patient presented with symptoms in the region of the maxillary central incisors. The patient reported a history of dental trauma in the anterior maxilla region 13 years before. A radiograph of the area revealed that tooth #9 had a completely calcified pulp chamber and root canal (Fig. 1*A*).

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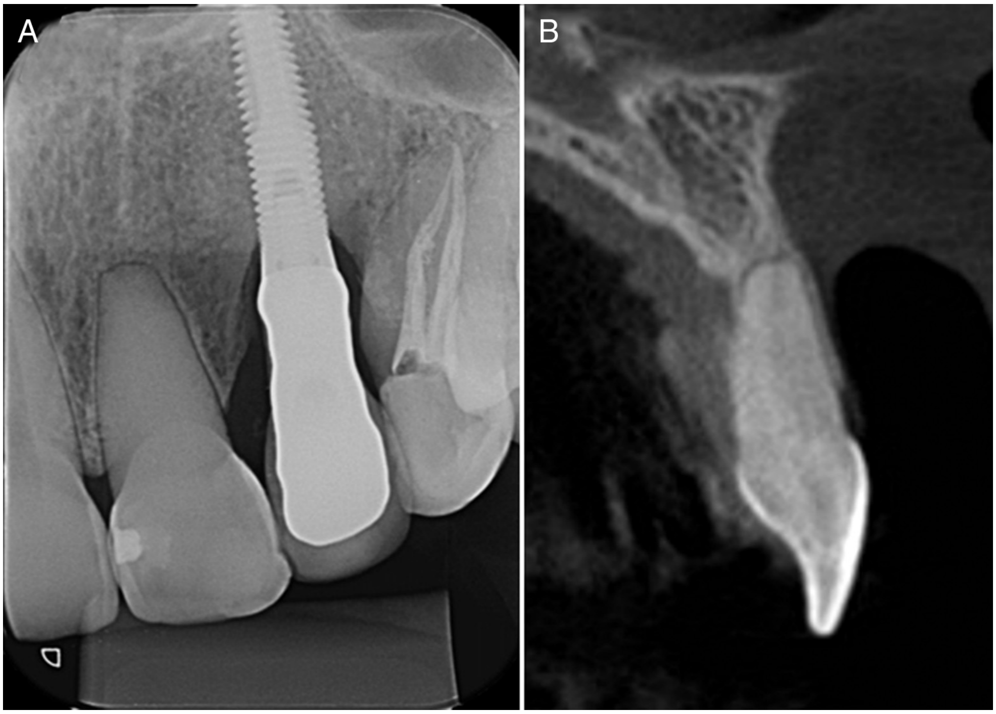

Figure 1. (*A*) A preoperative radiograph showing both the pulp chamber and the root canal completely calcified. (*B*) Sagittal reconstruction showing that only the last 2 mm were visible in the apical third of the root.

At the clinical examination, the tooth failed to respond to the thermal and electrical tests, but the patient reported pain to percussion, which suggests a diagnosis of initial acute apical periodontitis. Endodontic therapy with guided endodontic access as an initial strategy was the proposed treatment. This led the team to call for guided endodontic therapy and a minimally invasive access as the incisal treatment strategy.

A high-resolution CBCT scan was performed with the following settings: 0.12-mm voxel, gray scale, 14 bits, 26.9-second x-ray exposure, 120 kV, and 37 mA (iCAT; Imaging Sciences International, Hatfield, PA). A plastic lip retractor for soft tissue CBCT imaging was used as described by Januário et al (15) to allow for a more detailed view of the dentogingival unit. An apical radiolucent area was observed in the left maxillary central incisor, coinciding with the pain described by the patient. The canal space was only visible in the apical 2 mm of the root (Fig. 1*B*). In light of these findings, the patient signed an informed consent form and was scheduled for a guided endodontic access procedure. In order to guide a clean access through the extent of 11.79 mm of calcified material, a computer-aided design/computer-aided manufacturing approach was suggested. The following steps were taken to create a 3-dimennsional (3D)-printed template. Using the R700 Desktop Scanner (3Shape, Warren, NJ), an intraoral impression was converted into a 3D stereolithography file and then uploaded to virtual implant planning software (Simplant Version 11; Materialise Dental–Technologielaan, Leuven, Belgium). The CBCT image was added to this software, and both the CBCT scan and the surface scan were matched based on the radiographically visible structures. Then, the patient's soft and hard tissues were highlighted with the use of the soft tissue CBCT technique (15). The Simplant software was set to design 2 drills to be used for each guide. The first one was solely aimed at marking the access through enamel using the FG 1014 HL (KG Sorensen, Cotia, SP, Brazil). The second planning helped to design the template for the drill that would be used for guided endodontic access (Neodent Drill for Tempimplants, Ref: 103179; JJGC Ind e Comércio de Materiais Dentários SA, Curitiba, Brazil), with a total length of 20 mm, a 12-mm working length, and a 1.3-mm diameter; the drill was virtually superimposed on the root canal calcification. This virtual drill was angled to avoid the incisal edge of the tooth and to lead the course in such a way as to reach the visible lumen of the root canal (Fig. 2*A*). By means of the previously described position of the drill, the software automatically created a virtual template by applying its designer tool. Aiming at a precise transfer of the virtual plan to the surgical procedure, 2 clamp pins were simulated for stabilization purposes after the correct placement of the printed template on the patient's teeth. A guiding sleeve (with a 3.0-mm external diameter, a 1.4-mm internal diameter, and 8-mm length) was also virtually customized and incorporated into the planning process to access the root and clamp sites (Fig. 2*B*). The template generated was exported as a stereolithography file and sent to a 3D printer (Objet Eden 260 V, Material: FullCure 720; Stratasys Ltd, Minneapolis, MN). The previously mentioned sleeve (Ref: 102110; JJGC Ind e Comércio de Materiais Dentários SA) was integrated into the printed template to guide the drill during the orifice preparation and clamp fixation sites.

The first access guide to the tooth enamel was fixed and positioned under local anesthesia. A mark was placed through the template sleeve to indicate the exact region of the endodontic access cavity. Enamel was removed in this area using a diamond drill until the dentin was exposed. Subsequent to this, the first guide was removed, and a second dentin access guide was positioned and fixed to the patient's upper arch. We used the same bone cutting drill to perform the guided access through the calcified portion of the canal at a speed of 1200 rpm. The template was removed, and the rubber dam was placed. We observed a minimally invasive access opening that preserved the incisal edge of the tooth (Fig. 3*A*). We were able to introduce a K-type #10 file (Dentsply Sirona Endodontics, Ballaigues, Switzerland) into the canal to the working length (Fig. 3*B*). At this stage, an electronic foramen locator (RomiApex

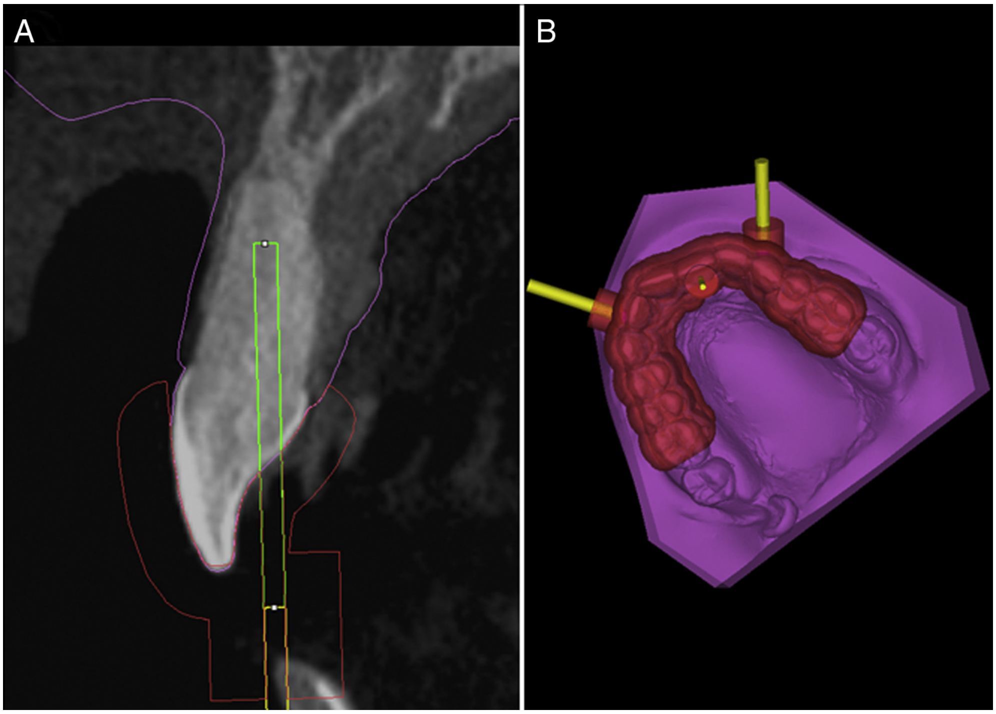

Figure 2. (*A*) Virtual planning. The modified approach that guided the drill angulation to avoid the incisal edge of the tooth while reaching the visible lumen in the apical third of the root. (*B*) The virtual template presenting 3 sleeves, respectively, designed for 2 clamp sites and 1 coronal and radicular access.

A-15; Romidan, Kiryat Ono, Israel) was attached to the file, and a digital radiograph was taken. Mechanical-chemical preparation of the canal proceeded with the use of a WaveOne Gold Medium reciprocating instrument (Dentsply Sirona Endodontics) under abundant irrigation with 2.5% sodium hypochlorite. Glycerin-based Pro Analysis calcium hydroxide intracanal medication (Lenza Farm, Belo Horizonte, MG, Brazil) was packed into the canal. A filler-based composite (Spectra; Dentsply Industria e Comércio Ltda, Petrópolis, Rio de Janeiro, Brazil)

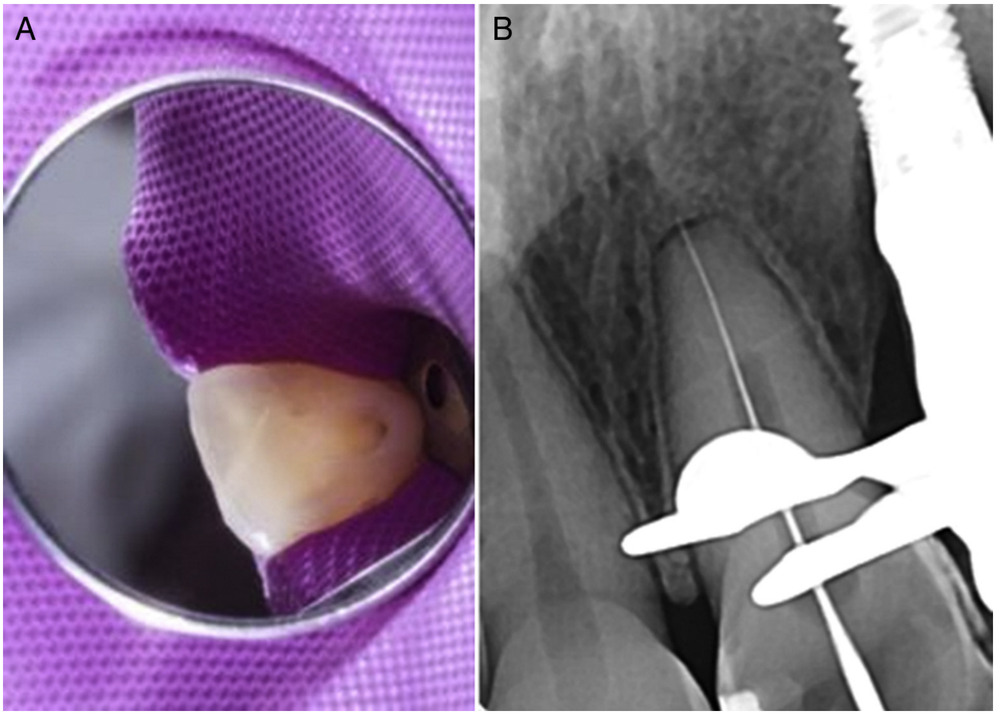

Figure 3. (*A*) The coronal access performed in a minimally invasive fashion preserving the incisal edge of the tooth. (*B*) A radiograph of a #10 K-type file reaching the root canal apical third with the purpose of establishing the working length.

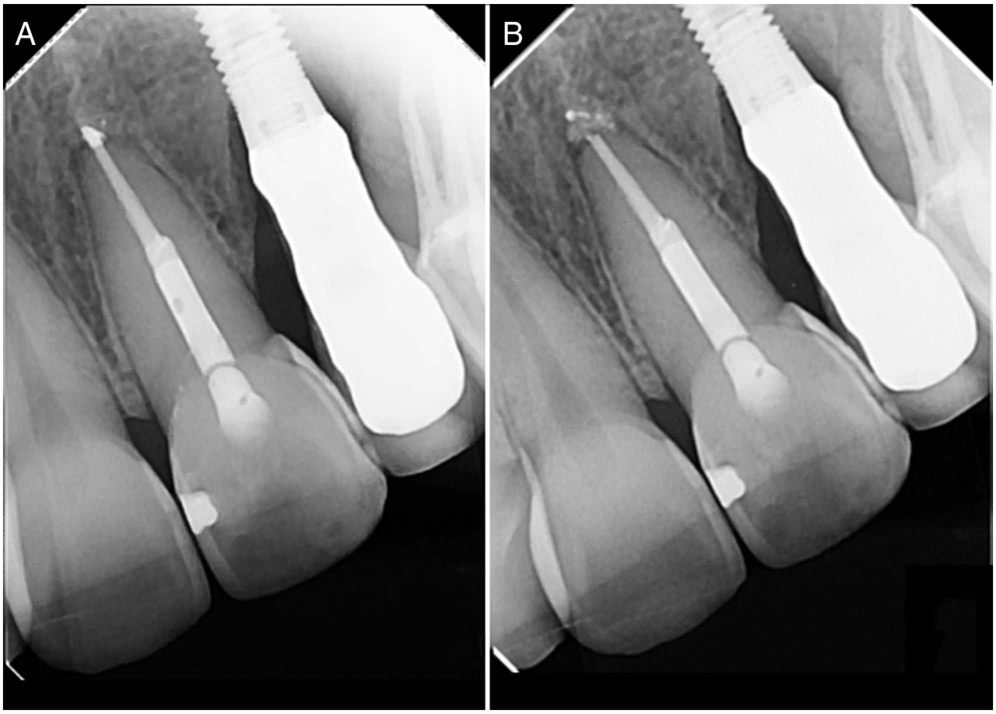

Figure 4. (*A*) The immediate postoperative radiograph. The root canal filled and the crown permanently restored with composite resin in a single appointment. (*B*) The periapical radiograph after 12 months.

was used for temporary sealing. The patient returned 14 days later asymptomatic. The root canal was filled by the hydraulic compression technique using gutta-percha cones (Odous De Deus, Belo Horizonte, MG, Brazil) and epoxy-based cement (AH Plus; DeTrey, Konstanz, Germany). The access cavity was cleaned and permanently sealed with the Spectra filler (Dentsply Industria e Comércio Ltda)-based composite only, without any other restorative approach. It is worth mentioning that under normal circumstances, without the aid of the guided access, major tooth structure destruction would require the use of fiber posts and indirect restorations, usually provided by other specialists such as prosthodontists, which would have increased both the cost and restorative effort to solve the same case (Fig. 4*A*). The case was followed up by clinical and radiographic tests 1 year after treatment (Fig. 4*B*). The patient was asymptomatic, and the radiographic image seemed to show a small alteration in the periodontal ligament space, which may be a sign of the presence of scar tissue.

Discussion

CBCT imaging is a valuable adjuvant method in root canal treatment. It aids the practitioner in diagnosing osseous pathologies, understanding complex root morphologies, and identifying calcifications and resorptive defects (12–16).

In 2015, the American Association of Endodontists and the American Academy of Oral and Maxillofacial Radiography updated their guidelines on the use of CBCT imaging in endodontics. They recommend CBCT imaging for the location of calcified root canals because of the high level of difficulty associated with this procedure (17, 18).

Pulp calcifications can occur as a "healing sign." When unrelated with signs and symptoms of apical periodontitis, endodontic treatment is not indicated (19). On the other hand, every time periapical changes and/or symptoms of discomfort are observed, endodontic intervention is recommended. In such cases, pulp calcifications are considered an additional challenge and are associated with high failure rates (20).

Authors have reported that the success rate after treating calcified root canals associated with apical periodontitis did not exceed 62.5%. On the other hand, success rates in these cases increased up to 89% when the procedures were performed by endodontic specialists (13, 21, 22). Nonetheless, there is a variable, yet commonly high, degree of difficulty in treating teeth with calcified canals.

In cases with radiographic signs of severe calcification of the canal and apical periodontitis, guided endodontic treatment may be indicated for a more predictable access to the apical section of the canal. Guided endodontics may be most beneficial to less experienced professionals because it eliminates the need for an operating microscope and allows for maximum preservation of the dental structure (3–5, 13, 14, 23, 24).

The coronal access may be related to a higher or lower risk of fracture depending on its extension (20). Furthermore, teeth with considerable coronal structure loss require the use of intraradicular posts to retain the permanent restoration, whereas more conservative openings do not require any type of retainers (25, 26). The need for an intraradicular post was not required in this case because of the minimally invasive coronary access used in this study.

A planned and guided conservative access aligned with the minimally invasive concept enables the location of apical canals in calcified teeth and the preservation of dental structure (23, 25). This article was able to show that the guided endodontic access in anterior teeth can be successfully altered to avoid incisal damage by simply changing the direction of the bur during the virtual planning. Many articles have described other techniques, all of which failed to spare part of the incisal edge despite using the guided access (3, 4, 13, 14).

It was not until recently that 3D models were introduced to endodontics in order to perform guided accesses and root canal location with promising results (3, 4, 14, 23, 24, 27). Customized printed 3D model access guides are created by overlapping the CBCT image with an intraoral scan image (1, 2, 28). From the clinical perspective, the guided access provides the operator with a more predictable and reliable technique that improves both short- and long-term results because it allows for more conservative accesses, thus preserving tooth structure (3–5, 13, 14, 27).

Conclusion

This study describes a case report about a severely calcified maxillary central incisor in which the planning and execution of a minimally invasive access was altered to mitigate the damage to the dental incisal edge. This conservative approach is likely to improve the long-term prognosis. It was made possible because the guided endodontic treatment was performed in a quick, safe, and predictable way.

Acknowledgments

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

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