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Guided Endodontic Treatment of Mandibular Incisor with Pulp Canal Obliteration following Dental Trauma: A Case Report

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Root canal obliteration is caused by hard tissue apposition and is often associated with teeth with a history of trauma, orthodontic movement, caries reaction, restorative procedures near the pulp chamber, and teeth of elderly patients. Preoperative planning of root canal treatment should be thorough and include an assessment of the patient's signs and symptoms in addition to the evaluation of complementary examinations. In a 27-year-old patient with dyschromia of the lower central incisor, a history of dental trauma, and a positive response to vertical percussion, an initial periapical radiograph was obtained that showed calcification of the canal and presence of a periapical lesion. The patient presented with pain on chewing, a positive response to palpation and a vertical percussion test. The diagnosis was symptomatic apical periodontitis. A cone-beam computed tomography scan was requested and a surface scan was performed to establish a static guide. The root canal was accessed in the middle third of the root and the canal was located using a minimally invasive approach. The root canal was treated conventionally. Results obtained showed the success of the treatment after a 3-year clinical and radiographic follow-up. Therefore, the use of an endodontic guide in cases of calcified canals significantly reduces the clinician's working time and offers a more predictable approach to the treatment of these pathologies.

Keywords: Cone-beam Computed Tomography; Guided Endodontics; Intraoral Scan; Root Canal Treatment; Tooth Calcification

Introduction

Root canal obliteration is caused by hard tissue apposition and is often associated with teeth with a history of trauma, orthodontic movement, caries reaction, restorative procedures near the pulp chamber, and teeth of elderly patients [1, 2].

When root canal treatment is indicated for pulpal or periapical pathology, it can pose a significant clinical challenge, as it is prone to technical failure in root canal localization, resulting in unnecessary loss of healthy root dentin, or root canal deviation leading to canal perforation in the worst-case scenario [3].

Preoperative root canal treatment planning should be thorough, evaluating available complementary imaging such as initial periapical radiographs and, if necessary, preoperative cone-beam computed tomography (CBCT), which is fully supported in the literature [4, 5].

Since 2016, the first case reports have been published that present a new treatment alternative, guided endodontics, for the treatment of calcified teeth [6]. The software aligns the CBCT with a scan of the patient's dental arch surface and digitally designs the ideal access cavity to locate the root canal in a minimally invasive manner [7].

As a result, endodontic procedures performed with a static guide are highly predictable, reduce the risk of damaging tooth structure, and significantly decrease the clinical time [8]. Additionally, 3D printing is available around the world and can be used to print static guides for endodontic practice [9].

The purpose of this case report is to describe a static-guided endodontic treatment of a lower central incisor with a history of dental trauma, presenting a calcified canal and periapical reaction, with a 3-year follow-up.

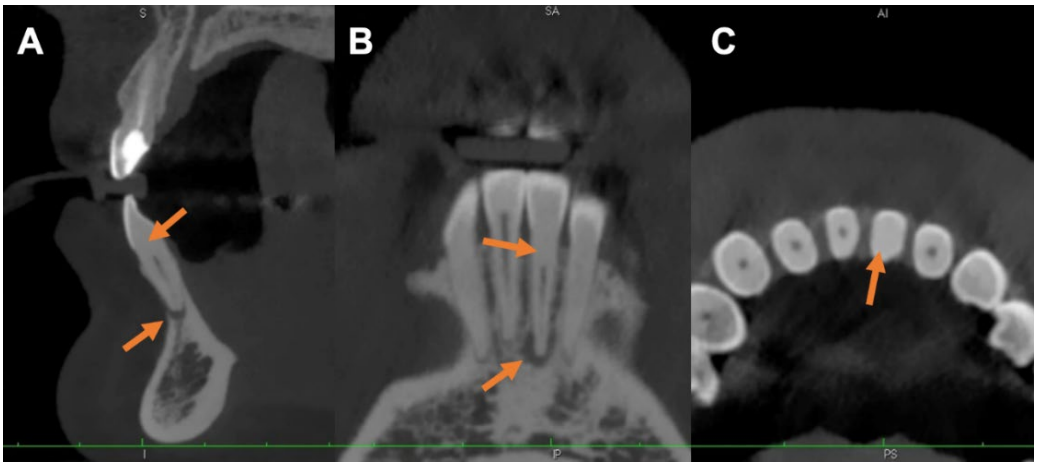

Figure 1. Dynamic CBCT analysis to detect calcification and presence of periapical reaction; *A*) Transaxial plane analysis showing calcification and the presence of periapical reaction; *B*) Coronal plane analysis showing severe calcification up to the middle third of the root canal and the presence of periapical reaction; *C*) Axial plane analysis showing the presence of severe calcification of the root canal

Case Report

A 27-year-old female patient visited the endodontic clinic with dyschromia of the lower central incisor. The patient had a history of dental trauma dating back to more than 5 years.

In the last few days, the patient presented spontaneous pain on chewing, with a positive response to palpation, normal probing depth over the entire tooth surface, and the soft tissues had a normal appearance. The mandibular central incisor responded positive to the vertical percussion test and had no response to the thermal sensibility test. The first periapical radiograph showed calcification of the root canal at the level of the pulp chamber and the middle third of the root. Compared with the adjacent central and lateral incisors, tooth #31 showed radiographic evidence of apical periodontitis, whereas teeth #41 and #32 were periapically healthy. Following the guidelines of the European Society of Endodontics, CBCT was acquired with a small field of view on a tomography unit (GIANO HR, Newton, Imola, Italy). The tomographic images confirmed the presence of canal calcification and periapical reaction, visible at the level of the middle third of the root (Figure 1).

A final impression was made with adhesive pastes (President, Coltene, Altstätten, Switzerland), and a study model was obtained and scanned with a laboratory scanner (AutoScan-DS-EX Pro, Shining 3D, Hangzhou, China). Once the two files (CBCT and scan of the model's surface) were obtained, they were processed with a software designed for guided implantology. After aligning the two files using the software, a virtual copy of the EG5 drill (Endoguide drill, SS White, Lakewood, USA) was made. The bur was superimposed towards the middle third of the root, where the root canal was located. The correct position of the drill was checked in three dimensions. The guide was designed and exported as an STL file for reproduction on a 3D printer.

The patient was checked for correct fit of the guide on the incisal surfaces of the anterior mandibular teeth, articaine 1/10000 (Septanest, St. Maur-des-Fossés, France) with vasoconstrictor was used for local anesthesia, and a mark was made through the guide to determine the access point with a pencil lead (2B, Staedtler, Nuremberg, Germany). Enamel was removed with minimal invasion, using a round diamond bur (1014, Microdont, Sao Paulo, Brazil), until the dentin was exposed. The speed was then set to 20000 rpm and the EG5 bur (Endoguide Burns, SS White, Lakewood, USA) with a diameter of 1.5 mm and a length of 34 mm was used with abundant irrigation. The middle third of the root was accessed with inward and outward movements, and the reference point was reached when the head of the high rotation dental air turbine came into contact with the reference created in the static guide.

Preparation of the access cavity was done in approximately 10 min. The tooth was then fully isolated for conventional endodontic treatment. The canal was explored with a 25 mm #10 K-file (Maillefer, Ballaigues, Switzerland), irrigated with 5.25% sodium hypochlorite, and instrumented with a medium reciprocating file (Maillefer, Ballaigues, Switzerland). Sonic activation (Eddy; VDW, Munich, Germany) was performed at 20-sec intervals for 1 min with 18% ethylenediaminetetraacetic acid (Ultradent, South Jordan, USA), followed by a final irrigation with 5 mL of saline. The canal was dried with medium sterile cones (Maillefer, Ballaigues, Switzerland). Obturation was performed using one #35/0.06 gutta-percha point (Coltene, Langenau, Germany), with the continuous heat wave technique

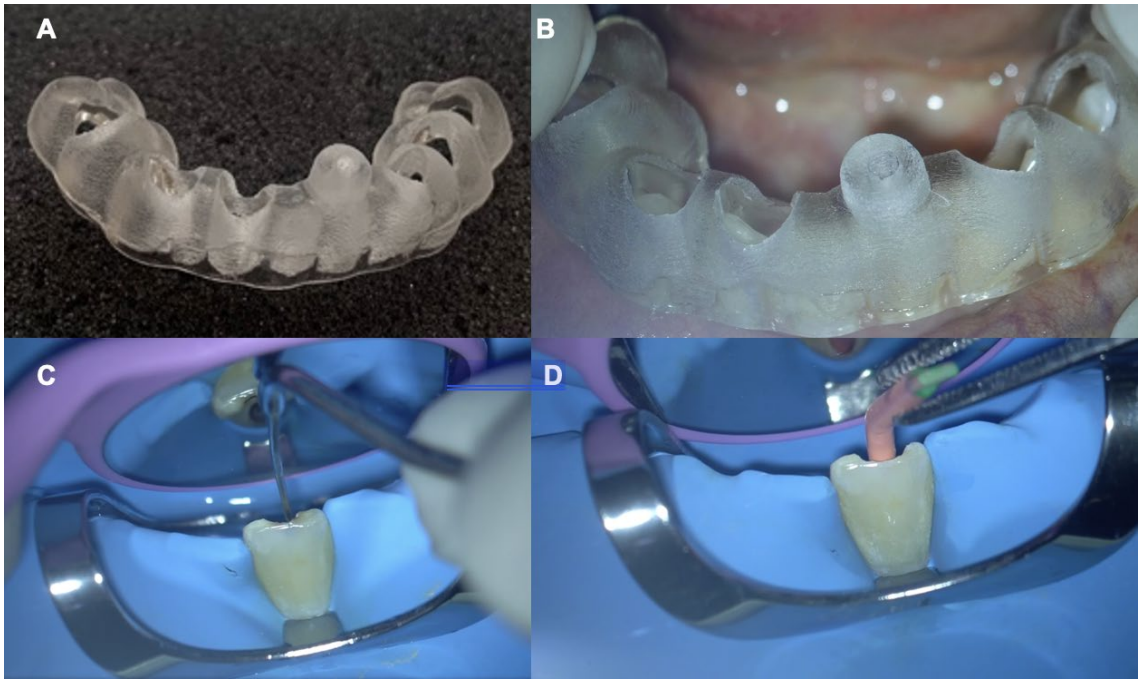

Figure 2. *A*) 3D impression of the static guide; *B*) Testing the guide in the lower dental arch; *C*) Locating the canal with the endodontic explorer; *D*) Testing the gutta-percha cone

(Beefill 2 in 1; VDW, Munich, Germany), along with amino epoxy resin-based cement (AH-Plus; Dentsply, Erlangen, Germany) for canal sealing. The access cavity was cleaned with a cotton swab moistened with ethanol, and the composite resin restoration (Brilliant Everglow; Coltene, Langenau, Germany) was placed with a two-step adhesive (Optibond FL; Kerr, Orange, CA, USA) (Figure 2).

Radiographic control was performed at the end of the root canal treatment and an acceptable three-dimensional obturation was observed, as well as cement extrusion towards the area of periapical reaction. Further radiographic images were obtained 6 months, 1 year, 2 years, and 3 years after the endodontic treatment. Reduction in the size of the periapical reaction and an absence of clinical symptoms were observed in the patient (Figure 3).

Discussion

Calcification of the pulp canal is considered a sign of healing in traumatized teeth, it can begin three months after the dental trauma, and it is important to note that no dentin deposition is detected on the root canal walls during the first year. In general, affected teeth are asymptomatic, as in the present case, but present dyschromia at the level of the crown and a periapical reaction on CBCT examination [10].

Studies have shown that mandibular incisors present a remarkable degree of symmetry in several parameters such as length, canal width, and dentin thickness [11]. To improve clinical decision making, individualization of root canals according to age, associated pathology and symmetry should be considered [12].

In the case of teeth with calcified root canals, the best option is a guided preparation using the longitudinal axis of the tooth as a reference for direct access to the root canal. For this purpose, the guide has been designed so that the bur reaches the middle third of the root canal, where the canal lumen is located [6]. When the procedure is performed conventionally, the probability of making a mistake is high, even with the use of ultrasound and dental surgical microscope [13]. The presented guided approach proved to be sufficiently accurate in establishing a safe treatment method for teeth with calcified root canals [6, 10]. Therefore, guided endodontics facilitates endodontic treatment by preserving more pericervical dentin, with a lower risk of root canal transportation and root perforation, and a shorter working time [7].

Cone-beam computed tomography was used for the presented treatment approach, and although the new CBCT units have a relatively low radiation dose, it is still high compared to conventional X-rays [14]. The risk of making procedural errors and the anatomic complexity for endodontic treatment justifies the use of CBCT in this case [14-16]. In addition, by optimizing the planning and execution of endodontic treatment, this technique helps increase the success rate of endodontic treatment [17].

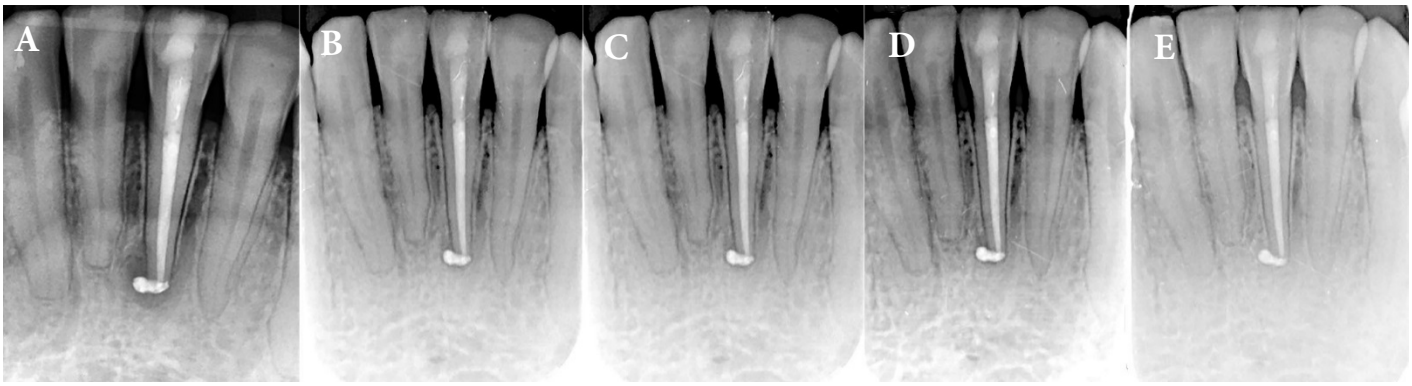

Figure 3. Radiographic controls; *A*) Immediately after root canal treatment (RCT); *B*) Six months after RCT; *C*) One year after RCT; *D*) Two years after RCT; *E*) Three years after RCT

Normally, a guide ring is used to determine the length of the root canal; but in this case, it was not, because the hole with the diameter of the Eg5 drill was made in the guide itself. This acted as a stop for the length of the active part of the drill, until it reached the head of the high rotation piece [18]. This technique facilitated the design of the guide and allowed a straight access to the root canal, minimizing dentinal wear and favoring tooth strength. However, slight wear was observed at the incisal edge. Therefore, when planning the guide, placing the high rotation piece with an angle is suggested, to avoid fracture or wear of the enamel and perform a minimally invasive approach [19].

Several studies have shown that the use of bone anchors is necessary for achieving correct stabilization of the guidewire, in order to prevent deviation from the trajectory planned in the guidewire design software and that their use is justified even in cases where the tooth has no adjacent teeth [17, 19, 20]. However, in the present case, bone anchors were not used at the level of the endodontic guide because it exhibited good stability at the level of the adjacent teeth, which reduced procedural errors during its execution.

It should be noted that guided endodontics is a new procedure that is becoming increasingly important in the treatment of calcified teeth. However, it requires further research and innovation in access drills, as their diameter must be specific to this type of treatment. These drills change the original shape of the canal due to their size [21]. Another limitation of guided endodontics is accessing calcified canals around the curvatures, as the bur only enters the straight part of the canal. It is worth noting that calcifications are usually found in the cervical and middle third of the root canal, while the vast majority of main curvatures are in the apical third, so guided endodontics is the best option for these cases and appears promising in becoming a standard endodontic procedure in the future [15].

Conclusions

Pulp canal obliteration has always posed a challenge for dental professionals as it is often associated with iatrogenic mishaps. Therefore, the use of endodontic guidance in cases of calcified canals significantly reduces the clinician's working time and offers a more predictable treatment approach for these pathologies.

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Conflict of interest

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Author contributions

Conceptualization: Valverde H, Erazo A. Analysed of clinical data, treatment execusion, performed the radiographic examinations, and interpreted the imaging findings: Valverde H. Formal analysis of bibliografy: Valverde H, Quille L, Erazo A. Writing-original draft: Valverde H, Quille L, Erazo A. Writing-review & editing: Valverde H, Erazo A.

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