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Static Guided Endodontic Management of a Calcified Maxillary Central Incisor: A Case Report

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Abstract: ***Pulp canal obliteration (PCO) presents significant challenges in endodontic treatment due to difficulty in canal localization. This case report describes the use of static guided endodontics for managing a calcified maxillary central incisor in an 18-year-old patient presenting with anterior maxillary pain. Cone-beam computed tomography (CBCT) and intraoral scanning were integrated to design a three-dimensional printed guide for precise canal access. Chemomechanical preparation and obturation were successfully completed following guided access. The procedure enabled accurate canal localization with minimal tooth structure removal and no procedural complications. These findings suggest that static guided endodontics is a reliable and minimally invasive approach for managing PCO cases, improving treatment precision and clinical outcomes.***

Keywords: Pulp canal obliteration; Guided endodontics; Cone beam computed tomography; Calcified canal; Endodontic access cavity; Three-dimensional printing; Minimally invasive dentistry

1. Introduction

Pulp canal calcification is a frequently encountered clinical finding characterized by the deposition of hard tissue within the pulp space,which may cause partial or complete calcific obliteration of the pulp chamber and root canal system. This condition is commonly associated with teeth that have experienced dental trauma, orthodontic movement, carious irritation, restorative procedures performed near the pulp chamber, or age-related changes in elderly patients. (1) Clinically, calcified teeth are often asymptomatic and may be detected incidentally during radiographic examination or suggested by a characteristic yellowish discoloration of the crown.

If patient is symptomatic, root canal treatment becomes inevitable, Endodontic management of teeth with canal obliteration can be particularly challenging, as locating the canal pathway may be technically challenging. Conventional access cavity preparation in such cases may lead to excessive removal of healthy dentin, deviation from the original canal path, or even perforation, ultimately compromising the prognosis of the tooth. (2)

Careful preoperative assessment is therefore essential when managing calcified canals. Conventional periapical radiographs provide essential initial diagnostic information.
Advances in three dimensional radiography (CBCT) and digital dentistry have further enhanced the management of calcified canals through the introduction of guided endodontics.

Due to the risk of technical errors and to reduce treatment time, a computer-assisted approach was developed to localize calcified root canals in a minimally invasive manner, and the term guided endodontics was introduced by Krastl and Zehnder in the year 2016 (3) Guided endodontics improves canal localization, preserves tooth structure, and reduces working time. Advances in 3D printing have made static guides more accessible for routine use.

The purpose of this case report is to describe the management of a calcified maxillary central incisor with associated pain using a static-guided endodontic approach.

2. Case Report

An 18-year-old patient presented to the department of conservative dentistry and endodontics, Government Dental College and Hospital, Ahmedabad with pain in the upper right front tooth region since 1 month. The patient reported spontaneous pain during mastication since 1 week. Examination revealed tenderness on vertical percussion and palpation, with normal periodontal probing depths and healthy surrounding soft tissues. The maxillary right central incisor (#11) showed no response to thermal sensibility testing. The case was diagnosed as Pulpal necrosis with symptomatic apical periodontitis with #11.

On clinical inspection, discoloration of tooth #11 was observed. Preliminary intraoral periapical radiographs suggested pulp canal calcification in the affected tooth and PDL widening.

Following the guidelines of the European Society of Endodontology, cone-beam computed tomography (CBCT) was obtained using a small field of view (4x4) with a tomography unit (GIANO HR, Newtom, Imola, Italy). The tomographic images confirmed the presence and location of canal patency located at the middle third of the root, approximately 12.8 mm from the incisal edge.

A static guided endodontic approach was planned to facilitate precise canal location.

The template was fabricated by integrating the CBCT data with the patient's intraoral scan obtained using a 3Shape scanner. The merging process was performed using BlueSky Bio software, and the accuracy of alignment was confirmed. Subsequently, a virtual drill path was planned up to a length of 12.8 mm (target point), corresponding to the level at which canal patency was achieved. The planned path was verified in all three dimensions of the CBCT scan. A guide sleeve with an inner diameter of 1.3 mm, outer diameter of 1.4 mm, and a height of 5 mm was incorporated. The guide thickness was maintained at 3.5 mm with an offset of 0.15 mm. Two inspection windows were included to facilitate heat dissipation during drilling. For enhanced stability, the guide was designed to extend over two adjacent teeth on either side. After planning, the operator exported the design files in STL format, and the guide was fabricated using additive manufacturing with a NextDent 3D printer and NextDent resin.

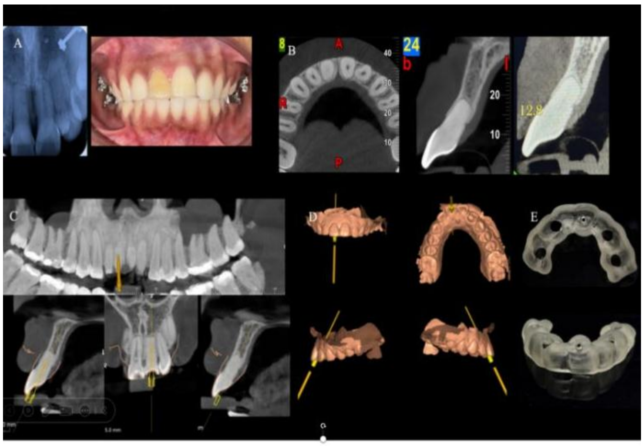

FIG1: A: radiograph and discoloration in 11, B: A CBCT image showing canal obliteration, C: 3D guide planning D: 3D model of oral cavity,E: 3D printed surgical guide

After fabrication, the fit of the guide was clinically verified. Local anesthesia was administered using 2% lignocaine with 1:100,000 adrenaline. Isolation was achieved using a split rubber dam technique (Coltene). A caries indicator dye (PrevestDenPro) was used to mark the access point through the guide on the tooth surface.

Enamel was removed with minimal invasion using a round diamond bur (1014; Microdont, São Paulo, Brazil) until dentin was exposed. Subsequently, the handpiece speed was set to 20,000 rpm, and a bur (1.2 mm diameter) was used.

The middle third of the root canal was accessed using gentle inward and outward movements along the planned path and irrigated with 5.25% sodium hypochlorite between 2 mm advancements, and the predetermined reference point was reached when the head of the high-speed turbine contacted the reference stop created in the static guide.

The canal was initially explored with a 21-mm C+ file (Dentsply Maillefer, Ballaigues, Switzerland) and irrigated with 5.25% sodium hypochlorite. Intraoperative radiographs were obtained to confirm proper canal trajectory and rule out deviations. After successful canal negotiation, the working length was determined.

Biomechanical preparation was performed up to size #35, 6% taper using 5 mL of 5.25% sodium hypochlorite and 5 mL of saline, with ultrasonic activation of sodium hypochlorite using Ultra-X (Orikam).

An intracanal medicament of calcium hydroxide mixed with saline was placed, and the access cavity was temporarily sealed. The patient was recalled after 7 days, at which time the patient was asymptomatic.

At the subsequent appointment, a master cone radiograph was obtained and verified. Final irrigation was performed using 5.25% sodium hypochlorite, followed by saline, EDTA, and a final saline rinse. The canals were dried using paper points (Coltene, Langenau, Germany). Obturation was carried out using a 35/0.06 gutta-percha cone (Coltene, Langenau, Germany) along with BioRoot RCS (Septodont) as the root canal sealer.

The access cavity was cleaned with a cotton pellet moistened with ethanol, and the final restoration was placed using composite resin (Tetric N-Ceram; Ivoclar Vivadent, Schaan, Liechtenstein) with a self-etch adhesive system (Clearfil SE Bond; Kuraray Noritake Dental Inc., Tokyo, Japan) according to the manufacturer's instructions.

Post-operative radiographic evaluation demonstrated an acceptable three-dimensional obturation. Follow-up radiographs obtained two months after treatment showed no evidence of periapical pathology, and the patient remained asymptomatic during follow-up visits.

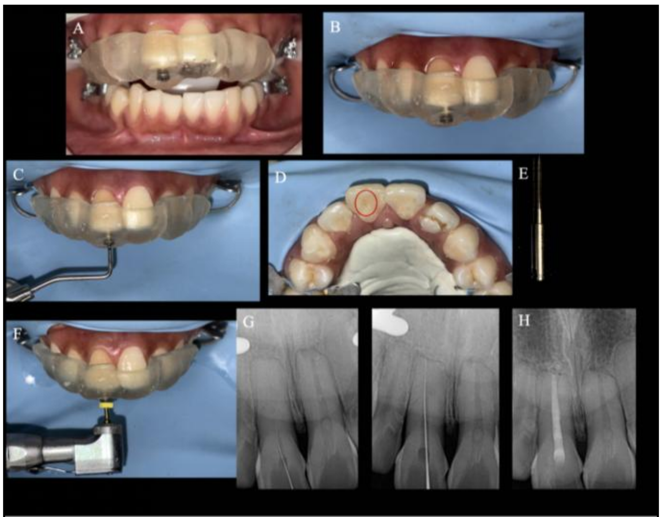

FIG 2: A: Checking the fit of the guide, B: Rubber dam isolation, C: Marking the access point, D: Access point marked,E: Bur, F: Bur positioned in the template, G: Canal negotiated, H: Obturation

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3. Discussion

Pulp canal obliteration (PCO) is a recognized sequela following dental trauma and has been reported in approximately 15–40% of teeth after luxation injuries (4)

Progressive dentin deposition within the root canal system may also occur due to various stimuli, including caries, cervical pulpotomy procedures, restorative interventions, orthodontic treatment, and physiological aging (5). The condition is often detected incidentally during radiographic examination or suggested clinically by a yellowish change in crown coloration.

As per the guidelines of the European Society of Endodontology, root canal treatment should only be initiated when clinical symptoms or radiographic signs of pulpal or periapical pathology are present (6). The presence of pain and tenderness on percussion suggested underlying pulpal or periapical pathology, indicating the need for endodontic treatment.

Long-term observational studies suggest that apical periodontitis may develop in up to 27% of teeth affected by pulp canal obliteration over time. Endodontic treatment in such teeth is often technically demanding and associated with a higher risk of procedural complications. A retrospective study evaluating incisors with post-traumatic canal obliteration reported technical failures such as root perforation, instrument fracture, or inability to locate the canal in nearly one-third of the cases, resulting in reduced healing rates following treatment (8)

Advances in imaging technologies, particularly cone-beam computed tomography (CBCT), have improved diagnostic accuracy by allowing three-dimensional assessment of the root canal system. In the present case, CBCT imaging enabled identification of the calcified segment in the middle third of the root at approximately 12.8 mm from the incisal edge, facilitating precise treatment planning.

Guided endodontics is a predictable technique for accessing calcified canals using digitally planned drilling pathways. Previous studies have demonstrated minimal deviation between the planned and clinically executed drilling paths (9) Clinical reports have further demonstrated successful management of calcified anterior teeth using guided endodontic techniques (10)

Buccolingual dentin loss is hard to assess on 2D radiographs but reduces fracture resistance, especially in the cervical region. Guided endodontics provides controlled, minimal dentin removal, while conventional methods cause irregular and excessive loss, weakening the tooth.

Overall, guided endodontics allows faster, more predictable canal localization with less dentin loss and is less operator-dependent. (11)

Guide printing is critical and requires proper calibration, use of manufacturer-recommended components, and regular replacement. Post-processing steps such as washing and curing are essential for dimensional stability.

The guide sleeve, through which the drill passes, should be 8 mm long for optimal precision; shorter sleeves reduce drill stability. During planning, the active drill length must be subtracted from this 8 mm. If the canal is not visible up to this depth on CBCT, the technique becomes limited. In this case, a 20 mm drill was used, and the canal was visible beyond a depth of 12.8 mm, providing a safety margin.

The drill diameter (0.85 –1.3 mm) is often larger than calcified canals, so careful planning of the canal position is necessary. After drilling, small precurved #8 or #10 K-files should be used with copious irrigation to locate and negotiate the canal. (1)

Despite its advantages, guided endodontics has limitations. It requires additional imaging, digital planning, and fabrication of a 3D guide, increasing cost and time. It is best suited for relatively straight canals (e.g., maxillary incisors and canines). In severely curved or complex canals, deviations may occur. The fixed drilling path also reduces tactile feedback, making accurate preoperative planning essential.

4. Conclusion

This case report demonstrates that static guided endodontics enables precise and minimally invasive access to calcified root canals, facilitating successful treatment without procedural complications. The integration of CBCT imaging and three-dimensional printed guides improved accuracy and preserved tooth structure. This approach represents a valuable adjunct in managing challenging PCO cases and may enhance predictability in complex endodontic procedures when appropriate digital planning protocols are followed.

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