

Guided Endodontic Access Preparation to Manage Pulp Canal Obliteration in a Maxillary Right Central Incisor – A Case Report

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Abstract

Pulp canal obliteration (PCO) in calcified teeth presents significant challenges for endodontic therapy, especially when associated with discoloration. This case report illustrates the successful management of a discolored maxillary central incisor exhibiting PCO through guided endodontic access (GEA). A 28-year-old male with a history of dental trauma presented with discoloration with tooth #11 and a missing tooth #21. Clinical examination revealed a non-vital tooth with asymptomatic apical periodontitis. A three-dimensional (3D) treatment plan was utilized to create a 3D template by cone-beam computed tomography and intraoral scanning, enabled minimally invasive palatal access. Endodontic therapy was completed in a single session. Subsequent prosthetic rehabilitation was planned for the missing left central incisor. This case highlights the efficacy of innovative GEA as a conservative and predictable approach to complex cases involving calcified canals, discoloration, and missing teeth, reducing the risk of iatrogenic errors while preserving tooth structure and surrounding periodontal tissues through reduced heat generation with high-speed arotor compared to conventional micromotor-based access cavity preparation facilitating esthetic restoration.

Keywords: Calcific metamorphosis, Cone-beam computed tomography, External apical root resorption, Guided endodontics, Minimally invasive access.

INTRODUCTION

Pulp canal obliteration (PCO) is commonly associated with dental trauma, excessive orthodontic force, iatrogenic dental procedures,^[1] physiological aging, or regenerative endodontic therapies.^[2] The indication for endodontic treatment in asymptomatic teeth with PCO and no periapical pathology remains debatable.^[3] Achieving esthetic outcomes in teeth with PCO is challenging,^[4] often necessitating intentional root canal treatment (RCT) before internal bleaching for discoloration unresponsive to external bleaching.^[4] Restoring missing teeth typically involves adjacent tooth preparation. The American Association of Endodontists acknowledges the considerable difficulty and potential complications associated with RCT in such cases.^[5]

To address the challenges of PCO management, the concept of Guided Endodontics emerged.^[6] This technique combines cone-beam computed tomography (CBCT) (NewTom Vgi, Verona, Italy) imaging with intraoral scanning to generate a

three-dimensional (3D) template for precise and minimally invasive endodontic access preparation. Guided endodontics has successfully located canals in calcified anterior and posterior teeth, reducing complications such as transportation, perforation and dentin loss, while adhering to the biological principles of chemo-mechanical preparation and 3D obturation.^[6-10]

This case report introduces a novel approach to guided endodontic treatment of a calcified anterior tooth, emphasizing tooth preservation through conservative techniques. High-

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speed airotor instrumentation for most of the drilling process significantly reduced the risk of accidental periodontal tissue damage, thereby facilitating subsequent placement of fixed prosthesis.

CASE REPORT

A 28-year-old male patient was referred to the Department of Conservative Dentistry and Endodontics presenting with discoloration of the right maxillary central incisor and a desire for implant prosthesis to replace the missing left maxillary central incisor. The patient reported a history of a road traffic accident 12 years prior. Medical history was unremarkable. The patient was classified as American Society of Anesthesiologists I. Clinical examination revealed discoloration of the right maxillary central incisor, matching shade A4 (Figure 1a). The left maxillary central incisor was absent, and the right lateral incisor exhibited slight proclination with interdental spacing (Figure 1b). Pulp sensibility tests were non-responsive, and percussion and palpation elicited no symptoms. Mobility and probing depths were within normal limits. Initial periapical radiographic examination demonstrated pulp canal calcification, external root resorption, and supraeruption of tooth #11 (Figure 1c). A diagnosis of non-vital tooth with asymptomatic apical periodontitis was made.

CBCT imaging revealed complete obliteration of the root canal within the coronal and middle thirds approximately up to 16 mm. A patent canal segment was identified solely in the apical portion, 4 mm apical to the root apex, accompanied by evidence of external root resorption (Figure 1d). In addition, an edentulous space was noted in the region of the left maxillary central incisor (Figure 1e).

On comprehensive explanation of the treatment plan, informed consent was obtained from the patient. An intraoral scan was acquired using a Helios 500 (3D intra oral scanner, Changzhou Sifary Medical technology, China) and subsequently transferred to Exocad for virtual endodontic guide planning. The patient's jaw DICOM image and STL file were superimposed for spatial orientation (Figure 2a and b). A virtual drill with a length of 20.230 mm was aligned within the root canal system via a conventional palatal access (Figure 2c). The virtual drill's design and orientation were optimized to safeguard the tooth's incisal edge and accurately direct the sleeve toward the root canal orifice (Figure 2d-f). A 3D assessment of the drill's position was conducted (Figure 2g-i). To facilitate orifice access, a customized virtual guiding pivot incorporating a channel for airotor and micromotor sleeves was fabricated (Figure 2j and k). The finalized template was exported as an STL file for 3D printing using a AccuFab-L4K-EN (Shining 3D, Hangzhou, China).

The template was secured to the anterior teeth, and its stability and alignment were verified (Figure 3a). Under local anesthesia administered through infiltration with lidocaine containing 1:80,000 epinephrine (ICPA health product ltd, India), the access guide was stabilized and positioned. A mark was made through the template sleeve to indicate the precise location for endodontic access cavity preparation. An initial opening in the enamel was created using a round diamond bur (Mani, Japan) in a high-speed handpiece (NSK, Japan). Subsequently, an air rotor with guided sleeves was positioned, and a canal penetration was achieved with an EA 40 diamond point and EA L 10 (Mani, Japan) in a high-speed handpiece along the intended path followed by MI stainless bur #2 with micromotor handpiece

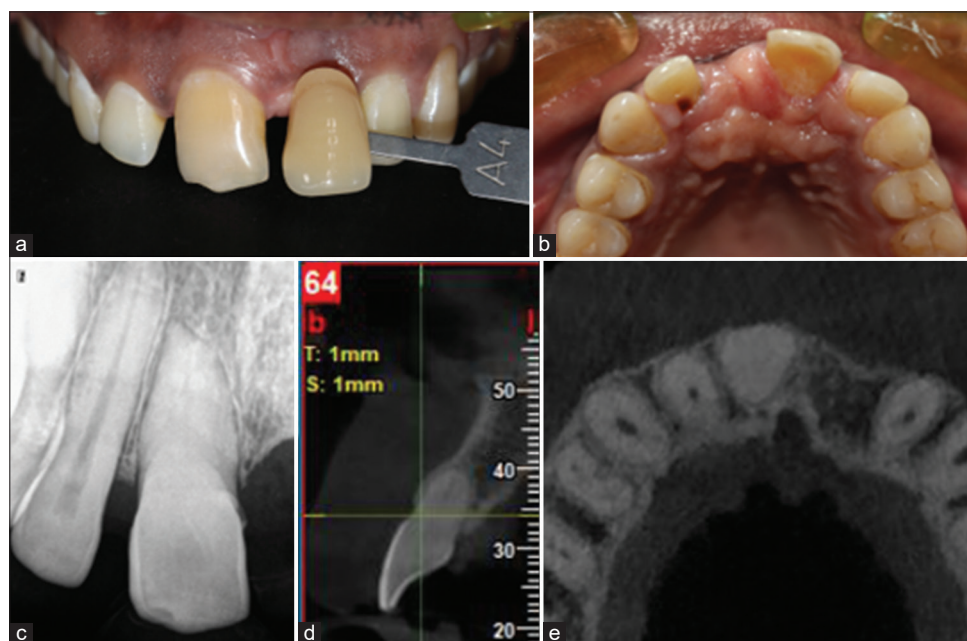


Figure 1: (a) Pre-operative intraoral view showing discoloured tooth with tooth #11; (b) Palatal view showing missing tooth with tooth #21; (c) Pre-operative RVG showing calcific metamorphosis, resorption and overeruption. (d) Pre-operative cone-beam computed tomography view showing complete obliteration of pulp chamber at cervical level of root till middle 1/3rd of root. (e) Occlusal view showing obliterated pulp chamber

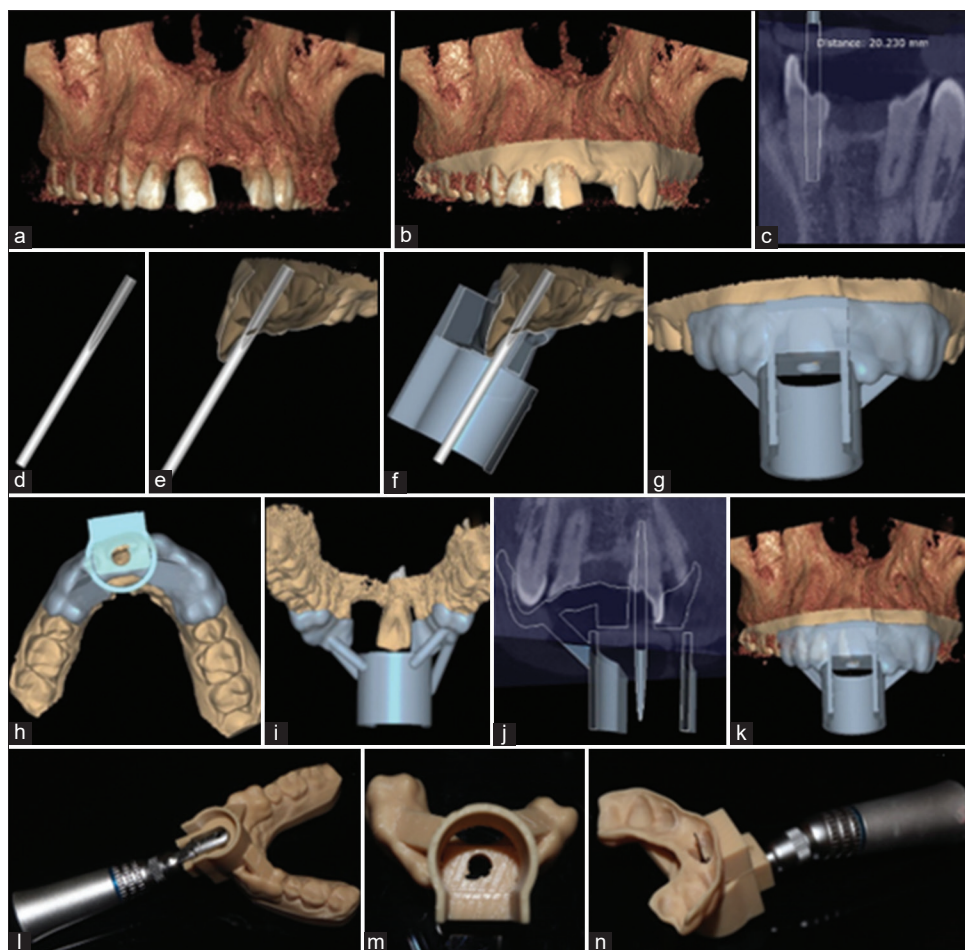


Figure 2: The preoperative planning using the following steps: (a) Data acquisition: Acquisition of DICOM data from cone-beam computed tomography; (b) Data integration: Incorporation of DICOM data into the STL file of patient's jaw; (c-e) Virtual treatment planning: Virtual planning of the guide path by inserting a virtual guide pin to establish the desired guide path; (f-i) Template design and Guide pin refinement: visualized in side, front, occlusal, and palatal views, demonstrating the virtual integration and placement of the guided template; (j) Template positioning: Virtual positioning of the guided template with the guided pin; (k) Template placement: Virtual placement of the fabricated guide in the maxilla, displayed in front view; (l-n) Physical representation: Generation of a 3D printed view of the guide and final assembly visualization in front and back views of the guide with sleeves and micromotor component

(Figure 3b and c). This approach facilitated a minimally invasive access cavity while preserving the incisal edge.

Saline irrigation was employed during the drilling process. Following 10 mm of canal penetration, a radiograph was captured with the diamond point *in situ* (Figure 3d and e) to assess the prepared channel's orientation from various horizontal angles. Drilling continued to a depth of 16 mm to the cemento-enamel junction (Figure 3f). Canal negotiation was initiated with a K-file #10, and working length was established using an apex locator (Morita, Tokyo, Japan) and confirmed radiographically (Figure 3g and h). A glide path was created with a K-file #15. Passive ultrasonic irrigation with 3% sodium hypochlorite was performed.

(Figure 3i) Canal cleaning and shaping were accomplished using Mani hand files up to size 80/0.02%. The canal was dried with a paper cone and obturated using gutta-percha cones and Bio-C Repair (Angelus, Brazil) through cold lateral

condensation (Figure 3j-l). Post-obturation restoration was completed with Type II glass ionomer cement (GC Fuji, Japan) (Figure 3m and n). The patient was subsequently referred to the Department of Prosthodontics for prosthetic rehabilitation of the missing tooth.

DISCUSSION

Calcific metamorphosis (CM), or PCO, is a frequent sequela of concussive and subluxation dental injuries.^[2] While the precise etiology remains elusive, it is postulated that neurovascular compromise and subsequent hard tissue deposition within the canal are implicated.^[4] This calcification obscures the pulp chamber, imparting a characteristic yellow hue to the crown. Clinically, CM may manifest as early as 3 months post-injury, though often remains undetected for up to a year.^[2]

External apical root resorption (EARR) is influenced by a combination of patient-related and orthodontic treatment-

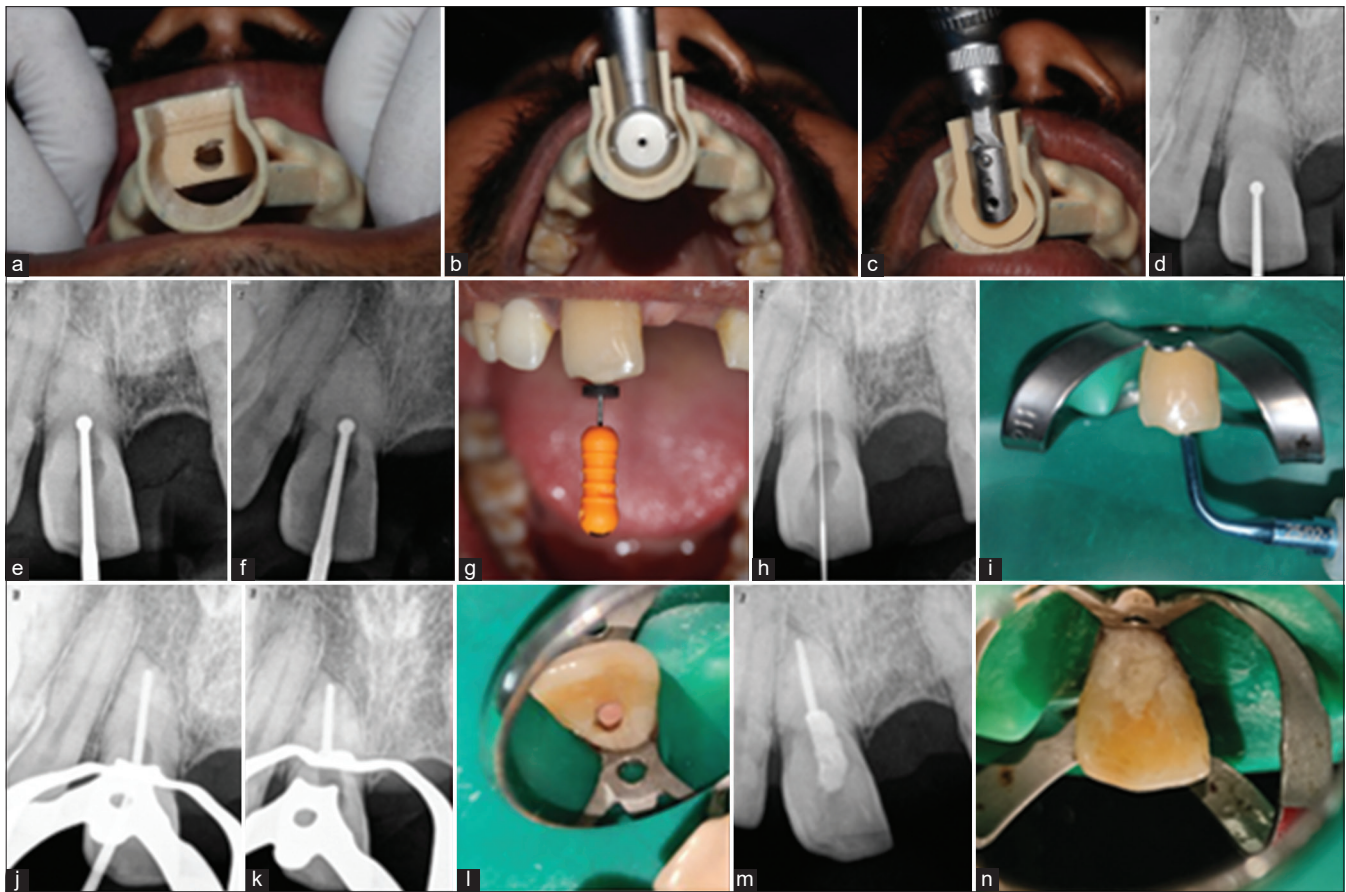


Figure 3: The operative procedure, as illustrated in (a-n), encompassed the following steps: (a and b) Template positioning for fit evaluation and insertion of the airtor with guided sleeves into the designated guide path; (c) creation of further opening using the micromotor with guided sleeves until the orifice was visible; (d-f) sequential drilling and radiographic documentation, commencing at the enamel, progressing 10 mm, and culminating at the cemento-enamel junction; (g and h) working length determination with a Neo probe; (i) ultrasonic irrigation with a 25/0.02% blue tip; (j) master cone selection; (k and l) gutta-percha obturation as visualized radiographically and intraorally; (m and n) final radiographic and intraoral views post-obturation (m)

related factors. Patient characteristics, including genetic predisposition, systemic conditions, malocclusion severity, and tooth morphology, contribute to EARR susceptibility. Orthodontic treatment parameters such as force magnitude, duration, and direction also play a significant role in its development.^[1] Severe EARR can compromise tooth longevity, emphasizing the importance of early detection and intervention.^[2] Andreasen proposed non-surgical RCT with calcium hydroxide as a potential management strategy for arresting EARR.^[5]

Root morphology exhibits variations, including short, blunt, apically curved, or pipette-shaped configurations. Teeth with blunt or pipette-shaped roots demonstrate a significantly higher susceptibility to root resorption compared to those with normal morphology.^[8] Malmgren's scoring system categorizes grade 3 resorption as "accentuated" characterized by the loss of nearly one-third of the root length.^[9] Similarly, Maués CP *et al.*'s classification identifies level-3 resorption as involving up to the first root third, aligning with the severity descriptor.^[12]

Early intervention is crucial in cases of PCO. Rock and Grundy advocated for initiating root canal therapy upon

the first radiographic signs of pulp chamber narrowing.^[3] This paper highlights the benefits of employing advanced technologies such as CBCT and guided endodontics in managing patients with PCO and EARR. CBCT excels in visualizing root canal morphology, identifying periapical pathology, detecting root fractures, aiding surgical planning, and assessing the extent of canal calcification.^[5] Aligned with the recommendations of the American Association of Endodontists and the American Academy of Oral and Maxillofacial Radiology, CBCT is considered indispensable for locating calcified root canals.^[7]

PCO represents a significant clinical challenge in endodontics. Conventional treatment modalities employing slow-speed burs often compromise procedural efficacy and elevate the risk of periradicular tissue injury. This manuscript introduces a novel approach utilizing the high-speed airtor to mitigate these limitations and optimize treatment outcomes.

PCO, characterized by complete or partial calcification of the root canal, can originate from diverse etiologies, including trauma, inflammation, and pulpal necrosis. The intricate anatomy of obliterated canals poses substantial obstacles

to traditional instrumentation, frequently resulting in canal perforations, instrument fracture, and persistent infection.^[11]

Slow-speed burs, while traditionally employed for PCO cases, suffer from inherent drawbacks. Their limited cutting efficiency and rotational speed increase the risk of procedural errors and iatrogenic damage. The generation of heat during instrumentation can induce thermal necrosis of periradicular tissues, exacerbating post-operative complications.^[15] The high-speed airtor, equipped with a water-cooled system, offers a compelling solution to the challenges posed by PCO. Its exceptional cutting speed and precision enable efficient canal negotiation and shaping while minimizing tissue trauma. By reducing procedural time and enhancing access, the airtor holds the potential to revolutionize PCO management.

This guide will delve into the step-by-step process of utilizing the high-speed airtor for PCO treatment, providing clinicians with a comprehensive understanding of this innovative technique. By highlighting the advantages and addressing potential challenges, this document aims to empower dental professionals to achieve superior clinical outcomes for patients with PCO.

Guided endodontic therapy significantly improves treatment predictability, allowing clinicians to perform RCTs with greater precision and reduced risk of procedural errors. This approach has been shown to enhance treatment outcomes, even when performed by less experienced practitioners.^[9] It is particularly advantageous in cases involving calcified canals, as it facilitates access and canal negotiation without the need for a dental microscope.^[4] By minimizing the likelihood of perforations, ledge formation, and missed canals, guided endodontics offers a reliable and consistent method for achieving successful long-term results.^[13,15]

CONCLUSION

The high-speed airtor's superior cutting speed, coupled with water cooling, enhances efficiency, precision, and minimizes tissue trauma while bypassing PCO. Reduced instrument fracture, improved canal negotiation, and faster treatment times

contribute to better clinical outcomes when using a high-speed airtor in conjunction with guided endodontics.

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