



Guided Endodontic Management of Pulp Canal Obliteration in a Maxillary Canine with Root Resorption and Prior Iatrogenic Deviation: A Case Report

Mohammad Naqibeiranvand ^a , Babak Zandi ^a , Mandana Naseri ^b , Nazanin Foroozandehfar ^{c*}

^a Department of Endodontics, School of Dentistry, Shahid Beheshti University of Medical Sciences, Tehran, Iran; ^b Iranian Centre for Endodontic Research, Research Institute of Dental Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran; ^c Research Institute for Dental Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran

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*Corresponding author:

Nazanin Foroozandehfar,
Research Institute for Dental
Sciences, Shahid Beheshti
University of Medical Sciences,
Tehran, Iran.

E-mail: nazanin.ffar@gmail.com

Abstract

This case report describes the successful guided endodontic treatment of a maxillary left canine (#23) with pulp canal obliteration (PCO) in a 30-year-old female patient. The patient had a history of orthodontic treatment and Le Fort I orthognathic surgery, both recognized as potential factors contributing to canal calcification. The patient had a history of a failed root canal treatment, contributing to incomplete canal instrumentation and iatrogenic damage (gouging) during access cavity preparation. The case was referred for completion of treatment. Upon referral, clinical and radiographic examinations revealed advanced canal obliteration, procedural gouging from the prior attempt, and a radiolucent line suggestive of a horizontal root fracture. Cone-beam computed tomography (CBCT) confirmed the extent of canal calcification, ruled out the suspected fracture, and showed a localized palatal external root resorption, likely related to previous orthodontic forces. Given the complexity of the case, a static-guided endodontic technique was selected as the preferred treatment approach. A custom 3D-printed guide, generated from merged CBCT and intraoral scan data, enabled conservative and accurate access to the calcified canal. Although a hand K-file fractured during canal negotiation, the fragment was successfully retrieved using ultrasonic devices under magnification. The tooth was treated successfully. Clinical and radiographic follow-ups at six and twelve months confirmed resolution of the periapical lesion and complete symptom relief, demonstrating that guided endodontics can serve as a safe and effective treatment option in teeth with PCO.

Keywords: Cone-beam Computed Tomography; Dental Pulp Calcification; Endodontics; Guided Endodontics; Intra-Oral Scanning

Introduction

Pulp canal obliteration (PCO) involves the accumulation of hard tissue within the root canal system, often making canal localization challenging or even impossible during endodontic procedures [1]. It most commonly develops as a delayed consequence of dental trauma, but may also be associated with aging, orthodontic treatment, orthognathic surgery (particularly Le Fort I osteotomy), extensive restorations, carious lesions, or regenerative procedures [1-7]. Clinically, affected teeth are often asymptomatic and may only exhibit discoloration or radiographic

evidence of pulp space narrowing or obliteration [8]. While PCO is a frequent sequela of trauma, progression to pulp necrosis and infection occurs in only a small proportion of cases [5, 9]. Nevertheless, if clinical or radiographic signs of pulpitis or apical periodontitis are present, endodontic intervention becomes necessary [5, 10]. Managing these cases conventionally is often fraught with difficulty due to limited canal visibility and restricted access, increasing the risk of procedural complications such as perforation, excessive dentin removal, or instrument separation [1, 5, 11]. To address these challenges, guided endodontics has emerged as a modern technique offering



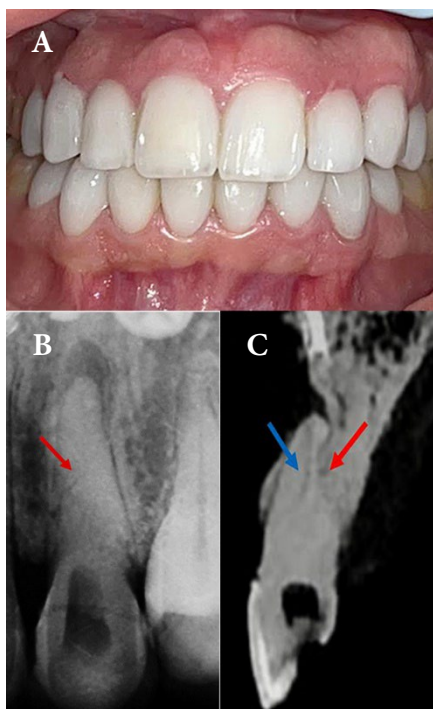


Figure 1. A) Overall photograph of patient's dentition; B) Initial periapical radiograph taken at the time of referral showing canal calcification and a suspected horizontal fracture line, indicated by a red arrow; C) Sagittal CBCT view of tooth #23 demonstrating a well-defined area of an arrested external resorptive defect on the palatal surface, marked by a red arrow. The root canal is obliterated up to the middle third; the visible portion of the canal is indicated by a blue arrow

enhanced precision and safety [5, 12]. This technique combines cone-beam computed tomography (CBCT) and intraoral scanning to produce a digital 3D model for virtual planning and fabrication of a customized access guide [13-15]. Two primary modalities are employed: static guidance, involving a pre-fabricated guide based on virtual planning, and dynamic navigation, which allows real-time tracking during access cavity preparation [16]. While both approaches have demonstrated promising outcomes, static guidance is often preferred due to its simplicity, reproducibility, and accessibility in routine clinical practice [17-20]. This case study presents the successful retreatment of a previously failed root canal treatment in a maxillary left canine with external root resorption and extensive canal calcification, using a static guided endodontic approach for precise and conservative access.

Case Presentation

A 30-year-old female patient was referred to the Endodontics Department at Shahid Beheshti Dental School by a general dentist following an unsuccessful attempt at root canal treatment on

tooth #23 (maxillary left canine). The patient had a documented history of orthodontic treatment, Le Fort I orthognathic surgery, and ceramic laminate veneers (Fig. 1A). She was not taking any medications at the time. The patient's medical history was non-contributory, and she was classified as ASA I according to the American Society of Anesthesiologists Physical Status Classification System.

Clinically, she reported occasional spontaneous pain in tooth #23, which was also sensitive to percussion.

The previous treatment had been initiated but was unsuccessful in negotiating the canal. As a result, the endodontic procedure was left incomplete. Additionally, gouging occurred during the prior access cavity preparation while attempting to locate the canal. The patient was then referred for completion of treatment.

Upon referral, a periapical radiograph was taken (Fig. 1B), revealing canal obliteration, along with a horizontal radiolucent line suggestive of a possible horizontal root fracture. To confirm the diagnosis, a CBCT scan was ordered.

High-resolution CBCT images with a voxel size of 100 microns, operating at 110 kV, and a field of view measuring 6×6 cm² (NewTom Vgi, Verona, Italy) were obtained. The sagittal CBCT section of the target tooth (Fig. 1C) confirmed extensive canal calcification extending through the coronal and middle thirds of the root canal. A localized external resorptive defect was also noted on the palatal surface of the root in the CBCT images, likely related to previous orthodontic treatment. The lesion appeared to be arrested, as evidenced by the intact surrounding periodontal ligament and bone. Furthermore, CBCT imaging ruled out the presence of a horizontal root fracture; the radiolucent line initially suspected was determined to be a superimposition of the palatal resorptive defect. Signs of gouging associated with the prior treatment were apparent on both the periapical radiograph and CBCT scans.

Given the severe calcification and complexity of the case due to previous incomplete treatment, guided endodontic technique was chosen as the method of treatment.

Medit i700 digital intraoral scanner (Medit Co., Seoul, South Korea) was utilized, and the resulting scans were merged with the CBCT dataset using Blue Sky Bio planning software. Using the integrated data, a custom virtual guide was designed for tooth #23, with the drill path precisely aligned with the anticipated canal trajectory (Fig. 2A-2C). The guide, incorporating a metal sleeve (Neodent, Curitiba, Brazil), was fabricated using 3D printing technology (Fig. 2D). At the first visit, local infiltration anesthesia was administered on both the labial and palatal sides using 2% lidocaine with 1: 80,000 epinephrine (Darou Pakhsh Co., Tehran, Iran). The guide was

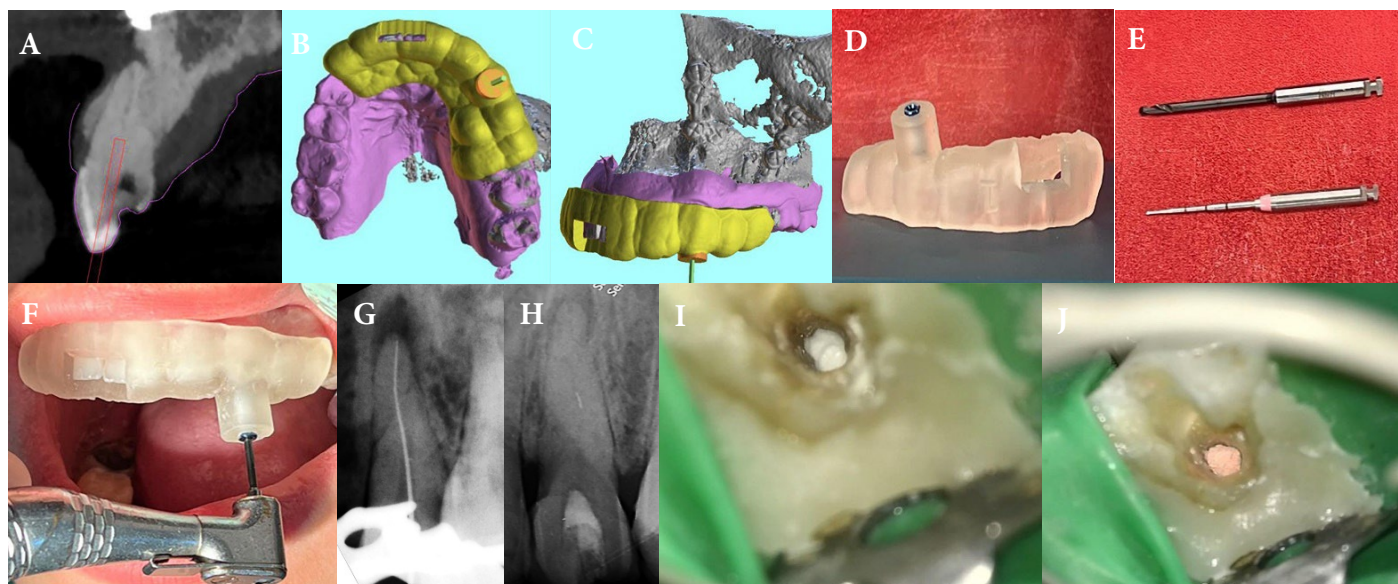


Figure 2. A–C) Integration of CBCT data and intraoral scan using Blue Sky Bio planning software; D) The custom-designed endodontic guide with a metal sleeve; E) A Ø1.1 drill (E-top) and a Muncie #005 bur (E-bottom) are used for access cavity preparation; F) The guide was positioned in place during access cavity preparation; G) Insertion of a hand K-file to verify the accuracy of the drilled pathway; H) Fractured 2 mm segment of the file visible within the root canal; I) Microscopic view: The apical 5–6 mm of the canal was sealed with cold ceramic; J) The remaining canal was obturated with gutta-percha and AH-26 resin-based sealer. Isolation was achieved with a rubber dam and flowable composite.

seated to check for proper fit, conservative access to the calcified canal was initiated using a Ø1.1 mm drill (Neodent, Curitiba, Brazil) through the metal sleeve, and further preparation was continued using a Muncie #005 bur (Hager & Meisinger Ltd., Neuss, Germany) (Fig. 2E–2F). A rubber dam was then placed, and a #10 hand K-file (MANI Inc., Utsunomiya, Japan) was used to negotiate the canal, and a periapical radiograph confirmed successful canal penetration (Fig. 2G). After initial negotiation, the canal was prepared using the passive step-back technique up to a #20 hand K-file to preflare the coronal third of the root canal and facilitate apical access. However, during further negotiation, a 2 mm fragment of the #20 K-file separated and remained inside the canal (Fig. 2H).

Following this accident, the canal was irrigated, creamy calcium hydroxide was placed inside, and a temporary Cavit restoration (Golchai Pharmaceutical Co., Karaj, Iran) was then applied to the tooth. The patient was discharged and scheduled for another visit to manage the separated instrument and continue endodontic treatment.

At the next visit, after administration of local anesthesia and rubber dam isolation, the separated instrument was successfully retrieved using the T6 tip from Dr. Talal's ultrasonic endodontic tip set (Woodpecker, Guilin, China). Under magnification using a dental operating microscope (Carl Zeiss, Oberkochen, Germany), initial dentin around the fractured segment was conservatively removed to expose and create space around the file. Subsequently, ultrasonic vibrations were applied directly

adjacent to the fragment, which facilitated its loosening and eventual dislodgement. Cleaning and shaping were carried out up to size 25, 6% taper using rotary files (Fanta Dental, Shanghai, China). Irrigation was performed with 5.25% NaOCl activated by a sonic device (EasyinSmile, Passaic, United States), and sterile paper points were used to dry the canal.

Due to the complexity of the case and the risk of micro-perforations near the previously resorbed area, the apical 5–6 millimeters of the root canal were sealed with cold ceramic (Samin Teb Co., Tehran, Iran) to take advantage of its biocompatibility and excellent sealing properties (Fig. 2I). The remaining portion of the canal was obturated with gutta-percha (Meta-Biomed, Cheongju City, Korea) using a warm vertical method (Fig. 2J). A temporary Cavit filling was applied to seal the access cavity, after which the patient was referred for the final restoration of the tooth. six-month and one-year clinical and radiographic follow-up demonstrated successful healing of the periapical radiolucency observed at baseline, along with resolution of the signs and symptoms associated with tooth #23 (Fig. 3A–3C).

Discussion

This paper presents the successful management of a maxillary left canine exhibiting extensive pulp canal obliteration (PCO), complicated by a previously failed root canal treatment and a history of procedures potentially predisposing the tooth to calcification.

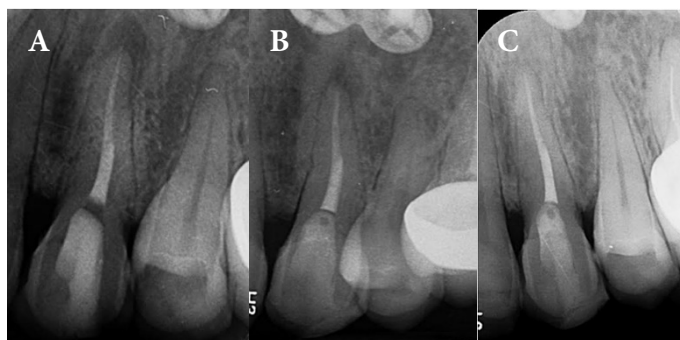


Figure 3. Follow-up radiographs of tooth #23: A) Immediately post-operation; B) Six-month post-operation; C) One-year post-operation, demonstrating progressive healing and resolution of periapical pathology.

The literature indicates that orthodontic forces may contribute to the formation of pulpal calcifications, marked by the accumulation of mineralized tissue within the pulp chamber, which can complicate future procedures like endodontic treatment [21-23] and orthognathic surgeries, particularly Le Fort I osteotomy, have also been reported to be associated with PCO, especially in maxillary teeth [6, 7, 24]. Therefore, in the present case, both prior orthodontic treatment and Le Fort I osteotomy could have contributed to the development of PCO.

This case, complicated by a prior failed endodontic treatment accompanied by gouging during access preparation, was referred for further management. Upon referral, pulp canal obliteration (PCO) and a large external root resorption area were diagnosed, making the case complex and necessitating treatment considerations beyond conventional endodontic approaches.

As reported in a systematic review by Vinagre *et al.* [25] When conventional canal negotiation is not feasible, clinicians may need to consider alternatives such as guided orthograde access or surgical retrograde approaches. The decision between these modalities depends on various factors, including canal anatomy, technological resources, clinician expertise, and patient-specific considerations.

In this case, guided orthograde treatment was not only technically viable but also aligned with the patient's preference for a minimally invasive option.

The application of 3D-printed endodontic guides was first introduced by Krastl *et al.* [26] in 2016, and has since gained considerable attention in clinical practice and research. Originally adapted from techniques in implantology, guided endodontics has emerged as a reliable and precise approach, particularly in complex cases where conventional methods present significant challenges [2, 26]. These include PCO, unusual anatomical variations, selected cases of periapical microsurgery, and other scenarios that complicate traditional endodontic access [2, 19, 25, 27].

Compared to conventional treatment, guided endodontics offers several advantages, including enhanced accuracy, reduced operative time, and a lower incidence of procedural errors such as perforation or excessive dentin removal [25, 28, 29]. Treatment of PCO-affected teeth is technically challenging, with a higher risk of complications like instrument fracture and canal perforation due to restricted access and visibility [1]. In the present case, even with meticulous planning and a conservative technique, a file fracture occurred during canal negotiation. Fortunately, the separated instrument was successfully removed using ultrasonic techniques under magnification. This underscores the procedural difficulty associated with PCO and the need for advanced tools and techniques.

CBCT plays a critical role in diagnosis and treatment planning in such cases [30]. In the present case, CBCT provided high-resolution 3D visualization of the canal anatomy, enabled accurate guide design, and ruled out a suspected horizontal root fracture. It also revealed a localized palatal apical resorptive lesion, a key diagnostic finding that guided the treatment strategy.

One recognized limitation of guided access, particularly in anterior teeth, is the need for a straight-line trajectory, which may compromise the incisal edge [2, 25]. In this case, aesthetic preservation was a key concern due to the presence of existing ceramic veneers. However, challenges such as the previous treatment access pathway and the presence of external root resorption on the palatal aspect of the root limited the ability to completely avoid the incisal edge when designing the guide. Nonetheless, the guided approach allowed for conservative access without compromising the restoration or requiring alteration of the laminate veneers.

Conclusion

This case report underscores the clinical value of guided endodontics in managing a previously unsuccessfully treated maxillary canine with PCO. By integrating CBCT images, digital intraoral scanning, and 3D-printing technologies, conservative and precise canal access was achieved despite significant anatomical challenges. Successful healing of the periapical lesion and the absence of symptoms at 6- and 12-month follow-ups confirm the effectiveness of this approach.

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Conflict of interest

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Authors' contributions

Conceptualization: MB; Methodology: MB; Investigation: NF; Writing-Original Draft: NF; Writing-Review & Editing: BZ/MN; Supervision: MB/MN. All authors read and approved the final manuscript.

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