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Perspective article

Cone-beam computed tomography-guided freehand technique for managing pulp canal obliteration: Clinical tips and precautions

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Pulp canal obliteration (PCO) is characterized by the progressive deposition of hard tissue within the pulp space, often leading to the radiographic disappearance of the canal.[1] It is a common sequela of dental trauma, with a reported prevalence ranging from 4 % to 24 % among affected teeth.[1] Although the exact pathogenesis remains unclear, PCO is believed to result from disruption of the pulp's neurovascular supply at the time of injury. Clinically, teeth with PCO typically show no response to sensibility testing; however, only 7 %—27 % of these cases progress to pulp necrosis and periapical disease.[1] Endodontic treatment of PCO-affected teeth presents considerable challenges, particularly in identifying and negotiating the obliterated root canal.[2]

In recent years, guided techniques such as static and dynamic navigation have been introduced to manage cases of PCO with periapical disease.[3] Additionally, a recent case report has demonstrated the potential of robotic assistance in locating calcified canals.[4] Compared to conventional freehand methods, these computer-assisted approaches offer safer and more accurate access, particularly in teeth with extensive obliteration. Static navigation uses preoperative cone-beam computed tomography (CBCT) data and a 3D-printed guide for predetermined drilling paths, while dynamic navigation allows real-time visualization and tracking of the bur. These technologies can reduce treatment time, preserve dentin, and minimize iatrogenic

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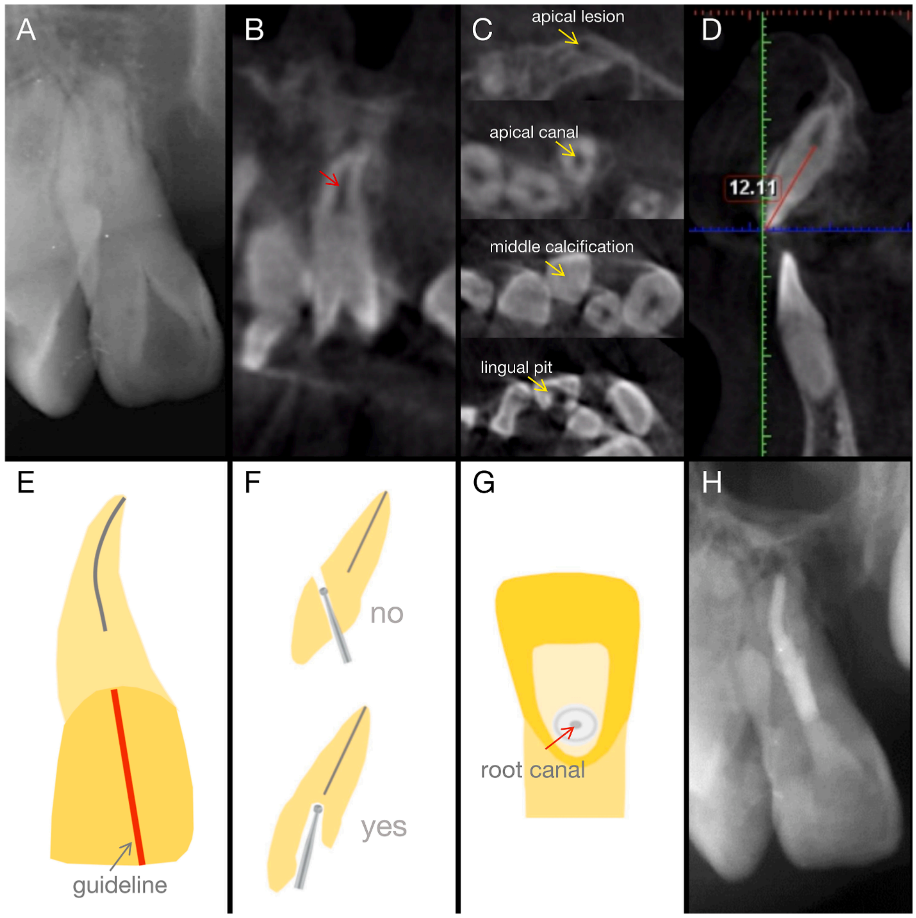

Figure 1 A 16-year-old male patient was referred by his orthodontist for the management of a carious lesion on tooth 21. Clinical examination revealed the absence of tooth 22 and gingival depression between teeth 21 and 23. A deep carious lesion was noted in the lingual pit of tooth 21. The tooth was tender to percussion and showed no response to cold and electric pulp sensibility tests. A pre-operative periapical radiograph (A) showed alveolar bone loss between teeth 21 and 23. Tooth 21 exhibited distal crown rotation and inclination, with the root angulated mesially. There was an apparent periapical radiolucency associated with tooth 21, and the canal appeared obliterated in the coronal and middle thirds, with no discernible root canal image. Coronal section (B) of a cone-beam computed tomography (CBCT) scan obtained during orthodontic treatment confirmed canal obliteration in the coronal and middle thirds, with a visible canal space (red arrow) remaining in the apical third. Axial CBCT sections (C) revealed the anatomical configuration of tooth 21 at coronal, middle, and apical thirds. Sagittal CBCT section (D) showed that the distance from the incisal edge to the point where the canal reappeared was approximately 12 mm. Tooth 21 was diagnosed with pulp necrosis (pulp canal obliteration) and symptomatic apical periodontitis. Root canal treatment was recommended, and written informed consent was obtained from the patient. Before rubber dam isolation, a removable, non-permanent marker was used to draw a guideline on the buccal surface of tooth 21, extending from the incisal edge to the cervical area, inclined mesially and aligned with the long axis of the root (E). After rubber dam isolation, the carious lesion in the lingual pit of tooth 21 was removed under the dental operating microscope using a round bur. A diamond bur was then used to initiate access cavity preparation along the previously marked guideline, angling palatally while avoiding contact with the incisal edge (F), to a depth of approximately 3 mm. Under magnification, the access site was examined for the presence of a bull's eye sign (G). Subsequently, a Munce bur size 2 was used in a slow-speed handpiece to carefully extend the access toward the apex. A size 15 C-Pilot file was used to explore the canal. Drilling was continued using a Munce bur size 1 to a depth of approximately 10 mm from the incisal edge, after which the canal was successfully negotiated with a size 15 C-Pilot file. The working length was determined using an electronic apex locator. The canal was instrumented, disinfected, and dried. Calcium hydroxide paste was placed as an intracanal medicament for two weeks. At the second appointment, the tooth was asymptomatic. The root canal was then obturated using the warm vertical compaction technique (H), and the access cavity was restored with composite resin. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

complications such as perforation or canal deviation. Navigation-assisted access is especially valuable in maintaining tooth structure and improving procedural predictability. However, limitations include the high cost of equipment, the need for CBCT integration, and, in the case of dynamic navigation, a steeper learning curve and additional calibration steps.[5] Static systems, while accurate, lack intraoperative flexibility once the guide is fabricated.

Conventional freehand methods, when combined with CBCT, a dental operating microscope (DOM), and delicate instruments, remain a widely adopted approach for managing calcified root canals. Compared to guided techniques, freehand access carries a higher risk of procedural errors, such as perforation or excessive dentin removal. However, with adequate training and thorough preoperative planning, this approach remains effective and practical, particularly in settings where navigation systems are not available. The clinical case presented in Fig. 1 demonstrated the successful management of a severely calcified maxillary anterior tooth using a CBCT-guided freehand technique. The following sections highlight practical tips and key precautions for treating similar cases.

Pre-operative periapical radiograph in PCO cases should be carefully analyzed for crown orientation, root curvature, and the extent of canal obliteration (Fig. 1A). Attention should also be given to the presence of periapical radiolucency and any remaining visible canal space to guide access and treatment planning. CBCT plays a vital role in the management of PCO by enabling 3D evaluation of root canal anatomy (Fig. 1B and C), including canal morphology, orientation, and the extent and distribution of calcification.[6,7] It also facilitates estimation of calcified tissue thickness (Fig. 1D) and aids in planning an optimal access pathway. To minimize radiation exposure, CBCT should be acquired using a high-resolution, limited field-of-view (FOV) scan, adhering to the "as low as reasonably achievable" (ALARA) principle.[8] Importantly, radiopaque structures visible within the canal on CBCT do not necessarily indicate complete obliteration; residual canal space may still be present. Therefore, even when a canal appears fully calcified on CBCT, it may still be clinically negotiable. To preserve tooth structure, excessive dentin removal should be avoided prior to attempting canal negotiation with endodontic files.

The access cavity preparation stage is critical in managing PCO, as it significantly affects the ability to locate and negotiate the calcified canal while minimizing complications.[9] In this case, a guideline (Fig. 1E) is marked on the buccal surface prior to rubber dam isolation to align with the long axis of the root, providing a visual reference for precise angulation. Under the DOM, initial access is performed using a round bur or diamond bur, following the marked guideline and angling palatally while avoiding contact with the incisal edge (Fig. 1F). This approach differs from the traditional technique of drilling perpendicular to the lingual surface, which may increase the risk of buccal cervical perforation in teeth affected by PCO.

Following dental trauma, PCO is characterized by the progressive deposition of hard tissue within the pulp space, resulting in gradual narrowing of the root canal.[1] Under magnification, this may appear as concentric rings or a target-like pattern centered on the canal (Fig. 1G), a characteristic known as the "bull's eye sign."[10] The central portion of the canal appears darker, surrounded by lighter hard tissue deposits. When a narrow lumen remains at the center of "bull's eye", canal negotiation may be possible using a small C-Pilot file (size 10 or smaller). C-Pilot files, or other rigid instruments made from specially treated stainless steel, offer greater stiffness than conventional K-files, helping to maintain direction during negotiation in calcified or constricted canals. However, in calcified curved canals, pre-curving the file is essential to reduce the risk of ledge formation or perforation. In cases where the canal appears completely calcified within the "bull's eye", fine ultrasonic tips or Munce Discovery burs can be used to selectively remove calcifications, allowing for subsequent canal negotiation with a C-Pilot file.

Post-operative periapical radiograph should be evaluated for the quality of obturation, including length, density, and adaptation of the filling material (Fig. 1H). The image should also be assessed for any signs of procedural complications, such as perforation, ledging, or overfilling.

In summary, although current studies support the promising potential of static and dynamic navigation in managing PCO, freehand methods combined with CBCT, DOM, and fine instruments remain an effective and practical approach when guided by adequate training and thorough preoperative planning.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article to declare.

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References

1. McCabe PS, Dummer PM. Pulp canal obliteration: an endodontic diagnosis and treatment challenge. *Int Endod J* 2012; 45:177—97.
2. Nasiri K, Wrbas KT. Management of calcified root canal during root canal therapy. *J Dent Sci* 2023;18:1931—2.
3. Kapoor A, Alagarsamy R, Lal B, et al. Dynamic navigation in endodontics: scope, benefits, and challenges - a systematic review. *J Endod* 2025 (in press).
4. Huang X, Mao L, Hou B. Locating a calcified root canal with robotic assistance: a case report. *J Endod* 2025 (in press).
5. Sharma S, Haldar P, Kumar V, et al. Learning curve for dynamic navigation procedure during endodontic management of permanent maxillary anterior teeth with pulp canal calcification: a risk-adjusted cumulative summation analysis of a single operator's experience. *J Endod* 2025;51:295—302.
6. Watanabe S, Yabumoto S, Okiji T. Evaluation of root and root canal morphology in maxillary premolar teeth: a cone-beam computed tomography study using two classification systems in a Japanese population. *J Dent Sci* 2025;20:927—35.
7. Nasiri K, Wrbas KT, Kuzekanani M. Managing the second mesiobuccal canal of maxillary first molars. *J Dent Sci* 2024;19: 1886—7.
8. Liu H, Shen Y. Nonsurgical endodontic treatment of a C-shaped, calcified maxillary first molar with five canals and a single fused root. *J Dent Sci* 2024;19:726—8.
9. Long Z, Song R, Zhao C, et al. Quantifiable design and comparative evaluation of straight-line minimally invasive endodontic cavity based on the anatomical features of the coronal part of root canal. *J Dent Sci* 2023;18:1621—9.
10. Liu H, Hieawy A, Shen Y. Endodontic treatment of two calcified mandibular central incisors: a case report. *Cureus* 2024;16: e53066.