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Technique sensitivity and iatrogenic complications of static guided endodontics in a calcified maxillary incisor: a case report

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Abstract
Static guided endodontics is advocated for conservative access in calcified canals; however, its success is highly technique-sensitive and dependent on guide design and bur selection. An 18-year-old male was referred for continuation of endodontic treatment in a discoloured maxillary central incisor without pain or swelling. Clinical and radiographic evaluation revealed a previously attempted endodontic treatment in a calcified canal associated with asymptomatic apical periodontitis and cervical perforation. Static guided endodontics was planned for conservative canal localization; however, intraoperative deviation of the drill path resulted in re-perforation due to guide- and bur-related limitations. The canal was subsequently located conventionally, obturated, and the perforation repaired with mineral trioxide aggregate. Follow-up demonstrated satisfactory healing. This case highlights the technique sensitivity and potential iatrogenic risks of static guided endodontics.

Keywords: Pulp canal obliteration, CBCT, Static guided endodontics, Perforation, MTA

Introduction
A calcified canal, also known as pulp canal obliteration (PCO), calcific metamorphosis (CM), or dystrophic calcification, is a pulpal response to stimuli such as trauma or aging, characterized by the rapid and uncontrolled deposition of hard tissue within the root canal space [1]. The reported incidence ranges from 4% to 24% and is most commonly observed in maxillary anterior teeth, with partial or complete calcification reported in approximately 4% of cases [2].
Dental trauma is the primary etiological factor; however, calcification may also result from physiological aging, deep caries, periodontal disease, pulp capping procedures, and excessive orthodontic or iatrogenic interventions [3]. The need to manage asymptomatic teeth without periapical pathology remains debatable, and periodic observation is often preferred. Intervention becomes necessary when symptoms develop, radiographic evidence of periapical disease is present (7–27% of cases), or the patient reports aesthetic concerns due to discoloration (70–80%) [1].
Treatment goals include conservative and minimally invasive approaches such as guided endodontics to minimize iatrogenic errors, internal bleaching, and restorative management of discoloration. This case report highlights the technical limitations of static guided endodontics in calcified canals and demonstrates how improper bur selection and guide design can lead to iatrogenic complications.

case history
Chief Complaint
An 18-year-old male patient presented with a chief complaint of malaligned teeth in the upper and lower anterior regions. He was referred by a private dental practitioner for continuation of root canal treatment in tooth 11. There was no history of pain or swelling.

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Clinical Examination
Clinical examination revealed a crown fracture involving the incisal edge, discoloration of the tooth, and a restoration in the cingulum area suggestive of a previously attempted root canal treatment. The gingiva appeared normal, firm, and resilient, with no evidence of swelling or sinus tract.

Radiographic Examination
The intraoral periapical radiograph revealed a coronal restoration with evidence of distal cervical perforation suggestive of gauging during access preparation, obliteration of the pulp chamber and root canal, widening of the periodontal ligament space, disruption of the lamina dura, and the presence of a periapical radiolucency in relation to tooth 11, despite the absence of clinical symptoms.

Diagnosis
Based on clinical and radiographic findings, a diagnosis of previously attempted endodontic treatment in a calcified maxillary central incisor with asymptomatic apical periodontitis was established.

Treatment Plan
The treatment plan was made as continuation of root canal treatment followed by management of discolouration in 11. Considering the loss of already existing cervical tooth structure, further dentin removal during conventional access cavity preparation to detect the root canal orifices could adversely affect the prognosis of the tooth. Therefore, static guided endodontics was planned to facilitate conservative canal localization, minimize additional iatrogenic damage, and improve the prognosis of tooth 11.

CBCT clearly showed that the canal orifice was located distally and palatal to the perforation, calcification in the cervical part of the root, middle and apical thirds remained patent (FIGURE -1). An acrylic static guide template was fabricated with the extension from 24 to 34. The template had a thickness of 1.5 mm, and the incisal table—an extension of the guide in relation to tooth 11—was 3 mm to aid correct bur orientation. A 1-mm guide hole was incorporated into the template based on CBCT planning.

After obtaining informed consent from the patient, the local anaesthesia with 2% Lidocaine hydrochloride with 1: 80,000 adrenaline was administered. Rubber dam isolation was achieved with extension from 15 to 25 for optimal isolation and guide stabilization, the perforation site was sealed with MTA, the template was positioned, and the initial entry point was marked, the access was made with round bur after entering into the dentin, the template was positioned and the access was made using long shank slow speed burs (endo tracer from komett) after entering into the desired depth, a #15 K - file was placed and radiograph was taken to confirm the access but it showed incorrect orientation as perforation in the previously repaired site. This indicated a procedural error. This may have been due to an error in guide fabrication or the use of an inappropriate bur.

The rubber dam was removed and checked for any bleeding around the gingiva and after confirming that there is no bleeding the rubber dam isolation was made and the access to canal orifice was made without the template by entering in distal and palatal direction. The root canal orifice was located. The initial binding file was a #15 K-file, working length was measured as 23mm and the canal was enlarged to 30/06 size with rotary NITI constant taper continuous rotation file with copious irrigation of 5.25% sodium hypochlorite, 2ml per instrumentation. The canal was obturated using warm vertical condensation technique. After obturation the Gutta percha was removed in the perforation site and cleaned with 3% sodium hypochlorite and repaired with flowable mineral trioxide aggregate (ENDOCEM MTA, MARUCHI). The access cavity was sealed with light cure glass ionomer cement.

At the 7-day follow-up, there was no history of pain and swelling but there was presence of bleeding on probing around 11. The patient was recalled after 30 days now there was no bleeding on probing around 11. Radiographs showed the presence of a thick barrier around the repaired perforation site, suggestive of healing. The patient was again recalled after 90 days and there was no evidence of bleeding around gingiva and there were no pathological changes in radiograph. The patient was advised for non-vital bleaching for discolouration but deferred this treatment since he is not worried about discolouration and expressed his willingness to continue this treatment after the completion of orthodontic treatment.

Although static guided endodontics was planned, intraoperative limitations in guide design and bur selection resulted in deviation from the ideal guided protocol. The guide was fabricated without a metal sleeve, which contributed to loss of angulation control during drilling. A long-shank tapered bur was used, which proved inappropriate for sleeveless guided access, ultimately leading to re-perforation at the previously repaired site.

Discussion
CBCT plays a crucial role in the management of calcified canals. It helps the clinicians to accurately determine the location, length, and direction of the obliteration, as well as calculate the precise depth and angle required for instrumentation. In other words, it provides a three-dimensional depiction of the internal tooth anatomy, which overcomes the limitations of two-dimensional radiographs like distortion and overlapping [4]. CBCT also detects anatomic variations in the canal and identifies the size, extent and location of the periapical lesions in the tooth. CBCT can be integrated with digital intraoral scans to provide a 3D template for guided endodontics. CBCT can also be used intra operatively by placing a radiopaque marker like gutta percha points. It helps to measure the exact distance and spatial relationship between the marker and the actual canal orifice in all planes [5].

Guided endodontics provides a precise, sleeveless path for the drill, facilitating minimally invasive access that preserves healthy tooth structure and significantly reduces the risk of iatrogenic errors such as root perforations or ledges. The steps involved in static guided endodontics include data acquisition, virtual planning, path design, template fabrication, and clinical verification. High resolution CBCT is performed to obtain DICOM file for the internal anatomy while an intraoral scan or digitized impression provides a Surface Tessellation Language (STL) file of the clinical crowns. These datasets are imported into specialized software (e.g., Blue Sky Plan, Implant Viewer) and superimposed to create a comprehensive 3D model. A virtual drill path is planned by positioning a virtual sleeve over the long axis of the root canal, ensuring the tip reaches the visible part of the patent canal. The designed template is exported as an STL file and 3D-printed or milled using biocompatible resin. Before use, the template's fit and stability are verified intraorally to ensure procedural reliability. The specific burs used include long-neck round diamond burs (e.g., BR 154), long-shank carbide LN burs, and Munce Discovery burs (specifically Size 1) in a low speed (approx. 500–2,000 rpm) with "pecking" or "picking" motions and constant irrigation to prevent overheating [6].

Errors during static guided endodontics may arise from digital workflow, guide stability, or anatomical constraints. Digital workflow errors include inaccuracies during CBCT–intraoral scan integration, design inaccuracies, and fabrication or printing errors [7]. Early detection of errors includes pre-operative digital verification, clinical fit-testing, and intra-operative monitoring to prevent iatrogenic damage, such as root perforations or excessive loss of healthy tooth structure [8]. Static guided endodontics is a highly technique-sensitive procedure, as its accuracy depends on precise digital planning, guide stability, and appropriate bur selection. Any discrepancy in bur–template interaction, particularly when tapered or long-shank burs are used, can lead to binding within the guide and unintended deviation of the drill path. The absence of metal sleeves around the guide hole further increases the risk of template wear and loss of angulation control during access preparation. These limitations are especially pronounced in teeth with calcification in the cervical third, where restricted working space and dense dentin increase resistance to bur advancement, thereby heightening the risk of iatrogenic complications such as root perforation. In this case, the procedural error likely resulted from improper bur selection and use. The absence of a metal collar around the drill hole failed to protect the template during access preparation. Additionally, a tapered bur was used instead of a thin, parallel, narrow long-shank bur such as Munce, Müller, or Messinger burs. The long shank tapered design caused the bur to bind at certain points, and forceful advancement led to damage of the template with a subtle change in angulation, ultimately resulting in perforation.

In this case, perforation occurred in the disto cervical part of the root which was immediately repaired with MTA. Immediate repair of the perforated site is important to prevent bacterial colonization and damage to adjacent periodontal tissues thereby affecting the prognosis of the tooth [9]. The use of bleaching agents does not affect the property of MTA. MTA provides a superior cervical barrier compared with GIC. But bleaching agents may sometimes disrupt the seal between MTA and dentin [10].

Orthodontic tooth movement may influence the healing response of teeth repaired with MTA by altering periodontal attachment and reparative mechanisms. However, available evidence is limited, and further research is required to establish definitive conclusions [11].

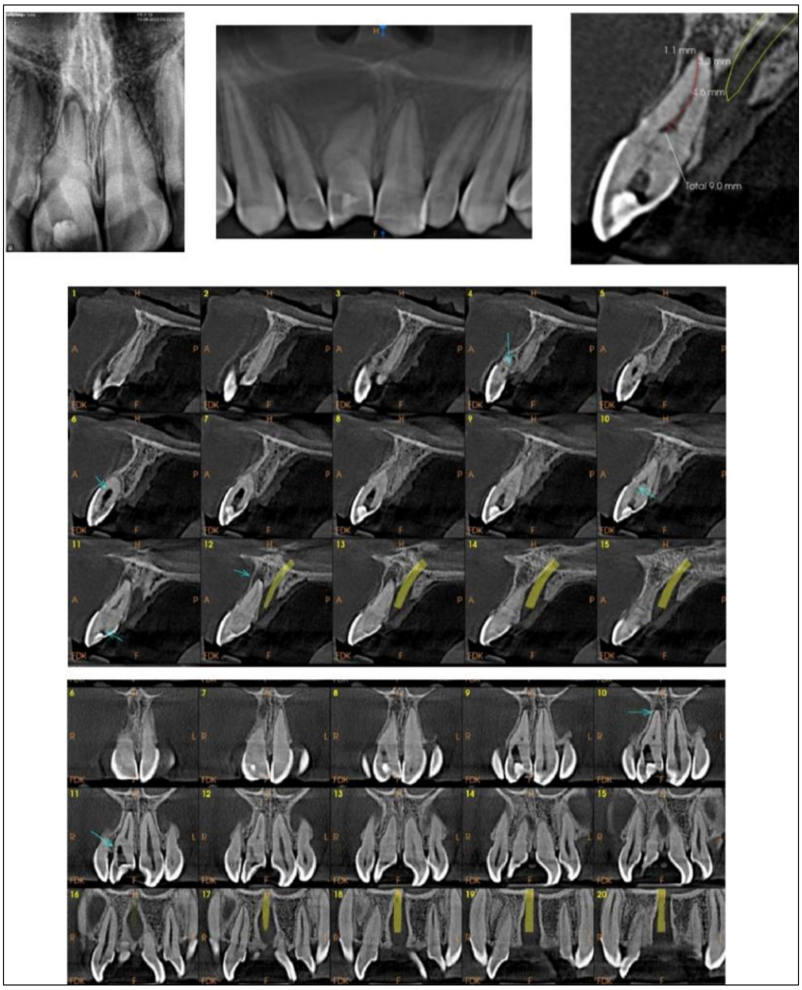
Clinical Significance

Static guided endodontics, though conservative, requires meticulous guide design and appropriate bur selection. Failure to adhere to these principles may result in serious iatrogenic complications

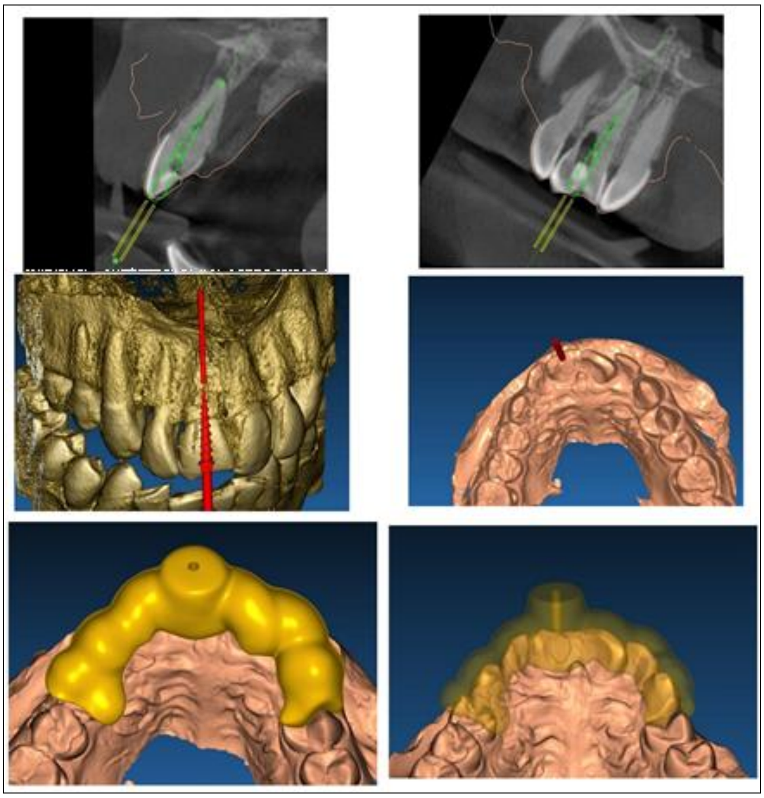
Conclusion

In conclusion, Static guided endodontics should be used cautiously in teeth with cervical calcification. Proper bur selection, use of metal sleeves, and strict adherence to protocol are essential to prevent iatrogenic perforation.

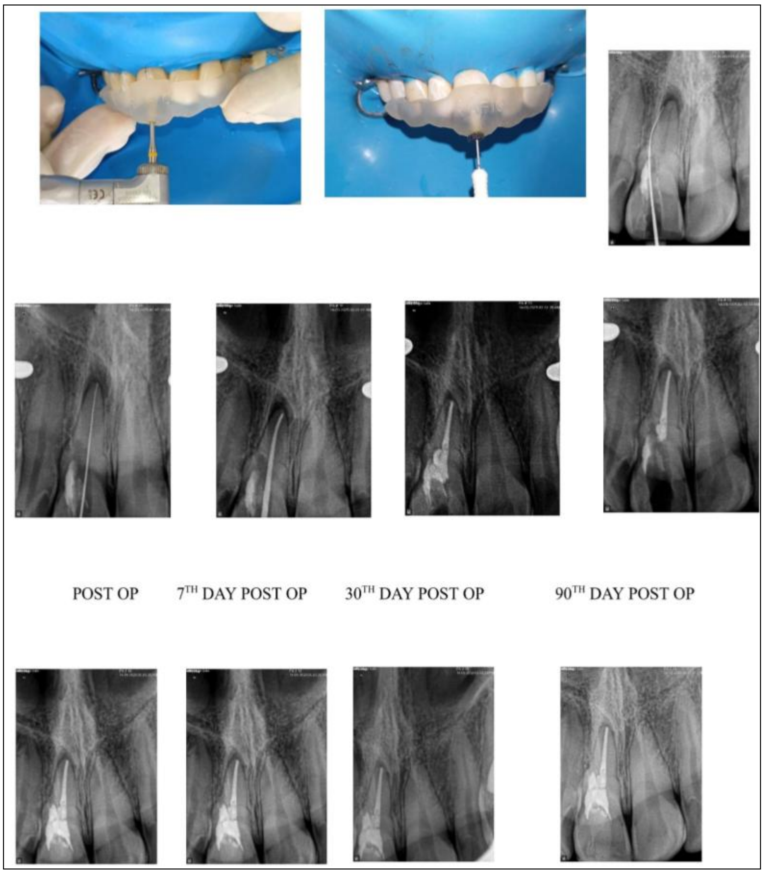
Pre Op Images



Static Guided Template Design



Intra Op and Post OP Images



Conflict of Interest
Not available

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