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Case Report

Dentistry Section

# A Case of Calcific Metamorphosis in Trauma-affected Maxillary Anteriors: A Guided Approach for Success

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## ABSTRACT

Pulp Canal Obliteration (PCO) is a frequent sequela of dental trauma that is defined by the radiographic presentation of augmented dentin deposition, which results in partial or total reduction of the pulp chamber and canal system. While usually asymptomatic, PCO may complicate subsequent endodontic treatment, especially when traditional techniques are used to navigate the calcified canals. Conventional approaches are dependent on the expertise of the clinician and are often associated with risks like perforation and unnecessary removal of tooth structure. Static Guided Endodontics (GE) is a new approach to treating such difficult cases. This method combines Cone-Beam Computed Tomography (CBCT) imaging with Computer-Aided Design (CAD) and 3D printing to create a custom-made guide that guides the access preparation with greater accuracy. By offering a pre-determined path to the canal, static GE reduces the risk of iatrogenic mistakes and enhances overall treatment results. This case report describes the treatment of a 19-year-old male with a history of dental trauma who presented with pain, swelling and discolouration of 11 and tenderness with respect to 21. Clinical and radiographic findings showed calcified canals and apical changes, leading to a diagnosis of pulp necrosis with PCO. GE treatment was planned. The report outlines the diagnostic procedure, planning, and implementation of the treatment.

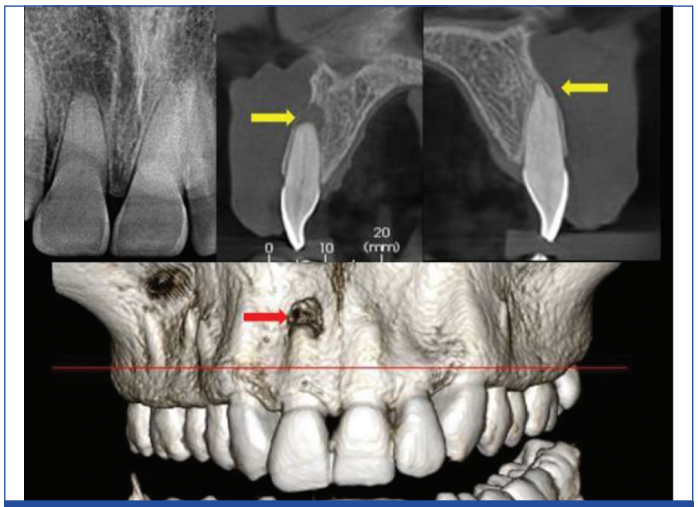
**Keywords:** Cone-beam computed tomography, Endodontic therapy, Pulp canal obliteration

## CASE REPORT

A 19-year-old male reported with pain and intermittent swelling in the maxillary anterior region for three months. He gave a history of pain, which was continuous in nature and aggravated on mastication and relieved on medication. The patient also gave a history of pain on change of posture. Swelling when present was located at the apical region of the right maxillary incisor intraorally. A detailed medical and dental history was taken, which revealed that the patient suffered from sports-related trauma three years ago. At that time, the teeth were asymptomatic and the patient received sutures for lip lacerations.

Clinical examination revealed discoloured 11,21 and a sinus tract present w.r.t 11 [Table/Fig-1]. Tenderness on percussion was positive for 11 and 21. No other soft tissue or hard tissue abnormalities were detected. Intraoral digital radiographs showed calcified pulp chambers and canals in 11 and 21. Tooth 11 also exhibited apical blunting with loss of Periodontal Ligament (PDL) space and lamina dura in the apical third, while 21 showed a widened PDL space. Cold test (Endo-Frost, Coltene-Whaledent) revealed no response w.r.t 11 and 21 compared to contralateral lower anterior teeth. CBCT (Planmeca Romexis, Finland) revealed a traceable but thin canal in 11, with thinning and mild expansion of the buccal cortical plate in the apical third [Table/Fig-2].

**[Table/Fig-1]:** Clinical intraoral photograph showing diffused swelling pointed with a yellow arrow.



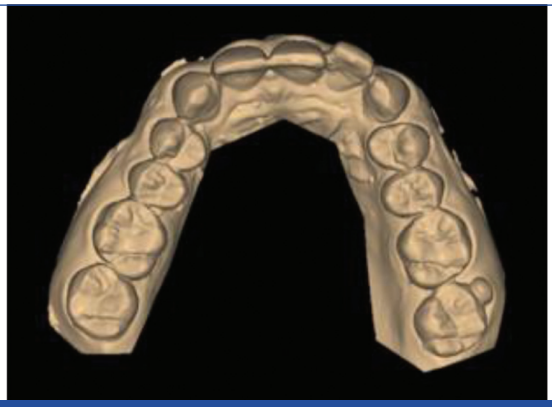

**[Table/Fig-2]:** Pre-operative radiographic investigations- IOPA and CBCT images.

A diagnosis of pulp necrosis with PCO secondary to trauma with respect to 11 and 21 was made. A multi-visit GE treatment was planned with 11 and 21 and informed written consent was obtained. The estimated position of the accessible pulp space in 11, 21 was determined using CBCT images. An epoxy-resin guide was then designed with the help of CAD using the 3Shape Implant Studio™ software (3Shape Implant Suite™). This process involved superimposing the CBCT scan images with intraoral scans to accurately adjust the guide's position and fit. The offset of 0.15 mm was set as the clearance between the guide and the patient's contact surface with a thickness of 3.5 mm [1].

Intraoral scans were obtained using an intraoral scanner (3Shape TRIOS™, 3Shape, Copenhagen, Denmark) and converted into Stereolithography (STL) files. A virtual guide was then created and subsequently 3D printed. The guide was fabricated using a Computer-Aided Manufacturing (CAM) technique [Table/Fig-3-5].

The guide was checked for fit intra-orally, ensuring that the stops on the adjacent teeth were approximating correctly. Local

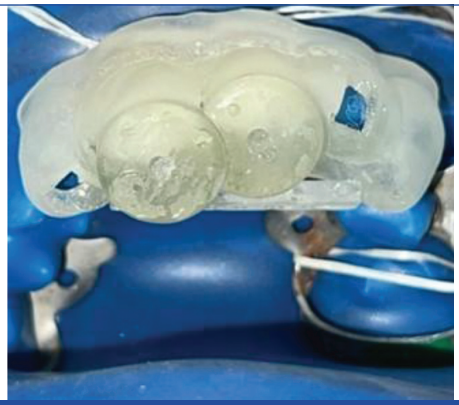
anaesthesia was achieved through infiltration by administering 2% Lignocaine hydrochloride 1:2,00,000 Adrenaline, followed by rubber dam isolation. Access opening was done in 11 and 21 through the stent using Mueller Burs (Brasselar, USA) [Table/Fig-6]. Multiple radiographs were taken during access opening to check the alignment of the bur and to prevent any deviation from the drill path.



**[Table/Fig-3]:** STL file generated from intraoral scan of maxillary arch.

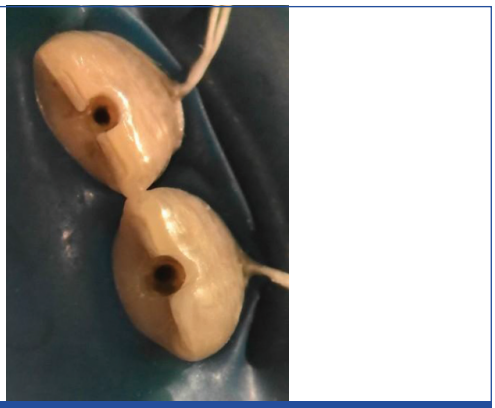
**[Table/Fig-4]:** Guide designed using CAD software.

**[Table/Fig-5]:** A 3D printed guide.



**[Table/Fig-6]:** Intraoral fit of the guide with rubber dam isolation.

Canal patency was achieved using 8C file (Denstply Maillefer, Tulsa, USA). Working length was determined using an electronic apex locator (Woodpex Five, Woodpecker, China) and confirmed radiographically [Table/Fig-7]. Apical preparation was done in both teeth till 25.04 using Hero Shaper Gold rotary files (Micro Mega, France). Copious irrigation was done with a volume of 20 mL divided between 5.25% sodium hypochlorite (Prime Dental, Maharashtra, India), intermittent rinsing using 17% ethylenediaminetetraacetic acid (Prime Dental, Thane, Maharashtra, India), 2% chlorhexidine (Prime Dental) and normal saline as a final rinse 30-gauge side vented needle (NaviTip, Ultradent, USA) for one minute each.



**[Table/Fig-7]:** Access opening using Mueller burs.

The canals were dried with sterile absorbent paper points and intracanal medicament for a period of seven days (RC Cal, Prime Dental products, India). Since the canal was not weeping, an intracanal medicament which is water soluble, effective for a short duration and can be easily removed, i.e., calcium hydroxide in paste form, was chosen. The cavity was sealed with a temporary restoration (Cavit G 3M ESPE™, Seefeld, Germany). In the second appointment, the canals were irrigated as per the protocol mentioned above and dried. Master cone was checked for fit radiographically [Table/Fig-8] and obturation was done using the single cone technique with AH Plus sealer (Dentsply Sirona, USA) [Table/Fig-9].

**[Table/Fig-8]:** Working length determination using 8C file.

**[Table/Fig-9]:** Obturation radiograph.

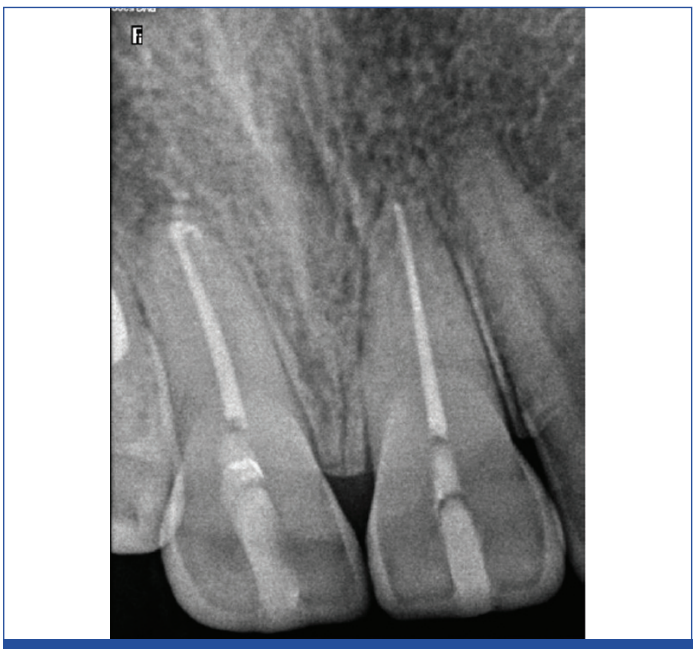
Non-vital bleaching procedure was planned one week after obturation. Gutta-percha was reduced below the Cemento-Enamel Junction (CEJ). A 2-mm thick barrier was made using Glass Ionomer Cement over the gutta-percha and a bleaching agent (Opalescence Endo, Ultradent, USA) was placed into the cavity. The cavity was then sealed with Cavit G. Patient reported seven days later with an

appreciable change in the shade of teeth [Table/Fig-10,11]. Patient was satisfied with the obtained shade and the access cavity was restored after 14 days with nanohybrid composite (Filtek Z350, 3M ESPE, MN, USA). A 2-week [Table/Fig-12] and 10-month follow-up showed no regressive changes in the periapex of 11 and 21 radiographically while clinically the teeth were asymptomatic and in function [Table/Fig-13].

**[Table/Fig-10]:** Shade of the teeth before non-vital bleaching procedure.

**[Table/Fig-11]:** Shade of the teeth after non-vital bleaching procedure.

**[Table/Fig-12]:** Post-obturation restoration.



**[Table/Fig-13]:** 10-month follow-up radiograph.

## DISCUSSION

Traumatic Dental Injuries (TDIs) demand accurate diagnosis, effective treatment planning, and consistent follow-up to ensure favourable outcomes. Maxillary central and lateral incisors are the most commonly affected teeth in these cases [2]. Following a TDI, various pulpal responses may occur, including pulp necrosis, internal resorption, and PCO [2,3].

The PCO, also referred to as Calcific Metamorphosis (CM), is a common sequela of dental trauma, particularly following concussion and subluxation injuries. It is characterised by the progressive layering of dentin-like substance within the canal system, with occasional yellow discolouration of the crown [4-6].

The PCO may present as either total or partial. In total PCO, the outline of the pulp chamber and root canals is hard to decipher on radiographic examination. In partial PCO, the pulp chamber is indistinct, and the root canals appear significantly narrowed but remain visible [7]. It can develop in up to 3.8-24% of traumatised anterior teeth. Despite the structural changes, many of the teeth with PCO remain asymptomatic [8].

Clinical intervention should be considered only in the case of signs and symptoms. Some of these include tenderness to percussion, Periapical Index (PAI) score > 3 and a loss of response to sensibility testing [9].

PCO can be managed using a conventional non-guided approach and a guided approach [10]. The disadvantages of a non-guided approach are the inability to locate the canal, excessive root dentin removal and increased chances of perforation. GE was introduced in 2016 as an alternative to conventional access cavity preparation, especially in cases involving PCO and conditions such as irreversible pulpitis or apical pathosis [9,11].

The findings of the present case closely parallel those reported by Llaquet Pujol M et al., and Krastl G et al., demonstrating a consistent and predictable workflow for managing trauma-induced PCO using static GE [9,11]. In all the case reports, anterior teeth presented with long-standing post-traumatic calcific metamorphosis, loss of pulp sensibility, and radiographic evidence of apical pathology, clinical scenarios in which traditional canal location is difficult and carries a significant risk of iatrogenic errors. Each case employed a similar digital workflow that integrated CBCT imaging with intraoral surface scanning to design a predetermined drill path, followed by fabrication of a 3D-printed template to guide minimally invasive access. Although the guiding systems, bur design, and manufacturing materials varied slightly among reports, the overall protocol remained consistent, involving guided penetration through the calcified segment, early negotiation of the apical canal, rotary instrumentation, and conventional obturation. Krastl used a metal-sleeved guide and Straumann bur, and Llaquet employed various printed/milled guides, whereas the present case utilised a resin guide with Mueller burs and required additional radiographic confirmation. The current case also incorporated a more extensive irrigation protocol and non-vital bleaching, features not included in the earlier reports. All three studies documented favourable clinical and radiographic healing, reinforcing that static GE provides a safe, reproducible, and conservative approach for managing severely calcified canals.

There are two main approaches in GE, namely, static and dynamic GE [12]. In the static method, a fixed surgical guide is created using a combination of CBCT imaging, surface scanning, and virtual planning software. These 3D-printed templates direct the bur along a preplanned path, ensuring precision during access cavity preparation [13].

Dynamic Navigation (DN) utilises real-time guidance throughout the procedure. An optical triangulation system- featuring a stereoscopic motion-tracking camera- tracks the position of a calibrated handpiece in three dimensions. DN systems typically include a mobile device, ceiling-mounted light, motion-tracking camera,

and implant planning software. These components work together to dynamically guide the bur along the planned angle, path, and depth, until the target point within the tooth is reached [13].

The static method offers accuracy and efficiency while lacking flexibility. However, the dynamic method offers the clinician a chance to adapt to the unexpected canal deviation while providing a more minimally invasive approach [13].

Mueller burs (Brasseler, USA) were used here along with a static guide for precise access opening. These carbide burs have long stainless-steel shafts to ensure the highest possible strength and a small round working end of varying size for achieving minimal access.

Guided approach ensures the negotiation of hard-to-find canals without excessive hard tissue loss, especially in the cervical areas-a site prone to root fractures. CBCT makes sure that the alignment of the bur is proper and reduces the chances of straying from the correct path [14].

However, static guides are only effective in straight canals, limiting their use in curved or complex anatomies. The tooth must remain periodontally stable during the CBCT and drilling phase to avoid any possible error due to potential movement [14]. In the current case addition of a metal sleeve to the guide would reduce the chances of bur vibration, which may lead to gauging of the canal wall.

Future directions may point towards more predictable, easy-to-use software for a dynamic guided approach, which may enable the clinician to become more proficient in managing such teeth with PCO.

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