



RESEARCH ARTICLE

USE OF MINERAL TRIOXIDE AGGREGATE FOR THE ENDODONTIC MANAGEMENT OF AN OBLIQUE ROOT FRACTURE IN A PERMANENT MAXILLARY CENTRAL INCISOR: A 15-MONTH FOLLOW-UP CASE REPORT

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Abstract

Oblique root fractures in immature permanent teeth are rare and may be overlooked on conventional radiographs, making diagnosis and management challenging. An 11-year-old boy presented with a complicated crown fracture of the maxillary right central incisor with an immature open apex following trauma. Initial radiographs suggested a horizontal root fracture. Persistent intracanal bleeding and recurrent mobility during follow-up prompted CBCT, which revealed an oblique root fracture with labial displacement of the coronal fragment. The tooth was stabilized with a flexible splint and treated conservatively using mineral trioxide aggregate (MTA) obturation. At 15-month follow-up, the tooth remained asymptomatic, functional, and demonstrated satisfactory healing. CBCT is valuable in diagnosing complex root fractures when conventional radiographs are inconclusive. Conservative management with stabilization and MTA obturation can achieve favorable outcomes in immature permanent teeth.

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Introduction: -

The majority of traumatic dental injuries (TDIs) occur in children and adolescents, where the loss or compromise of a permanent tooth may have significant lifelong consequences. Management of traumatic injuries in younger patients differs from that in adults due to factors such as immature root development, ongoing facial growth, and the need to preserve teeth until growth completion. Traumatic injuries involving permanent anterior teeth are frequently encountered in pediatric patients, with maxillary incisors being the most commonly affected. Root fractures are relatively uncommon with reported prevalence ranging from 0.5% to 7%. These injuries involve damage to the dentin, cementum, and pulp and may present with varying clinical outcomes depending on factors such as the

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location and direction of the fracture, extent of displacement, stage of root development, and pulpal status. The presence of combined traumatic injuries involving the same tooth, such as crown fractures associated with root fractures, may further complicate the prognosis due to the cumulative effects on the structural integrity of the tooth and surrounding periodontal tissues. Mineral trioxide aggregate (MTA) is widely used in pediatric endodontics because of its excellent sealing ability, biocompatibility, and capacity to promote hard tissue formation. However, reports describing MTA obturation for oblique root fractures in immature permanent teeth are limited. This case report presents the clinical and radiographic outcome of the management of a complex traumatic injury involving an oblique root fracture in a permanent maxillary central incisor of an 11-year-old child using MTA obturation, with a 15-month follow-up.

Case Presentation: -

An 11-year-old boy reported to the Department of Pediatric and Preventive Dentistry, PMS Dental College, Thiruvananthapuram, with the chief complaint of a broken upper front tooth following trauma one week earlier. The patient had sustained a fall resulting in injury to the maxillary anterior region, associated with pain and fracture of the upper front tooth. He initially visited a nearby dental clinic, where analgesics and antibiotics were prescribed before being referred for further management. Intraoral examination revealed a complicated crown fracture involving the permanent maxillary right central incisor (11), with a vertical fracture line extending to the gingival margin and bleeding from the gingival sulcus (Fig. 1). The tooth exhibited mobility. Congenitally missing mandibular lateral incisors (32 and 42) were also noted. The child's medical history was non-contributory.

Baseline radiographic investigations included an intraoral periapical radiograph (IOPAR) and an orthopantomogram (OPG) (Fig. 2) to evaluate the extent of injury and rule out associated maxillofacial trauma. The initial IOPAR demonstrated a complicated crown fracture associated with a horizontal fracture line involving the coronal third of the root and an immature open apex in relation to tooth 11 (Fig. 3A). Based on the clinical and radiographic findings, a provisional diagnosis of a complicated crown fracture associated with a horizontal root fracture was made. Considering the immature root development and the clinical presentation, a conservative treatment approach was planned with apexification followed by root canal treatment. Owing to the mobility of the traumatized tooth, stabilization was achieved using a passive flexible splint fabricated with a 0.016-inch stainless steel orthodontic wire bonded to teeth 21, 11, 12, and 22. The patient was scheduled for periodic follow-up at 4 weeks, 6–8 weeks, and 4 months, in accordance with the International Association of Dental Traumatology (IADT) guidelines. The splint was removed at the 4-month follow-up visit.

During the follow-up period, endodontic treatment with respect to tooth 11 was initiated. Following access cavity preparation, canal negotiation, copious irrigation, and biomechanical preparation, profuse intracanal bleeding was encountered. Calcium hydroxide was placed as an intracanal medicament, and the access cavity was temporarily sealed. At the subsequent review visit (8 weeks), persistent bleeding was observed despite completion of biomechanical preparation. The bleeding appeared to originate from granulation tissue communicating through the fracture line, thereby preventing placement of a mineral trioxide aggregate (MTA) apical barrier for apexification. Owing to the unusual clinical presentation and persistent bleeding, the patient was referred to the Department of Oral and Maxillofacial Radiology for further evaluation to assess the possibility of an additional root fracture. Further radiographic assessment demonstrated a fracture line associated with displacement of the coronal fragment and the coronal and middle thirds of the root, with the fractured segments deviating from the long axis of the tooth, raising suspicion of a more complex fracture pattern. Calcium hydroxide was again placed as an intracanal medicament, and a decision was made to obturate the canal with mineral trioxide aggregate at the subsequent appointment.

After achieving adequate hemostasis, mineral trioxide aggregate (Angelus, Londrina, Brazil) was delivered using a MAP System (ProduitsDentaires SA, Vevey, Switzerland) and used as the obturation material up to the cemento-enamel junction (CEJ). (Fig 3b) The coronal portion of the tooth was restored using Ionoseal (VOCO GmbH, Cuxhaven, Germany) as a base, followed by composite resin restoration. At the one-month follow-up after obturation, mobility of tooth 11 had reduced, and the patient remained asymptomatic. However, at the three-month follow-up, increased mobility was noted. The patient reported sustaining a second traumatic episode after being struck in the maxillary anterior region by a football while playing. Periodontal examination revealed an increased probing depth on the labial aspect.



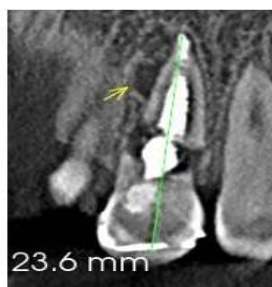
Fig 1



Fig 2



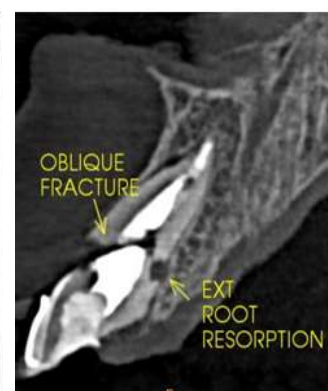
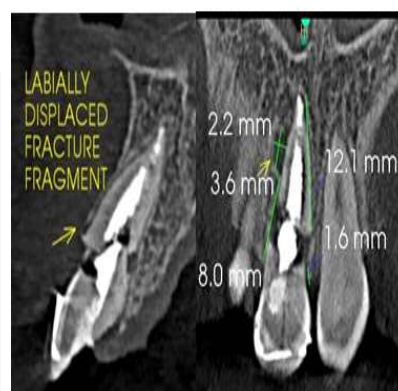
Fig 3 (a)Pre operative (b)MTA obturation (c) After 3month (d) GPplaced through labial aspect showing probing depth of 7 mm



- **Single canal-RG**
WL=23.6mm
- **The apical fragment has shifted toward the distal direction relative to the coronal fragment.**



- **The coronal fragment measures 2mm within the crestal bone and the apical fragment measures 12mm. 1.5 mm separation b/w the two fragments labially.**



Oblique root fracture involves the mesial, distal, labial and palatal surfaces of the root- separating the tooth into 2, along its mid-root level

Fig 4: CBCT IMAGES



CBCT :3D Reconstructed image



FIG 5: SPLINTING DONE

A gutta-percha point was inserted into the periodontal defect; and radiographic tracing demonstrated a probing depth of approximately 7 mm (Fig. 3d). As the clinical findings were inconsistent with the initial radiographic diagnosis cone-beam computed tomography (CBCT) was advised for comprehensive evaluation.

CBCT examination revealed an oblique root fracture involving tooth 11 with labial displacement of the coronal fragment and early external root resorption (Fig. 4). These findings established the definitive diagnosis of a complex crown-root fracture associated with an oblique root fracture, explaining the persistent mobility and periodontal

defect that were not fully appreciated on conventional radiographs. Based on the CBCT findings, additional stabilization was achieved using a lingual flexible splint. (Fig 5) The patient was reviewed clinically and radiographically at regular intervals throughout the follow up period. At the final follow-up, the tooth remained asymptomatic and functional, with no evidence of pain, swelling, sinus tract formation, or pathological mobility., and the tooth remained functional with acceptable esthetics. (Fig 6) In the present case, the tooth exhibited a complex traumatic injury pattern involving a complicated crown fracture with a fracture line extending vertically toward the cemento-enamel junction (CEJ), associated with an oblique root fracture. Such combined crown-root fracture patterns pose a significant clinical challenge due to the difficulty in diagnosis, stabilization of fractured segments, maintenance of coronal seal, and increased risk of complications during healing. The primary objective of treatment is preservation of the affected tooth, maintenance of periodontal health, and promotion of healing between the fractured segments. Management strategies depend on the clinical condition and may include repositioning and stabilization of displaced fragments, periodic monitoring, and endodontic intervention

Discussion: -

Traumatic injuries to permanent anterior teeth are frequently encountered in children and adolescents, with falls, sports-related injuries, and road traffic accidents being the most common causes. Root fractures are relatively uncommon, accounting for only a small proportion of traumatic dental injuries. Their prognosis depends on several factors, including the location and direction of the fracture, degree of fragment displacement, stage of root development, pulpal status, and the time elapsed before treatment. The present case represents a complex traumatic injury involving a complicated crown fracture associated with an oblique root fracture and displacement of the fractured fragments. Such combined injuries present significant diagnostic and therapeutic challenges because the clinical presentation may not correspond to the findings obtained from conventional two-dimensional radiographs. In the present case, the initial intraoral periapical radiograph suggested a horizontal root fracture associated with a complicated crown fracture. However, persistent intracanal bleeding during endodontic treatment, followed by recurrent mobility and increased periodontal probing depth during follow-up, raised suspicion of a more complex injury pattern.

According to the International Association of Dental Traumatology (IADT) guidelines, CBCT should be considered when conventional radiographs do not provide sufficient information for diagnosis or treatment planning. In the present case, CBCT revealed an oblique root fracture with labial displacement of the coronal fragment and early external root resorption, findings that were not clearly appreciated on the initial periapical radiographs. Earlier CBCT evaluation at the time of presentation might have facilitated a more accurate diagnosis and treatment planning, thereby highlighting the importance of three-dimensional imaging in selected cases of traumatic dental injuries where clinical findings and conventional radiographs are inconsistent.

Initial management focused on stabilization of the traumatized tooth using a passive flexible splint in accordance with IADT recommendations. During endodontic treatment, persistent intracanal bleeding prevented placement of an MTA apical barrier. The bleeding was presumed to originate from granulation tissue communicating through the fracture line, reflecting the complexity of the injury. Following adequate hemostasis, MTA was selected as the obturation material instead of conventional gutta-percha obturation. This decision was based on the complex fracture anatomy and the communication between the root canal and periodontal tissues. MTA was considered advantageous because it sets into a hard, stable mass in presence of moisture and provides an effective seal, thereby minimizing communication between the root canal and the surrounding periodontal tissues. Its biocompatibility, bioactivity, and ability to promote hard tissue formation are additional advantages in maintaining a favorable environment for healing in the immature traumatized tooth. Therefore, complete canal obturation with MTA was chosen as a conservative approach to achieve a durable intracanal seal in this case.

The patient sustained a second traumatic episode during follow-up, resulting in increased mobility and periodontal probing depth. These findings necessitated further investigation, ultimately leading to the diagnosis of the displaced oblique root fracture and early external root resorption. Despite these additional challenges, conservative management combined with periodic clinical and radiographic monitoring resulted in preservation of the tooth with satisfactory function and esthetics throughout the follow-up period.

This case underscores the importance of correlating clinical findings with radiographic interpretation and maintaining a high index of suspicion when the clinical course is inconsistent with the initial diagnosis. Early use of CBCT in selected complex traumatic injuries may facilitate timely diagnosis of occult fracture patterns, guide

appropriate treatment decisions, and improve long-term prognosis. Furthermore, the successful use of mineral trioxide aggregate as an obturation material in this case supports its role in conservative management of immature permanent teeth with complex traumatic injuries. However, the predictability of this treatment approach cannot be established from a single case report.

Conclusion: -

Complex traumatic injuries involving a complicated crown fracture associated with an oblique root fracture may not be completely appreciated on conventional radiographs, this case demonstrates the importance of correlating clinical findings with radiographic interpretation and maintaining a high index of suspicion when the clinical course is inconsistent with the initial diagnosis. Timely re-evaluation using cone-beam computed tomography (CBCT) facilitated definitive diagnosis and appropriate treatment planning. Conservative management involving flexible splinting, MTA obturation, restoration, and regular clinical and radiographic monitoring resulted in preservation of the tooth with satisfactory function and esthetics over a 15-month follow-up period. However, the favorable outcome observed in this single case should be interpreted cautiously and does not establish MTA as a predictable treatment for oblique root fractures. Longer-term follow-up and further clinical evidence are required to determine the prognosis and optimal management of similar complex traumatic injuries

Informed Consent

Written informed consent was obtained from the patient's parent/legal guardian for treatment and publication of the case report, including the use of clinical and radiographic photographs.

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