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2 Use of Mineral Trioxide Aggregate for the Endodontic Management of an Oblique Root

3 Fracture in a Permanent Maxillary Central Incisor: A 15-Month Follow-up—A Case

4 Report

7 ABSTRACT

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

20 **Keywords:** Dental trauma; Oblique root fracture, Mineral trioxide aggregate; Cone-beam
21 computed tomography; Conservative management.

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31 **INTRODUCTION**

32 The majority of traumatic dental injuries (TDIs) occur in children and adolescents, where the
33 loss or compromise of a permanent tooth may have significant lifelong consequences.
34 Management of traumatic injuries in younger patients differs from that in adults due to factors
35 such as immature root development, ongoing facial growth, and the need to preserve teeth
36 until growth completion. Traumatic injuries involving permanent anterior teeth are frequently
37 encountered in pediatric patients, with maxillary incisors being the most commonly affected
38 teeth.

39 Root fractures are relatively uncommon with reported prevalence ranging from 0.5% to 7%.
40 These injuries involve damage to the dentin, cementum, and pulp and may present with
41 varying clinical outcomes depending on factors such as the location and direction of the
42 fracture, extent of displacement, stage of root development, and pulpal status. The presence of
43 combined traumatic injuries involving the same tooth, such as crown fractures associated with
44 root fractures, may further complicate the prognosis due to the cumulative effects on the
45 structural integrity of the tooth and surrounding periodontal tissues. Mineral trioxide aggregate
46 (MTA) is widely used in pediatric endodontics because of its excellent sealing ability,
47 biocompatibility, and capacity to promote hard tissue formation. However, reports describing
48 MTA obturation for oblique root fractures in immature permanent teeth are limited.

49 This case report presents the clinical and radiographic outcome of the management of a
50 complex traumatic injury involving an oblique root fracture in a permanent maxillary central
51 incisor of an 11-year-old child using MTA obturation, with a 15 month follow-up.

52 **CASE PRESENTATION**

53 An 11-year-old boy reported to the Department of Pediatric and Preventive Dentistry, PMS
54 Dental College, Thiruvananthapuram, with the chief complaint of a broken upper front tooth
55 following trauma one week earlier. The patient had sustained a fall resulting in injury to the
56 maxillary anterior region, associated with pain and fracture of the upper front tooth. He
57 initially visited a nearby dental clinic, where analgesics and antibiotics were prescribed before
58 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 cementoenamel 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.(Fig 3c)

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. 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 had not been 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 for a period of 9 months. 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 cementoenamel 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

123 of complications during healing. The primary objective of treatment is preservation of the
 124 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

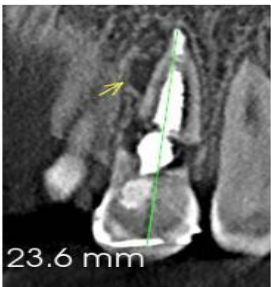


intervention when indicated

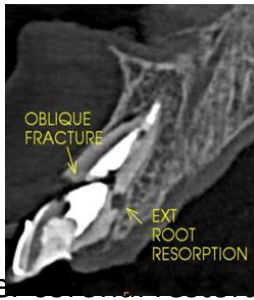


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Fig 1:pre operative



- **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.**



7 mm



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

Discussion

Traumatic injuries to permanent anterior teeth are frequently encountered in children and adolescents, with falls, sports-related injuries, and road traffic

141 accidents being the most common causes. Root fractures
142 accounting for only a small proportion of traumatic dental injury
143 on several factors, including the location
144 and direction of the fracture, degree of
145 fragment displacement, stage of root
146 development, pulpal status, and the time
147 elapsed before treatment.

FIG 5:SPLINTING DONE on, nds



148 The present case represents a complex traumatic injury involving a complicated crown
149 fracture associated with an oblique root fracture and displacement of the fractured fragments.
150 Such combined injuries present significant diagnostic and therapeutic challenges because the
151 clinical presentation may not correspond to the findings obtained from conventional two-
152 dimensional radiographs. In the present case, the initial intraoral periapical radiograph
153 suggested a horizontal root fracture associated with a complicated crown fracture. However,
154 persistent intracanal bleeding during endodontic treatment, followed by recurrent mobility
155 and increased periodontal probing depth during follow-up, raised suspicion of a more
156 complex injury pattern.

157 According to the International Association of Dental Traumatology (IADT) guidelines, CBCT
158 should be considered when conventional radiographs do not provide sufficient information for
159 diagnosis or treatment planning. In the present case, CBCT revealed an oblique root fracture
160 with labial displacement of the coronal fragment and early external root resorption, findings
161 that were not clearly appreciated on the initial periapical radiographs. Earlier CBCT
162 evaluation at the time of presentation might have facilitated a more accurate diagnosis and
163 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 because of its excellent sealing ability, biocompatibility, bioactivity, and ability to promote hard tissue formation. These properties make MTA a suitable material for the management of immature permanent teeth with traumatic injuries requiring conservative endodontic treatment.

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 as a predictable biomaterial in the conservative management of immature permanent teeth with complex traumatic injuries.

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.

196 Conservative management with stabilization, mineral trioxide aggregate obturation, and
197 regular follow-up resulted in preservation of the tooth with satisfactory clinical and
198 radiographic outcomes over a 12-month follow-up period.

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