IEJ Iranian Endodontic Journal

Complex Dentoalveolar Trauma in a Growing Patient: Management of Avulsion and Alveolar Fracture

Pourya Esmaeelpour [a], Maryam Forghani [a], Fatemeh Zourmand Ghasemi [a*]

[a] Department of Endodontics, Faculty of Dentistry, Mashhad University of Medical Sciences, Mashhad, Iran

Article Type: **Case Report**

Received: 10 Feb 2026
Accepted: 06 Apr 2026
Published: 21 Apr 2026
Doi: *10.22037/iej.v21i1.50396*

****Corresponding author***: Fatemeh Zourmand Ghasemi, Vakilabad Blvd., Faculty of Dentistry, Mashhad University of Medical Sciences, Mashhad, Iran.

E-mail: zourmandF4031@mums.ac.ir

Abstract

Traumatic dental injuries (TDIs) involving both tooth avulsion and alveolar fracture present significant clinical challenges, particularly in growing patients, where long-term restorative planning must accommodate ongoing craniofacial development. This report describes the multidisciplinary management of an 11-year-old boy who sustained avulsion of tooth #21 and an associated alveolar fracture following a sports-related injury. Clinical and cone-beam computed tomography evaluations revealed an alveolar segment fracture extending from teeth #12 to #21. The displaced segment was manually repositioned and stabilized using a flexible composite and wire splint. Subsequent loss of pulpal vitality in teeth #11 and #12 was managed by root canal treatment with interim calcium hydroxide therapy. Given the patient's incomplete skeletal growth, a minimally invasive Maryland bridge was selected to replace the missing tooth #21. Clinical and radiographic follow-up at 6 and 12 months demonstrated normal healing of the alveolar bone and periodontal structures, with no evidence of root resorption or ankylosis. Successful management of complex dentoalveolar trauma in growing patients requires early diagnosis, appropriate splinting, endodontic intervention when indicated, and growth-conscious prosthetic rehabilitation. Long-term follow-up is essential to monitor healing and plan future definitive treatment.

Keywords: Alveolar Fracture; Avulsion; Dentoalveolar Trauma; Maryland Bridge; Traumatic Dental Injuries

Introduction

Traumatic dental injury (TDI) is a significant orofacial injury, with reported incidence rates ranging from 18% to 30%. Adolescents, particularly those aged 11 to 15 years, exhibit a higher susceptibility, with a prevalence of approximately 13% [1]. Falls are the most common cause of TDIs, followed by incidents related to fights, sports, and accidents, respectively [2]. Moreover, maxillary incisors are the most frequently affected teeth in dental trauma [3, 4] and they play an important role in the individuals' aesthetics and function. TDI complications are categorized into periodontal and pulpal complications. Periodontal complications, such as external root resorption, surface resorption, and replacement resorption, are more frequent than pulpal complications, such as pulp necrosis and internal root resorption. Research indicates that the type of trauma, time of consultation, and stage of root development are factors influencing complication rates [5, 6]. Timely identification, comprehensive assessment and appropriate treatment are necessary to maximize the chances of maintaining pulpal and periodontal health [7]. Given that oral health is an integral component of general well-being, untreated dental damage in children is associated with decreased satisfaction with appearance and reduced self-esteem, potentially leading to significant social issues, such as impaired ability to engage in social, professional, and daily activities [8]. Avulsion, the complete displacement of a tooth, and alveolar fracture, a fracture of the facial or oral socket wall, are severe forms of TDI associated with a significant risk of complications highlighting the importance of proper management.[9]. This case report describes the treatment procedures of a patient presenting with both maxillary central incisor avulsion and alveolar fracture.

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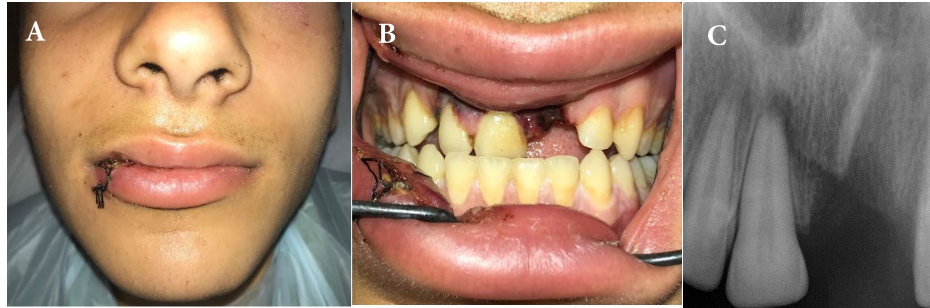

Figure 1. Preoperative images: *A*) Extraoral; *B*) Intraoral; *C*) Radiographic view of the traumatized region

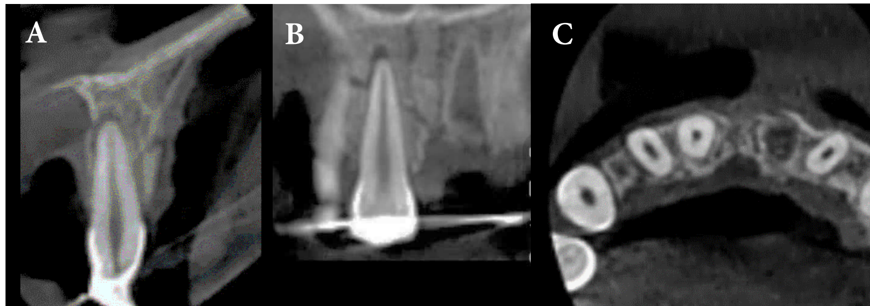

Figure 2. Preoperative CBCT views of the traumatized region: *A*) Sagittal; *B*) Coronal; *C*) Axial view

Case Presentation

An 11-year-old Persian male patient with no significant medical history presented to the Department of Endodontics, School of Dentistry, Mashhad University of Medical Sciences, Iran, with severe dentoalveolar trauma sustained during a boxing-related sport accident 48 h prior. This had resulted in the avulsion of tooth #21. Attempts to locate the avulsed tooth were unsuccessful at the scene of the accident. There was no history of loss of consciousness, seizures, or otorrhagia/epistaxis. The patient was initially evaluated at a regional hospital where the lip laceration was sutured, and was subsequently referred with the chief complaint of anterior maxillary teeth mobility.

Extraoral examination revealed facial symmetry with diffuse swelling in the upper lip region (Fig.1). Intraoral examination demonstrated grade 3 mobility of the teeth #11 and #12, and avulsion of tooth #21 (Fig. 1). Initial pulp sensibility testing was performed using two methods:

1. Cold test with an ethyl chloride–based refrigerant spray (Luber Cool; Rasa Dent, Tehran, Iran) applied to a cotton pellet placed on the mid-facial surface, with tooth isolation using cotton rolls;
2. Electric pulp testing (EPT) with a Digitest II unit (Parkell, Farmingdale, NY, USA), with the electrode on the incisal third of the labial surface and toothpaste as a conducting medium.

   Responses were recorded quantitatively (Cold test: scale 0–4; EPT: scale 0–10) for each tooth. At baseline (Day 0), teeth #11 and #12 demonstrated diminished responses compared with the control tooth #14 (Cold=2; EPT=7). Percussion and palpation tests elicited a severe response in teeth #11 and #12. Radiographic examination using varying vertical angulations, along with cone-beam computed tomography (CBCT), revealed an alveolar fracture line extending from the mesial socket of tooth #21 to the mesial aspect of tooth #12 at the apical third. Periodontal ligament (PDL) widening was evident in teeth #11 and #12 (Fig. 2).

The patient's parents were informed of the potential risks, benefits, and guarded prognosis associated with the proposed treatment, and informed written consent was obtained. Following local infiltration of 2% lidocaine with 1:80,000 epinephrine (Darupakhsh, Tehran, Iran), the displaced alveolar segment was manually repositioned. The mobile segment was stabilized using a passive flexible composite-and-wire splint (0.4 mm diameter) in accordance with the American Association of Endodontists (AAE) guidelines (Fig. 3). Oral hygiene and diet instructions were provided, chlorhexidine mouthwash was prescribed, and the patient was discharged under parental supervision.

At the two-week follow-up, teeth #11 and #12 continued to respond to pulp sensibility tests, albeit with reduced readings compared with baseline. After four weeks, the splint was removed; pulp sensibility testing at this stage demonstrated no response in both teeth #11 and #12, consistent with pulp necrosis. A summary of the sequential test findings is presented in Table 1.

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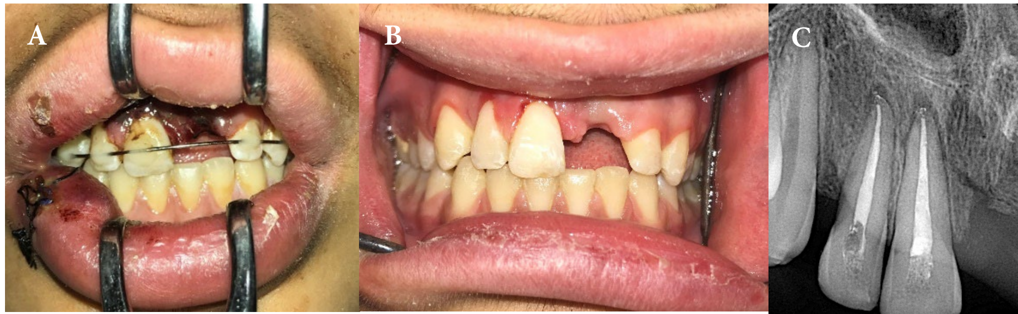

Figure 3. *A*) Stabilizing teeth by a titanium splint; *B*) Removing splints 4 weeks later; *C*) Root canal treatment of traumatized teeth

The endodontic treatments were performed in two visits. After the administration of local anesthesia, rubber dam isolation was achieved; however, due to slight mobility and to avoid applying additional traumatic forces, the split-dam technique was used. The access cavities were then prepared using a high-speed handpiece with a round diamond bur under water spray. The working lengths were determined using an electronic apex locator (Dpex; Woodpecker, Guilin, China) and confirmed radiographically. The canals were prepared using the rotary ProTaper system (Denco, Shenzhen, China) with the crown-down technique. During instrumentation, 5 mL of 5% sodium hypochlorite was used in each canal and ultrasonically activated for 20 sec using a 45 kHz Ultra X device (Eighteeth Medical Technology, Changzhou, China).

At the end of the first visit, the canals were dried with sterile paper points and medicated with calcium hydroxide paste (Golchadent; Golchai, Iran). The access cavities were sealed with temporary filling material (Cavisol; Golchai, Iran), and the patient was recalled after one week.

At the second visit, after rubber dam isolation, the calcium hydroxide dressings were removed by irrigation with 5 mL of 5% sodium hypochlorite, which was similarly activated for 20 sec with the same Ultra X device, followed by a final rinse with normal saline. Master cone radiographs were taken to confirm proper working lengths. The root canals were dried and obturated using the warm vertical condensation technique with gutta-percha and AH-26 sealer (Dentsply DeTrey, Konstanz, Germany). Final radiographs were obtained to verify obturation quality. The access cavities were sealed with temporary restorative material (Cavisol; Golchai, Iran). Finally, the teeth received their definitive composite restorations in the restorative department. Definitive treatment options for the missing tooth #21 were discussed, including: orthodontic space closure, implant placement, prosthetic replacement, auto-transplantation, and a Maryland bridge. Considering the patient's incomplete dental and skeletal growth, the Maryland bridge was selected. The patient was referred to the Aesthetics and Restorative Dentistry Department, where a Maryland bridge was fabricated (Fig. 4). At the 6- and 12-month follow-ups, the Maryland bridge was stable with healthy surrounding tissues. The patient strictly followed the instructions to avoid direct chewing on the bridge and maintained excellent oral hygiene, which contributed to the preservation of the periodontium. The restoration remained functionally sound and maintained its esthetic quality throughout the observation period without complaint (Figs. 4 & 5).

Discussion

TDIs present significant health, economic, and psychosocial challenges in children and adults, requiring treatments that are often lengthy, costly, and carry a considerable risk of failure, thus placing a substantial burden on healthcare resources, patients, and their families. Furthermore, while TDIs are common worldwide,

Table 1. Sequential pulp sensibility test responses (Cold test: 0–4; Electric pulp test (EPT): 0–10) of teeth #11, #12, and the control tooth (#14) were recorded at baseline, 2 weeks, and 4 weeks

Visit	Time Point	Tooth	Cold Test (0–4)	EPT (0–10)
1	Day 0	11	2	8
		12	2	7
		14 (Control)	3	6
2	2 weeks	11	1	9
		12	1	8
		14 (Control)	3	6
3	4 weeks	11	0	0
		12	0	0
		14 (Control)	3	6

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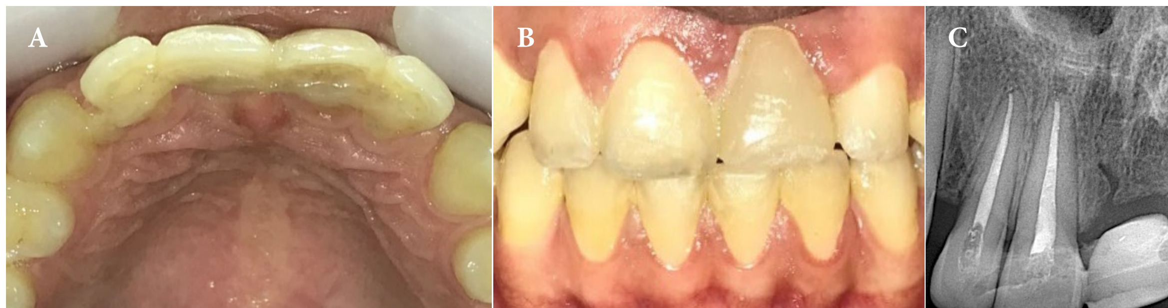

Figure 4. *A)* Occlusal; *B)* Frontal view of Maryland Bridge; *C)* 6-month follow-up radiographic evaluation

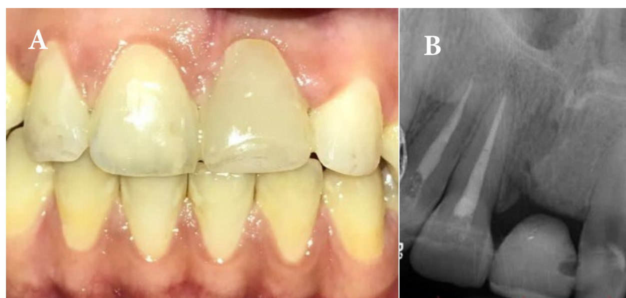

Figure 5. Twelve-month follow-up evaluation; *A*) Frontal view; *B*) Radiographic evaluation

their occurrence varies depending on social, behavioral, and cultural factors. The lack of consistent registration and classification methods hinders effective study and comparison of research findings [10, 11].

According to Andreasen [9], TDIs are categorized into four main groups: injuries to the hard dental tissues and pulp, injuries to the periodontal tissues, injuries to the supporting bone, and injuries to the gingiva or oral mucosa. TDIs involving supporting bone are more common in adults and can include the following types: comminution of the alveolar socket, fracture of the alveolar socket wall, fracture of the alveolar process, fracture of the mandible, or maxilla. Our case suffered from a fracture of the alveolar process and the alveolar socket. This pattern of injury indicates a high-energy impact transmitted through the alveolar segment, which can disrupt the blood supply of adjacent teeth and set the stage for pulpal necrosis despite prompt repositioning.

Thorough extraoral examination and site-specific examination of hard tissue and teeth are inseparable parts of the evaluation of TDI cases [9, 12]. Intraoral examination in TDIs often reveals pain, altered occlusion (potentially with premature contacts), displacement of adjacent teeth, gingival lacerations, step deformity, tenderness, and negative pulpal test results in the acute phase [7], which were consistent with the findings in the present case. In this patient, the simultaneous movement of both central incisors was an objective clinical sign of alveolar segment involvement combined with diffuse upper lip swelling, which confirmed an alveolar fracture and guided the management approach.

Radiographic evaluation is essential for diagnosing TDIs. Although periapical and occlusal radiographs are useful, CBCT provides more accurate data, particularly when conventional radiographs provide inadequate information [9, 13]. In this case, periapical radiographs were sufficient for confirming segment alignment after repositioning, but long-term follow-up radiographs remain crucial for the early detection of root resorption or alveolar bone remodeling.

Immobilization is a key component of TDI management, with various dental trauma splints (DTS) available, including composite and wire splints, orthodontic wire and bracket splints, titanium trauma splints, fiber splints, arch bar splints, wire ligature splint, and composite splints. While arch bar, ligature, and composite splints are considered rigid, semi-rigid splints are advantageous as they allow for periodontal recovery and minimize ankylosis risk [14]. This is because the controlled stress from semi-rigid splints promotes collagen production and maintains blood circulation in the periodontal ligament, whereas prolonged rigid splint use can lead to ankylosis and resorption due to the lack of physiological tooth movement [15]. Ideally, splints should be flexible and allow some tooth mobility to facilitate optimal healing. One such splint with favorable mechanical characteristics is a wire composite splint, which was selected in the present case [16]. The semi-rigid nature of this splint permitted physiologic mobility while maintaining stability of the alveolar segment, optimizing conditions for revascularization and soft tissue repair.

Among manual, surgical, and orthodontic repositioning techniques, manual and surgical repositioning involve different levels of operator control over applied forces [1]. The manual approach is particularly advantageous when the traumatized tooth is displaced palatally, resulting in occlusal interferences, as was evident in our case. When manual repositioning of the dislocated tooth is impossible, orthodontic repositioning is advised, and its particular benefit is the application of extremely light and controlled forces [1, 17].

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Common complications observed after dental trauma include pulpal necrosis, which is the most common/earliest complication, usually occurring within the first year after trauma [3, 5, 6]. Other sequelae include root resorption, which may progress silently for months or years; pulpal canal obliteration (PCO), a para-physiologic defense mechanism characterized by progressive dentin deposition [1, 18]; and ankylosis, representing replacement resorption with osseous fusion of the root surface, often following severe trauma.

In our case, pulp canal necrosis due to severe trauma was managed with calcium hydroxide therapy for two weeks, followed by root canal treatment. Calcium hydroxide is valuable as a subsequent medicament to encourage hard tissue repair and prevent external root resorption [19]. Despite timely endodontic intervention, long-term radiographic monitoring is essential because growing patients demonstrate continuous alveolar development that may mask or aggravate future resorptive changes.

Several factors influence the likelihood and seriousness of these complications. The type and severity of the injury play a key role. Severe displacement, such as in lateral luxation, can disrupt the vascular supply, leading to pulp necrosis as seen in our case [5, 20]. Another critical determinant is the stage of root development; immature teeth possess superior revascularization capacity, whereas mature teeth, like those in this case, are more prone to necrosis and less likely to show spontaneous pulp healing. Conversely, immature roots tend to undergo pulp canal obliteration due to continued odontoblastic activity [1, 3, 12].

In growing patients with missing teeth, the choice of prosthetic replacement must carefully balance esthetic, functional, and biological considerations, since ongoing craniofacial development limits the use of definitive restorative options. Although dental implants are typically the preferred option for replacing a single missing tooth, a conservative approach is generally recommended for patients with developing jaws. This is due to the ongoing growth and changes in jaw structure, which may affect the long-term stability and positioning of implants [21]. In such growing patients, the choice of prosthesis must also account for biological preservation and the possibility of future modifications as growth continues. Resin-bonded bridges (RBBs), such as the Maryland bridge used in our case, represent a reliable and conservative method for tooth replacement that restores both esthetics and function, thereby enhancing patient satisfaction. Due to the risk of implant ankylosis and interference with alveolar development, implants are contraindicated in children and adolescents [22]. In this context, the Maryland bridge provided distinct advantages, including reversibility and no interference with ongoing alveolar growth, making it a suitable interim prosthesis until skeletal maturity is reached. However, certain clinical selection criteria must be satisfied to ensure optimal outcomes. These include good oral hygiene, teeth in their final occlusal position, absence of parafunctional habits, no periodontal mobility or heavy occlusal loading on the abutment tooth, and unrestored or minimally restored abutment teeth. Despite potential complications such as debonding, advances in resin cements and surface conditioning methods have significantly enhanced the longevity and success rate of resin-bonded prostheses [23]. In the present case, the Maryland bridge achieved favorable esthetic harmony with adjacent teeth, and the patient expressed high satisfaction with the esthetic result, reinforcing the clinical practicality of this conservative and reversible treatment option in growing individuals.

Finally, the case stresses the significance of preventive strategies: in contact sports like boxing, custom-made mouth guards remain the most effective evidence-based measure to prevent dentoalveolar trauma and its associated social and economic burdens.

Conclusion

This case report details the successful multidisciplinary management of a complex dentoalveolar trauma in an 11-year-old male following a boxing-related incident, notably complicated by a 48-hour delay in presentation and the presence of an alveolar fracture alongside tooth avulsion. The key to the favorable outcome stability maintained at 12 months was the immediate, precise manual repositioning of the compromised alveolar segment, followed by stabilization with a flexible wire-composite splint, aligning with the need for controlled mobility to promote periodontal healing. Furthermore, the necessity of a growth-sensitive prosthetic plan was confirmed by the selection of a Maryland bridge for the missing maxillary central incisor, thus avoiding interference with ongoing craniofacial development. This case underscores the critical role of thorough diagnostic imaging (CBCT) in identifying subtle bone injuries and reinforces that a conservative, phased approach addressing acute stabilization, subsequent endodontic care for adjacent teeth, and patient-specific provisional prosthetics is paramount for achieving functional and aesthetic success in managing severe dental trauma in growing individuals.

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Acknowledgements
None.

Conflict of interest
None.

Funding support
None.

Authors' contributions
Conceptualization: PE; Methodology: MF/PE; Formal Analysis and Investigation: PE/FZG; Writing; Original Draft Preparation: PE/MF/FZG; Writing; Review and Editing: FZG; Supervision: MF. All authors read and approved the final manuscript

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Please cite this paper as: Esmaeelpour P, Forghani M, Zourmand Ghasemi F. Complex Dentoalveolar Trauma in a Growing Patient: Management of Avulsion and Alveolar Fracture. Iran Endod J. 2026;21(1): e10. Doi: 10.22037/iej.v21i1.50396.

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