World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(REVIEW ARTICLE)

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Approaches to Managing Traumatic Dental Injuries in Permanent Teeth: Narrative Review

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World Journal of Advanced Research and Reviews, 2025, 28(02), 2358-2363

Publication history: Received on 19 October 2025; revised on 24 November 2025; accepted on 27 November 2025

Article DOI: https://doi.org/10.30574/wjarr.2025.28.2.3987

Abstract

Background: Dental trauma in permanent teeth often occurs in children and adolescents, with various clinical manifestations ranging from enamel infraction to avulsion. Understanding management and concept of dental trauma is crucial to achieve good treatment, then discussing the management-concept is needed.

Purpose: This literature review aims to summarize current concepts and treatment options for permanent tooth injuries, focusing on clinical decision-making based on the extent of dental trauma.

Result: Management of dental trauma depends on the type and severity of injury. Enamel infractions may require no treatment, while fractures can be treated with composite restorations or fragment reattachment. Pulp involvement requires pulp capping, pulpotomy, or root canal treatment depending on root maturity. Luxation and avulsion require immediate repositioning or replantation, with splinting and long-term monitoring of pulp vitality.

Conclusion: Proper diagnosis and immediate management are crucial to ensure favorable outcomes in dental trauma cases.

Keywords: Dental Trauma; Permanent Teeth; Fracture; Luxation; Human & Health

1. Introduction

Traumatic dental injuries (TDIs) represent a significant public health problem, particularly among children and adolescents. Epidemiological studies indicate that the global prevalence of TDIs ranges from 20% to 30% in children, and nearly half of children will experience a dental injury before the age of 18. Maxillary central incisors are the most commonly affected due to their anterior position and incomplete root development. Despite the oral region comprising only about 1% of the body area, it reports for nearly 5% of all bodily injuries [1–4]

Beyond the immediate aesthetic and functional consequences, TDIs can result in severe complications, such as pulp necrosis, root resorption, and malocclusion, which negatively affect long-term oral function and quality of life. Moreover, psychological impacts, including dental anxiety, and daily activity difficulties, are also frequently reported following traumatic dental incidents [4]. The etiology of TDIs is multifactorial, including falls, traffic accidents, harassment, and

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sports contact [5]. A retrospective study conducted at the University Dental Clinic of Vienna found that falling accidents accounted for 63.1% of TDI cases, with upper central incisors being the most commonly affected teeth [1].

Pediatric dentist and general practicers often serve as the first gate to receive the case, doing early diagnosis, and treatment [6]. However, standardize the guidelines is needed. Therefore, this literature review aims summarize current concepts and treatment options for permanent tooth injuries, focusing on clinical decision-making based on the extent of dental trauma.

2. Research methods

This manuscript was prepared as a narrative literature review. A comprehensive search of the scientific literature was conducted to identify relevant publications related to traumatic dental injuries (TDIs) in permanent teeth. Searches were performed in PubMed, Google Scholar, Scopus, Text book and ScienceDirect using keywords such as “dental trauma,” “traumatic dental injuries,” “permanent teeth,” “tooth fracture,” “luxation injuries,” “avulsion,” “pulp management,” and “IADT guidelines.” Relevant data were synthesized qualitatively. Ethical approval and informed consent were not required since this review did not involve human or animal subjects.

3. Results

The management of traumatic dental injuries (TDIs) involves several essential steps that guide clinicians from initial assessment to definitive treatment, including minimizing anxiety in both the child and parent at the first visiting, obtaining history, performing a thorough extraoral and intraoral clinical examination, providing appropriate first-aid measures, and finally delivering the specific treatment required for the identified injury [7,8]

Management of traumatic dental injuries in children is often distressing for both the child and the parents, and can also be challenging for the dental team. Because a TDIs may represent the first-ever dental visiting for children, then minimizing anxiety during the initial visiting becomes essential. Children frequently receive extensive examination, radiographs, or treatment, making a good environment and gentle behavior are crucial for gaining cooperation. Techniques such as the knee-to-knee examination can assist in assessing very young children when the patient is not too cooperative. The treatment care such as perform diagnosis, manage pain, and follow up care should ideally be provided by a child friendly approach [7,8]

Taking a history is a fundamental component of dental trauma assessment and must be carried out promptly and accurately before proceeding to clinical examination. Essential information includes basic personal details, chief complaint, and symptoms such as pain on biting, mobility, or sensitivity, which may indicate displacement or pulpal involvement. Medical history, including tetanus immunization status, should always be recorded, along with any relevant previous dental experiences. Because trauma may sometimes be associated with neurological injury, the child should be observed from the moment they enter the clinic for signs such as lethargy, confusion, vomiting, headache, abnormal pupil responses, or clear discharge from the ears or nose. Identifying these symptoms early helps determine whether emergency medical is required and ensures that dental management proceeds safely.[7,8]

Clinical examination of traumatic dental injuries in young children can be challenging, particularly when the child is frightened or uncooperative. The appearance of the injury may also seem more severe to the parents, as even a small amount of blood mixed with saliva can give the impression of heavy hemorrhage. A knee-to-knee or lap examination is useful for gaining clear access to the mouth when the child cannot sit in a dental chair. After gently cleaning the area, the assessment begins with extraoral inspection for swelling, lacerations, mandibular deviation, or signs suggesting facial fractures. Intraoral evaluation includes checking soft-tissue injuries, embedded fragments, tooth mobility, displacement, occlusal disturbances, and possible alveolar or root fractures. Crown discoloration should also be noted as it may indicate pulpal changes. Because pulp testing in young children is often unreliable immediately after trauma, vitality must be monitored over time [7,8]

First-aid management in orofacial trauma begins with ensuring that the airway remains clear, as bleeding can obstruct breathing in young children. Deep lacerations should be sutured under local anesthesia using appropriate materials such as chromic black silk and the affected area must be thoroughly cleaned and irrigated to reduce debris and infection risk. Topical antiseptics such as chlorhexidine or iodine may be used to lower bacterial contamination, while fluid replacement is considered when significant blood loss is present. Systemic antibiotics may be considered when TDIs soft-tissue wounds are contaminated, surgical intervention is extensive, or when the child’s medical condition warrants additional protection. Tetanus status should also be reviewed in cases involving environmental contamination, as a

booster or tetanus immune globulin may be needed depending on immunization history. These early measures help stabilize the child and prepare the injured area for further dental evaluation and treatment [7,8]

This manuscript will describe how to manage various cases of dental injuries such as enamel infraction, fractures, luxation injuries, root fractures, and avulsions, with treatment protocols depending on pulp involvement and root development stage [4,9].

4. Discussion

Effective early management of traumatic dental injuries in children requires more than simply following clinical steps. It relies on how well the clinician manages the child's emotions, gathers accurate information, and responds to urgent concerns. The first visit often sets the information and some treatment process. When a child or parent is anxious, cooperation becomes difficult, which can result in an incomplete examination or misinterpretation of symptoms. Creating a calm or good environment through gentle communication and supportive interaction with the parent is essential for obtaining reliable findings and making appropriate decisions [7,8]

A complete trauma history is equally important because it guides the clinician in determining the next steps. Details such as how the injury occurred, when it happened, and whether there were any neurological symptoms influence the urgency of care, the need for radiographs, and the possibility of medical referral. Missing critical information, such as the extra-oral dry time in an avulsion case, can lead to incorrect treatment choices or a failure to recognize complications early [7,8]

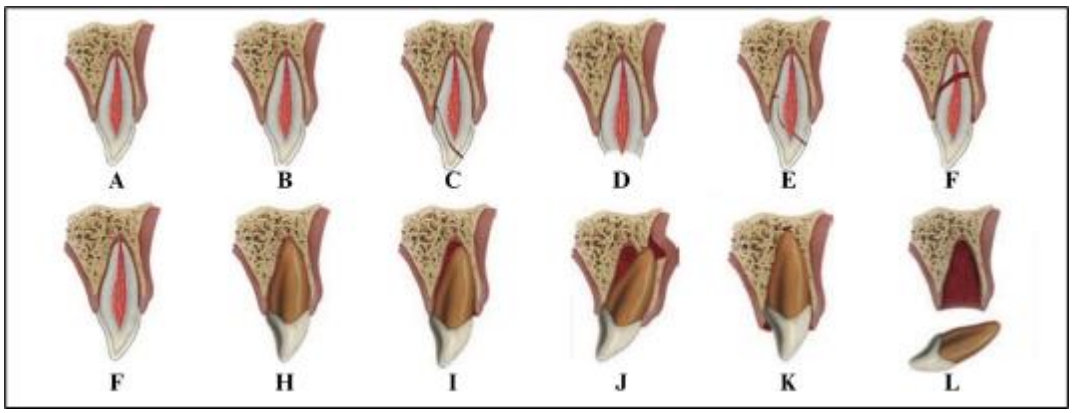

Figure 1 Various traumatic dental injuries, enamel infraction (A), enamel fracture (B), crown fracture without pulpal involvement (C), crown fracture with pulpal involvement (D), crown-root fracture (E), root fracture (F), concussion (G), subluxation (H), extrusive (I), lateral luxation (J), intrusive (K), avulsion (L) [9,10]

Clinical examination in young children can be challenging due to fear, pain, or limited cooperation. Using child-friendly techniques, such as examining the child in a knee-to-knee position with the parent, allows better access and comfort. Findings including tooth mobility, displacement, soft-tissue injuries, and occlusal changes must be interpreted carefully because they may indicate deeper injuries such as root or alveolar fractures. Since pulp tests are often unreliable immediately after trauma, particularly in young children, clinicians should avoid premature conclusions about pulp vitality and instead rely on careful follow-up [7,8]

Early first aid has a major influence on both short-term stability and long-term outcomes. Maintaining a clear airway is always the highest priority, especially when bleeding is significant. Soft-tissue wounds should be gently cleaned, irrigated, and sutured when necessary using appropriate materials. Proper debridement and the use of antiseptic solutions help reduce infection risk and support healthy healing. In situations involving substantial blood loss, fluid replacement may be required to prevent complications. Antibiotics and tetanus toxoid, human tetanus immunoglobulin should be consider based on the history of dental trauma and vaccinated history. These initial steps not only stabilize the child but also provide the clinical foundation necessary for determining the most suitable management strategy for each type of injury, allowing the clinician to transition into more detailed, injury-specific treatment approaches [7,8]

Once the child is stabilized and the injury has been properly assessed, the next step is to determine the appropriate treatment based on the type and severity of the trauma of permanent teeth. The following section outlines the recommended treatment for each trauma type.

- **Enamel infraction of permanent tooth.** This accident is very common, but often overlooked. Some reference mention the treatment of enamel infraction is layering with composite [11], while other reference advices layering with composite if the infraction is severe, otherwise no treatment is needed [12].
- **Enamel fracture of permanent tooth.** In some cases, if the fragment of tooth is available, then attempt to reattached it by using bonding agent and composite resin [12–14]. Another alternative treatment is depended on the extent and location of fracture. If the fracture is small, then polish and grinding the tooth edges, however if the fracture is severe, then restored it by using composite resin [11–15]
- **Crown fracture without pulpal involvement of permanent tooth.** This case involves fracture enamel and dentine. If the tooth fragment is still available, then rinse with saline and attempt to re-attached it by using glass ionomer cement or bonding-composite resin. If the tooth fragment is not available, then restore the damage by using composite resin. Consideration adding lining such as calcium hydroxide or zinc oxide eugenol may necessary if the damage too deep or close to the pulp[11–15].
- **Crown fracture with pulpal involvement.** This case involves fracture enamel, dentine and involving pulp (pulp is exposed). If the apical root of tooth is still open, then pulp capping or pulpotomy (depend on size of pulp exposure) is recommended option in order to promote the root development (if the tooth is vital) [12,15], if the tooth is non vital (open apex) then, apexification is an option [15]. if the tooth is mature (with closed apex), then pulp capping, pulpotomy, root canal treatment with post and crown could be an option, depends on the cases [11,12,15].
- **Crown-root fracture.** This fracture is typically involving crown and root of tooth with or without pulpal involvement. If without pulpal involvement, then tooth fragment could be re attached as described crown fracture without pulpal involvement [13], another option is removal the coronal fragment, then cover the exposed dentine with glass ionomer or use bonding agent, composite (if needed) and do restoration (composite, etc) [12]. If the case involving pulp exposure with immature (open apex) and tooth is vital, then pulpotomy should be considered as an option to promote the root development. If the tooth is mature, then root canal treatment, with composite resin as restoration or post and crown restoration if needed [11,12,15].
- **Root fracture.** This is relatively uncommon type of fracture. If there is displacement of the crown, then coronal fragment should be repositioned as soon as possible, by passive and flexible splint for 4 weeks. No endodontic treatment should be started at the emergency visit, however pulp status and healing of fracture should be monitored at least one year. If the pulp become necrosis, endodontic treatment of the coronal segment only will be indicated, where apexification approach may be needed. If the cervical fracture line is located above alveolar crest, and the fragment is very mobile, then removal the fragment, followed by root canal treatment and restoration with a post retained crown may be required. Additional treatment such as orthodontic treatment of apical segment, crown lengthening surgery, surgical extrusion, even extraction could be a future treatment option [12]. While the other expert, treat this case based on fracture line, if the fracture line is present in the middle third, then extraction should be an option (fig 1A) [11], if the fracture line is in apical third (fig 1B), obturation is needed until possible working length (apexification approach may be needed) and apical segment should be removed by surgery [11,13,15], if the fracture line is near to gingival margin (fig 1C), coronal portion of fragment can be removed, following by endodontic treatment and restored with post-crown, orthodontic or surgical extrusion may be necessary to improve this situation [11,15]

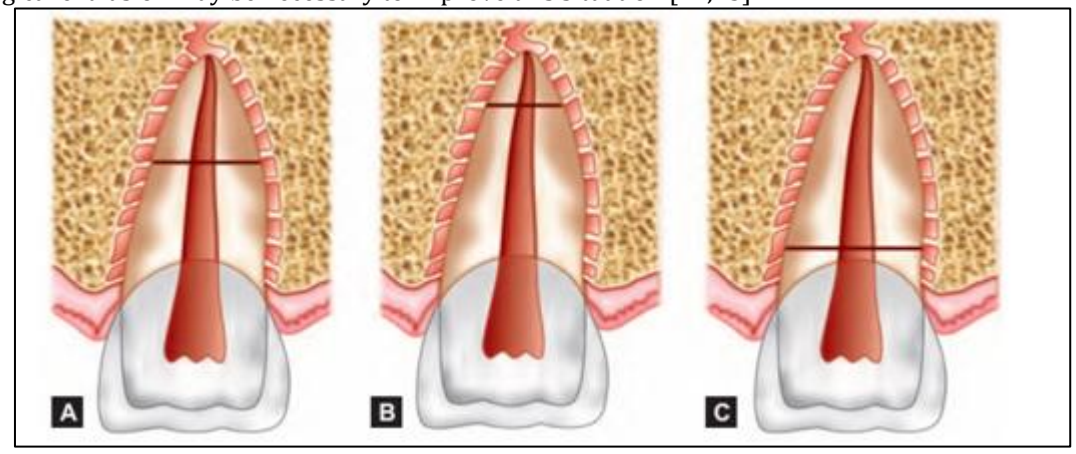

Figure 2 Treatment of root fracture depending on fracture line.[16]

- **Concussion in permanent tooth.** Basically, in concussion, there is no treatment, however it needs to monitor the pulp at least 1 year, by follow up 4 weeks, 6 month and 1 year. The patient is also asked to exercise care while eating to prevent traumatized the tooth injury and eating soft diet in the next few days (10-14 days) [11–13,15].
- **Subluxation in permanent tooth.** In subluxation treatment, basically almost similar with concussion treatment, however if the mobility of permanent tooth is excessive, then stabilize by using flexible splinting is necessary for 2-4 weeks depends on the severity of mobility [11–15].
- **Extrusive in permanent tooth.** In extrusive treatment, reposition the tooth by gently pushing back the tooth into the socket under local anesthesia, then stabilize it by using passive and flexible splint for 2-4 weeks. The patient also advice to take soft diet in several days. The pulp is monitored periodically, if it becomes necrotic, then endodontic treatment is necessary [11–15].
- **Lateral luxation.** Gently reposition to its original location under local anesthesia, stabilize by using passive and flexible splint for 2-4 weeks, if there is marginal bone breakdown, then splint it for 2-3 months. The pulp is monitored periodically [11–15] If this displacement is occurred in tooth with incomplete root formation, hopefully spontaneous revascularization may occur. However, if the pulp becomes necrotic, endodontic procedure suitable for immature tooth should be proceded. If it is occurred in tooth with complete root formation where the pulp becomes necrotic, then endodontic treatment should be proceeded [12]
- **Intrusive.** Principal treatment of intrusive is reposition the displacement tooth [11–15]. If the tooth with complete root formation and mild intrusion (< 3mm), allowing re-erupt spontaneously for 2-3 months [11,12,14]. If it is not erupted spontaneously after 2-3 months, then reposition orthodontically before ankylosis develops (if the tooth is intruded 3-7 mm, reposition orthodontically is also indicated) or reposition surgically and stabilize using flexible splint for 4 weeks (if the tooth is intruded > 7mm, reposition surgically is indicated) [11,12]. If the tooth with incomplete root formation, allow the tooth to spontaneously re erupt. If there is no sign of re eruption within 4 weeks, then initiate the orthodontic repositioning [12]. Pulp vitality is also monitored periodically.
- **Avulsion.** The avulsion in permanent tooth should be reimplantation and stabilize by using flexible splint wire [11,13,15] The reimplantation should perform immediately with golden period around 20-30 minutes [17] If the immediate reimplantation could not be performed, then the tooth should be storage in milk, physiological saline, saliva, Hank's balanced salt solution to make the golden period much longer [13,15]

5. Conclusion

Traumatic dental injuries in permanent dentition remain a significant challenge in dentistry, particularly in children and adolescents.and the treatment must still be individualized based on the type of injury, pulp status, and root development stage. Preventive education for caregivers, parents, and patients is essential to improve timely management and getting good result.

Compliance with ethical standards

Acknowledgments

The authors would like to express their sincere gratitude to the Faculty of Dental Medicine, Universitas Airlangga, for providing academic support and access to scientific resources essential for completing this narrative review.

Disclosure of conflict of interest

The authors declare no conflict of interest.

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