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Traumatic dental injuries in the primary dentition: A comprehensive review

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Abstract

This review aims to cover the best practices for diagnosing, classifying, and managing these injuries according to current clinical guidelines, as well as examining recent studies on the topic. Dental trauma in young children is a common concern, especially as they go through stages of active play and development. Most of these accidents happen at home, usually from falls. Recent research has been exploring the environmental and personal risk factors that lead to these injuries. When primary teeth, which are closely linked to permanent teeth, get injured, it can cause a range of problems for both sets of teeth, now and in the future. Complications following primary tooth trauma may include pulp necrosis, root resorption, early tooth loss, and disturbances in the permanent successors, such as enamel hypoplasia, discoloration, and eruption abnormalities. The risk and severity of sequelae are influenced by the child's age, type of injury, and number of affected teeth. Long-term follow-up until eruption of the permanent teeth is therefore essential. The complexity of these injuries, along with the difficulty of getting young children to cooperate and the high levels of anxiety in both kids and their parents, highlights the importance of healthcare professionals following accurate protocols for diagnosis, treatment, and follow-up. Sometimes, it is necessary to refer to a specialist. Effective management of TDIs in the primary dentition requires early diagnosis, adherence to evidence-based guidelines, and a child-centered, minimally invasive approach to reduce both immediate and future complications.

Keywords: Primary tooth trauma, traumatic dental injuries, deciduous tooth, primary tooth, avulsion, tooth injuries

1. Introduction

Dental trauma involves injuries to the teeth, gums, and nearby soft tissues (1). Although the mouth covers only about 1% of the body's total area, it accounts for 5% of all bodily injuries (1). Among preschool children, oral injuries make up 17% of all bodily injuries (2). The upper front teeth (maxillary incisors) are the most commonly affected in both primary and permanent sets, but primary molars can also be damaged due to indirect trauma to the jaws (3-5). Even though boys are often said to experience more dental trauma because they are generally more active than girls, research shows that the environment and a child's activities are more significant factors than gender (6, 7). Trauma to primary teeth is most common between the ages of 2 and 3, when motor skills are still developing (4). The higher rate of trauma in primary teeth compared to permanent teeth is largely due to the ongoing development of motor coordination in young children (7-9).

2. Risk factors

Research shows that falls are the leading cause of dental trauma in young children (7, 10). In a retrospective study by Choi et al., falls at home, particularly in late spring, were found to be the most common cause of such injuries (11). The upper front teeth (maxillary incisors) are the most frequently affected, with factors like increased overjet, protruding incisors, lip incompetence, mouth breathing, and a short upper lip contributing to the risk of dental trauma (7, 12). A meta-analysis revealed that overjet can double or even triple the risk of trauma (13), with some studies indicating that an overjet of just 3 mm can increase the risk (14, 15).

Additionally, many sports elevate the risk of dental injuries, and using protective gear such as mouthguards is recommended for certain activities (16, 17). Other factors contributing to trauma risk include bicycling accidents, car accidents, violence, and child abuse (8, 18). Medical conditions like cerebral palsy, which involves neurological defects, epilepsy with seizure-related falls, ADHD, intellectual disabilities, and auditory and visual impairments, also increase the frequency of dental trauma in children (19-24). Moreover, children who have experienced dental trauma once are more likely to suffer it again, often affecting the same teeth (25).

3. Clinical and radiographic examination

Traumatic dental injuries (TDI) can impact people of all ages and backgrounds. When these injuries occur in young children during their growth and development, they can lead to irreversible functional, aesthetic, psychological, and social damage. Therefore, accurate diagnosis and prompt intervention by experienced professionals are crucial (26, 27). Due to health policies and the complex nature of dentoalveolar injuries, patients may have difficulty accessing dental specialists. Consequently, initial diagnosis and treatment might need to be handled by other health professionals who may lack dental experience (28).

When a patient presents with TDI, a comprehensive medical history—including general health, bleeding disorders, allergies, conditions requiring prophylaxis, and vaccinations—should be meticulously recorded (29, 30). Factors such as the time since the injury, its location, and the circumstances of how it happened are vital for accurate diagnosis and treatment. If a child presenting with dental trauma shows signs of neurological involvement, such as abnormal breathing, confusion, nausea or vomiting, or abnormal eye conditions, they should be sent to the emergency room immediately. Dental treatment should follow the doctor's evaluation (18).

All information related to the patient's medical history, diagnosis, treatment, and follow-up care should be documented thoroughly. The American Academy of Pediatric Dentistry (AAPD) has developed a sample form for all practitioners to use (31). Initial clinical and radiographic evaluations are essential for diagnosis, treatment planning, assessing injury severity, and follow-up care (32). During the extraoral examination, the facial skeleton, soft tissue injuries, temporomandibular joints, and functional movements of the jaw should be recorded (33, 34). The intraoral examination should assess soft tissues such as the lips, cheeks, and tongue for trauma and foreign objects, as well as occlusion, tooth and alveolar mobility, fractures of dental hard tissues, pulp exposure, color changes, and sensitivity to touch and percussion (34). Pulp sensitivity tests may yield false responses in young children due to the need for cooperation and temporary loss of sensitivity in injured teeth (35-37).

Radiographic imaging should be selected based on the ALARA (As Low As Reasonably Achievable) principle, ensuring it is necessary for altering the treatment plan and beneficial for prognosis. For soft tissue radiographs to check for foreign objects like teeth, use one-quarter of the usual exposure time. While advanced imaging techniques like CBCT are rarely used in young children, they can be helpful for diagnosing maxillofacial and alveolar fractures (32, 35). Photographic documentation is recommended for recording the initial injury and for follow-up examinations (36).

4. AI and pediatric dentistry

A crown fracture is a traumatic injury where part of the tooth's hard tissue is lost due to a force applied perpendicular or oblique to the tooth's edge (37). These

fractures are common in primary teeth (29). Because of the structural characteristics of primary alveolar tissues, luxation injuries often occur alongside primary tooth fractures (8, 38). Therefore, it is important to carefully examine for additional injuries when a crown fracture is present.

Studies on traumatic injuries in young children's primary teeth have found that enamel fractures are the most common (61.7-82%), followed by enamel-dentin fractures and complicated crown fractures (4, 39, 40). Current guidelines recommend a one-year follow-up for primary tooth fractures and regular monitoring of the child until age six if alveolar fractures are present.

4.1 Enamel Fracture

Enamel fractures in primary teeth, without exposing dentin, constitute a large portion of crown fractures (7, 41). Radiographic evaluation is not typically recommended for enamel fractures. Smoothing sharp edges that could damage soft tissues or affect function and nutrition is usually sufficient (42).

4.2 Enamel-Dentin Fracture

These fractures involve both enamel and dentin without exposing the pulp (42). Bacteria can enter through exposed dentin tubules in these cases, impacting the pulp-dentin complex where vascularity has been disrupted by trauma (43). Therefore, it is crucial to cover all exposed dentin surfaces with glass ionomer when moisture control is difficult or with composite resin restorations under ideal conditions (42).

4.3 Complicated Crown Fracture

This injury involves enamel and dentin structures, with pulp exposure due to trauma (42). Guidelines recommend restoring the exposed pulp through partial or cervical pulpotomy. Studies have shown high success rates using Mineral Trioxide Aggregate (MTA) and promising results with calcium silicate-based materials for pulpotomy (44). Calcium hydroxide has also been successful in partial pulpotomy cases (29).

4.4 Crown-Root Fracture

Crown-root fractures affect the enamel, dentin, and root structures of the tooth, with or without pulp exposure (42). Treatment may involve endodontic and restorative protocols for restorable teeth, or extraction of either the broken fragment or both fragments for non-restorable teeth (42).

4.5 Root Fracture

Isolated root fractures in primary teeth are rare, but they are less common compared to other primary tooth injuries (45). The goal in primary tooth root fractures is not to heal between the two fragments as in permanent teeth. If the coronal fragment is stable, no treatment is needed. If it is mobile, repositioning and stabilization with a flexible splint for four weeks or extraction of the coronal fragment is recommended (42).

In a study by Kevci et al. on 74 primary tooth root fracture injuries, extraction was the most common treatment. Complications, mainly limited opacities in adjacent permanent teeth, typically occurred within the first year after trauma (46).

4.6 Alveolar Fracture

This injury involves a fracture of the labial or lingual/palatal alveolar bone, often from a severe frontal impact (44). Displacement varies with the direction of the impact (8). Treatment includes repositioning the displaced segments under local anesthesia and stabilizing them with a flexible splint for four weeks (42).

Soft tissue injuries often accompany dental traumas or alveolar fractures. These injuries, such as contusions, abrasions, lacerations, and tissue avulsions, typically affect the lips, cheeks, and tongue and can result from the stress absorbed by soft tissues during trauma (8). Contusion-related hemorrhage is significant in diagnosing alveolar fractures, often resulting from broken bone fragments in maxillofacial traumas.

Injuries from a strong blow to the jaw, causing rapid and forceful closure of the teeth, often affect one or more molars (29). Treatment options, depending on the injury's severity, include monitoring, resin restorations, prefabricated stainless steel crowns, pulpotomy for pulp exposure, pulpectomy, or extraction if restoration is not possible (5, 47-50).

5. Luxation injuries

Luxation injuries, affecting the supporting structures of the tooth like the periodontal ligament and alveolar bone, are the most common type of injury in primary teeth (51-56). The higher incidence in primary teeth is due to their more spongy bone structure, which allows easier movement of the teeth, and the higher crown/root ratio in children (33). According to IADT guidelines, observational treatment is the best approach for most primary tooth traumas, except in cases involving aspiration, swallowing, or occlusal interference. This conservative management aims to minimize damage to the permanent tooth germ and prevent further pain for the child (36).

5.1 Concussion

A tooth that is initially sensitive to touch but shows no mobility, displacement, or sulcular bleeding (36).

5.2 Subluxation

The tooth is mobile and tender to touch, but there is no displacement. Sulcular bleeding may be present. Observation is the recommended treatment protocol for primary teeth with concussion and subluxation (36).

5.3 Extrusion

The tooth is partially displaced out of the socket, appearing elongated and having excessive mobility. If the tooth is not interfering with occlusion, is not excessively mobile, and has less than 3 mm of extrusion, it is observed for spontaneous repositioning (36).

5.4 Intrusion

Teeth are usually displaced labially or through the socket, partially or completely impacted. New guidelines suggest waiting for spontaneous re-eruption for up to 6 months (36). Most intruded teeth can re-erupt (57-60), with some studies reporting longer re-eruption periods (61). Intrusion is categorized by Von Arx into three degrees: I - mild intrusion, more than 50% of the crown visible; II - moderate intrusion, less than 50% of the crown visible; III - severe intrusion, crown completely intruded (61, 62). Partially intruded teeth have a higher re-eruption rate compared to completely intruded teeth (59, 62, 63). Younger children have a higher potential for re-eruption (59, 63, 64). Despite spontaneous re-eruption, sequelae such as pulp necrosis, root resorption, and pulp canal obliteration can occur due to damage to the neurovascular tissues at the apex (65-67). The risk of pulp necrosis and pulp canal obliteration is lower in children under 2 due to root immaturity (66). Post-trauma crown discoloration is not always associated with necrosis, and such teeth can be monitored symptom-free for extended periods (67, 68). Regular clinical and radiographic follow-up is crucial for the early detection of post-traumatic complications (67).

5.5 Lateral Luxation

The tooth is immobile and usually displaced in the lingual/palatal or labial direction, potentially causing occlusal interference. Spontaneous re-eruption is awaited for up to 6 months. Splinting is recommended only if the laterally luxated primary teeth, once repositioned, are mobile in their new position (36). A retrospective study showed that 99% of 104 laterally luxated teeth returned to their original position within one year (51). Repositioned teeth exhibit more pulp necrosis and pathological resorption compared to those treated conservatively (69).

5.6 Avulsion

Reimplantation is not recommended for avulsed teeth that are completely displaced from the socket. It is crucial to find the avulsed tooth, and a radiograph is recommended to rule out the risk of the tooth being embedded in soft tissues like the lip, cheek, or tongue. If there is a risk of the tooth being aspirated, pushed into the nose, or swallowed, or if there are symptoms like respiratory distress or coughing, the patient should be referred to the emergency room for further examination (8). Intrusion and avulsion injuries cause the most common sequelae in permanent teeth (64, 70-72). Enamel hypoplasia and crown discolorations in developing permanent teeth are frequently reported (64, 70, 73, 74). Due to the close relationship between the permanent tooth germ and the root of the primary tooth, the crown of the permanent teeth is likely to be affected. A recent retrospective study found that children under 2 have a higher risk of discoloration and hypoplasia, likely related to the immature bone structure and early stage of permanent tooth development at that age. The study also noted that the risk of complications in permanent teeth increases with the number of traumatized primary teeth (64, 70, 75). Because of the potential damage and complications to permanent teeth, serious injuries such as intrusion and avulsion should be followed up until the permanent teeth erupt (64, 76-79).

6. Related complications

Complications from hard tissue injuries in primary teeth can include color changes, calcific metamorphosis, pulp necrosis, sinus tracts, increased mobility, gingival swelling, abscess formation, and tooth loss. These injuries can also impact the nearby permanent tooth germs, leading to issues such as developmental defects in enamel, delayed eruption, and ectopic eruption of permanent teeth (55, 74, 80, 81).

Luxation injuries in primary teeth can result in complications like pulp necrosis, calcific metamorphosis, early tooth loss, and inflammatory root resorption. For permanent teeth, luxation injuries, especially those causing contact between the primary tooth and the developing permanent tooth crown, can lead to enamel defects such as opacity or hypoplasia. Other potential issues include root dilaceration and ectopic eruption of the permanent tooth, with enamel hypoplasia and discoloration being the most common sequelae (55, 74, 80-83).

While trauma to primary teeth is frequently linked to hypoplasia in permanent teeth, many studies are based on case reports without control groups. Since trauma-induced permanent tooth hypoplasia isn't easily distinguished from conditions like Molar Incisor Hypomineralization (MIH), amelogenesis imperfecta, and fluorosis, these conditions might inflate the prevalence

of enamel hypoplasias attributed to primary tooth trauma (51, 84, 85). Moreover, studies suggest that young children experiencing recurrent trauma while their permanent teeth are still developing face a higher risk of complications involving their permanent teeth (86).

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