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Trauma to the Primary Dentition and its Sequelae

Abstract: Trauma to the primary dentition is common. This injury may have an impact on the child and his/her parents. The examining dentist should take appropriate factors into consideration before providing the required treatment. This paper discusses the management of trauma to the primary teeth and describes the sequelae of injury to both the primary and secondary dentitions.

Clinical Relevance: In cases of trauma to the primary teeth, diagnosis and appropriate management is necessary to alleviate the pain and discomfort for the child and to decrease the risk of damage to the permanent successor. It is important to prevent inducing fear and dental anxiety in children during the management of this injury.

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Dental injury is a common injury^{1,2} and a review by Glendor reported that one-third of all pre-school children have suffered a traumatic dental injury involving the primary dentition.³ Trauma to the primary dentition can result in pain, loss of function, aesthetic concerns and psychological consequences for the child and his/her family. The peak incidence of dental trauma

is between 1 and 3 years of age and the most commonly affected teeth in both the dentitions are the maxillary incisors,⁴ because of their position in the dental arch. According to a Brazilian study, gender of the pre-school child and socio-economic factors are not significantly associated with traumatic dental injury to the primary dentition.⁵

more than 50% of the children with NAI.⁷ A cohort study from Scotland reported that 59% of physically abused children had orofacial signs, such as bruises and abrasions that would be easily visible to a dentist.⁸ An apparent discrepancy in the trauma history provided by the parents and the injuries found on examination, or a delay in presentation along with a different history by each parent, should arouse suspicion in the clinician's mind regarding NAI. A torn upper labial fraenum in a very young baby is an unusual injury and a cause for concern, especially when the trauma history is suspicious. If NAI is suspected, then the local safeguarding children protocol should be followed.

Some predisposing factors to dental trauma in children are:

- Increased overjet and insufficient lip cover;⁹
- Protrusion of upper incisors;⁷
- Anterior openbite: in a study among Brazilian pre-school children, it was noted that children with anterior openbite had twice the level of traumatic dental injury compared to those with a normal occlusal relationship;⁵
- Hyperactivity;^{10,11}
- Poor motor co-ordination and epilepsy.

Aetiology

Trauma to the primary dentition can be caused by different factors, such as:

- Accidents and sports.
- Orotracheal intubation – premature infants who require assisted ventilation may suffer from palatal groove formation along the hard palate, acquired palatal clefting and altered development of the dental arch in the primary dentition due to pressure from the endotracheal tube. It usually affects the maxillary primary incisor teeth, predominantly the left maxillary incisors. A possible explanation for this could be the placement site of the endotracheal tube causing follicular damage.⁶
- Non accidental injury (NAI) or physical abuse – Orofacial injuries are found in

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Types of injuries to the primary dentition

The extent and type of injury is usually related to the direction and intensity of the impacting traumatic force.¹² In the primary dentition, luxation injuries are more common than fractures owing to the less dense facial skeleton, plasticity of the periodontal ligament and short roots of deciduous teeth.¹³ The different types of injuries are:

- Crown fracture (uncomplicated, complicated);
- Root fracture;
- Crown-root fractures;
- Concussion;
- Subluxation;
- Luxation injuries;
- Avulsion;
- Injury to the alveolar process.

History and examination

A good history-taking followed by a thorough examination is essential following a traumatic injury in order to aid diagnosis and subsequent management. Notes should be clear and contemporaneous in all cases of trauma and they may sometimes be needed for legal purposes, such as compensation claims. Information regarding the time and cause of the injury should be noted in addition to the patient's medical history, any head injury, the child's conscious level, tetanus immunization status and whether any lost teeth or tooth fragments have been accounted for.

Extra-oral examination

In the case of a non-co-operative or a very young child, adult assistance may be necessary for the examination. If a child cannot sit or is unwilling to sit on his/her own in the dental chair, an examination can be carried out by laying the child on the parent's knees and leaning his/her head back onto the dentist's knees (Figure 1).

The clinician should look for any facial lacerations, haematomas and bleeding. Facial bone injuries or fractures should be ruled out by observing signs (eg limited mouth opening, facial asymmetry, bleeding from the

nostrils), palpation and by undertaking radiographic examination if needed.

Intra-oral examination

This should include:

- Soft tissue examination, including the investigation of any lacerations for tooth fragments and foreign material. Submucosal haemorrhage under the tongue can be suggestive of fracture of the mandible.
- Examination of the alveolar bone and occlusal abnormalities.
- Examination of the teeth including tooth colour, mobility, fracture and displacement. If several teeth move together in an enblock fashion, a fracture of the alveolar bone should usually be suspected.

Radiographic examination

A chest radiograph is advised when a lost tooth cannot be accounted for. A soft tissue radiographic examination is needed to confirm suspicion of a buried tooth fragment. Suggested radiographic views to be taken when suspecting dental trauma are: reproducible long cone technique periapicals, occlusal view or extra-oral lateral view, depending on the clinical presentation and the ability of the child to cope. Sometimes a parent's help may be needed, especially in a young child, to hold the film holder and stabilize the child's head.

When a deciduous tooth is luxated then it is important to check:

- Radiographic dimension of the luxated tooth: as the succedaneous tooth is located palatally to, and in close proximity to, the apex of the deciduous tooth, if a deciduous tooth is intruded away from the permanent follicle (ie labially), the radiographic image will be foreshortened. In contrast, if a deciduous incisor has moved palatally into the follicle of the permanent tooth germ, then it will appear elongated on the radiograph, demonstrating a risk for the developing permanent tooth.

- Symmetrical orientation of the developing permanent teeth: loss of symmetry between the contralateral developing permanent tooth germs indicates dislocation of the permanent tooth germ by the deciduous tooth.

Advice and treatment

Reassurance and general advice about first aid following trauma must be given. This includes: washing the wound with running water and compressing the area with cotton or gauze for 5–10 min in the case of excessive bleeding to achieve haemostasis, keeping calm and seeking emergency treatment from a dentist.¹⁴ Tetanus prophylaxis should be considered in the case of contaminated wounds.¹

Apart from safety of the underlying permanent successor, the nature of the injury, medical history, co-operation of the child, time until shedding of deciduous tooth, occlusion, aesthetics and speech are the important factors that need to be taken into account while considering treatment. Abnormalities in the developing permanent dentition can occur following severe injuries to primary teeth and hence the treatment given should avoid any further risk of damage to the permanent successors.¹⁴ Any sign of head injury or inhalation of teeth should prompt the clinician to seek immediate medical attention.

If a deciduous tooth is very mobile, extraction is indicated to avoid ingestion/inhalation and a topical anaesthetic helps reduce the discomfort of a local anaesthetic injection. Analgesics can be prescribed when pain is anticipated. Antibiotic prescription is usually governed by clinical judgement, as the benefit of systemic antibiotic treatment is unproven. A course of antibiotics may be prescribed if there



Figure 1. Examination of a young child laid across the parent's knee.

has been a soft tissue injury, alveolar bone damage or infection. In the case of fractures of the alveolar process, an appropriate referral to the hospital should be made for repositioning. If for this a general anaesthetic is to be given, a fairly comprehensive approach needs to be adopted to avoid a repeat anaesthetic within a short time.¹⁵

In the immediate post injury period, if toothbrushing is not possible, parents should gently clean the mouth twice a day using a swab dipped in a chlorhexidine rinse to prevent plaque accumulation. A soft diet is recommended for 10–14 days. The use of pacifiers and nursing bottles by very young children may need to be restricted, depending on the severity of the injury. Parents should be advised to watch for possible complications, including swelling or increased tooth mobility.

Treatment of different types of injuries

Uncomplicated crown fracture

This includes fracture of:

- Enamel; or
- Enamel and dentine.

It is generally sufficient to smooth off the sharp edges and, if the child is co-operative, the tooth can be restored with glass ionomer cement or a composite restoration.

Complicated crown fracture

This type of fracture involves the enamel, dentine and pulp. When attempting to treat the tooth, one should consider the amount of crown structure remaining and the time until exfoliation. In very young children with immature root apices or in young patients with fully formed roots, it is advantageous to retain the pulp vitality.¹⁴ Pulp capping or pulpotomy with calcium hydroxide,¹ followed by acid-etch composite restoration, may be carried out if the patient is co-operative. Recent studies have reported good success rates with the use of MTA (grey and white formulations) but these are based on pulpotomized primary molars.¹⁶ When the above treatment is not possible, extraction is indicated.

Root fracture (Figure 2)

The root fracture is usually located in the mid-root or in the apical third of the root.^{1,14} Splinting is generally not practical and is difficult owing to small tooth size and often owing to limited patient co-operation. If the fracture line is nearer the apex and the tooth is only slightly mobile, with minimal displacement of the coronal fragment, the tooth can be left untreated and it will usually undergo physiological resorption at the expected time. However, if the coronal fragment is displaced and loose, then extraction of the coronal fragment is necessary and the apical fragment can be left to resorb physiologically. This helps avoid damaging the permanent successor during extraction of the deciduous tooth.

Crown-root fracture

This fracture involves enamel, dentine and root structure of the deciduous tooth, with or without a pulp exposure. Sometimes the tooth is painful during eating due to its mobility. Extraction of the deciduous tooth is usually recommended following this type of injury.

Concussion and subluxation

In concussion injury, the tooth is tender to touch; in subluxation the tooth appears mobile and there may be bleeding from the gingival crevice. Generally, reassurance and maintenance of good oral hygiene is advised.

Luxation

Lateral luxation

In this type of injury, the crown is usually displaced in a palatal or lingual direction, and the root labially, and is firm. Gentle repositioning by combined labial and palatal pressure can be carried out if occlusal derangement is noted. When there is no occlusal derangement, spontaneous repositioning can be expected, usually within 3 months.¹ However, sometimes there is severe displacement and mobility, or the deciduous crown is displaced labially and the root palatally, involving trauma to the permanent tooth germ. In such cases, extraction of the deciduous tooth is usually the treatment of choice.

Intrusive luxation (Figure 3)

When intrusion has occurred, the apex of the deciduous tooth is usually displaced through the labial alveolar bone plate due to the labial curvature of its root. It is important to establish the direction and degree of displacement clinically and radiographically.

If the deciduous tooth is not displaced into the developing tooth germ, then spontaneous re-eruption of the intruded tooth is normally expected.¹⁴ If it does not re-erupt, then ankylosis of this deciduous tooth is likely and its extraction may be necessary to prevent ectopic eruption of the permanent successor. Occasionally, if the apex of the deciduous tooth is displaced into the developing



Figure 2. Root fracture of the maxillary primary central incisors.



Figure 3. Intrusion of the maxillary primary left central incisor following injury.

tooth germ, or if there are any signs of infection such as swelling, bleeding, abscess or pyrexia, then extraction of the deciduous tooth and antibiotic therapy are indicated. During extraction, grasping the primary tooth mesiodistally rather than buccopalatally may help reduce the incidence of trauma to the secondary tooth germ.

Extrusive luxation

In an extrusion injury, the deciduous tooth appears elongated clinically and is usually markedly mobile. In cases of minor extrusion, especially in an immature tooth, spontaneous alignment or careful repositioning is generally advised.¹⁴ However, in cases of delayed presentation, repositioning of the tooth may be difficult. In such situations, and in cases with severe extrusion, extraction of the deciduous tooth is the treatment of choice.

Avulsion

In this injury, the deciduous tooth is completely out of the socket and missing in the arch. It is important to make sure that the tooth is definitely avulsed and found, and not inhaled. Radiographic examination is essential to ensure that the missing tooth is not intruded. Replantation of an avulsed deciduous tooth as a treatment modality is avoided owing to the risk of damage to the underlying permanent tooth germs.^{1,14}

Follow-up procedures

Review appointments are necessary to diagnose complications, if any, and monitor the developmental status following the traumatic injury. The IADT guidelines¹⁴ for the management of traumatic injuries to the primary dentition advise the following follow-up regime:

- Intrusion and avulsion injuries are to be reviewed clinically at 1 week, clinically and radiographically at 6 months, 1 year and then every subsequent year until exfoliation of the primary tooth. In addition to this, intrusion injury is to be reviewed at 1 month clinically and radiographically and at 6–8 weeks clinically. Note: although the primary tooth is missing in the case of avulsion, the follow-up procedure is suggested to evaluate the influence of

trauma on the secondary successor.

- Patients with all other types of injuries, except uncomplicated crown fractures, should be reviewed at 1 week clinically, clinically and radiographically at 6–8 weeks and at 1 year. It is advised to monitor alveolar fracture and root fracture injuries yearly radiographically until exfoliation. Uncomplicated crown fractures are to be reviewed at 1 month clinically. No follow-up radiographic examination is generally advised for concussion and subluxation injuries unless clinically indicated.

Sequelae

It is important to inform the parents of all the possible complications in development of the permanent dentition following trauma to the deciduous dentition and this should also be recorded in the notes. The sequelae of injury and their extent for the permanent dentition are dependent on the age of the patient at the time of injury,⁷ stage of development of the permanent tooth, the intensity and type of trauma.¹⁷

A study carried out in Germany reported that, following trauma to the deciduous dentition, approximately 66% of patients who suffered trauma before 3 years of age experienced sequelae to the permanent dentition, in contrast to only 24% of patients who were older than 3 years at the time of trauma.¹² This may be related to the incomplete mineralization of bone and tooth germ at a very young age.

A study carried out in Germany reported that about 66% of the patients up to an age of 3 years suffered from sequelae to the permanent dentition in contrast to only 24% of patients older than 3 years following trauma to the deciduous dentition¹² and this may be related to the incomplete mineralization of bone and tooth germ at a very young age.

Intrusion injuries of the deciduous incisors are highly related to developmental anomalies of the permanent successors,¹⁸ whereas damage to the permanent dentition following fractures of the deciduous teeth is unlikely to occur.¹² In children up to the age of 2 years, intrusion and avulsion injuries are the most serious injuries noted to cause complications to the permanent successors.^{19,20}

Table 1 summarizes the most common sequelae in primary teeth following trauma.

Sequelae of injuries to the permanent dentition

Malocclusion

Delayed resorption of a non-vital deciduous tooth may lead to palatal eruption of the permanent successor. Also, premature loss of deciduous tooth may allow eruption of the permanent successor in a more labial position owing to lack of guidance.

White or yellowish-brown discoloration of enamel/white or yellowish-brown discoloration of enamel with circular enamel hypoplasia (Figure 5)

This occurs due to interference with enamel deposition and usually appears as demarcated, stained enamel opacities, usually on the labial surface of the permanent crown. Their size could vary from small to large spots. The discoloration with circular enamel hypoplasia is a more severe sequela with a horizontal groove, which encircles the crown, cervical to the discoloration. Both these sequelae commonly affect the maxillary permanent incisors, when the traumatic injury occurs between the ages of 2 and 7 years¹ and their reported frequency is 23% and 12%, respectively, following injuries to the deciduous dentition.²¹

Treatment options are acid-pumice microabrasion, external bleaching and composite restoration/veneer or porcelain veneer, depending on the severity of the discoloration and the hypoplasia. Porcelain veneers are not advised for the very young patient.

Crown dilaceration (Figure 6)

Crown dilaceration is due to the traumatic non-axial displacement of the formed hard tissue in relation to the developing soft tissues. It is rare and usually found in children where injury occurs at the age of 2 years or younger.^{1,20} Unerupted crown dilacerated teeth are usually foreshortened coronally on radiographic examination. Approximately half of these permanent teeth become impacted.¹

If unerupted, treatment involves

Sequela	Aetiology	Clinical Findings	Radiographic Findings	Treatment
Pulp necrosis (Figure 4)	Loss of vitality. Decisive factors for pulp necrosis found in a study are: age of the patient, degree of displacement, loosening and crown fracture. ²²	Often no pain. Permanent grey discoloration of the crown. Possible presence of a sinus/fistula/swelling.	Failure of pulp cavity to reduce in size. Arrested root development. Periapical radiolucency or signs of root resorption. Note: enlargement of the follicle of the developing permanent tooth may imitate a periradicular radiolucency. ¹	Endodontic treatment or extraction of the primary tooth indicated if symptoms, infection or apical pathology.
Pulp obliteration	Common complication following trauma. Injury to the neurovascular supply of the pulp leads to dentine deposition coronally.	Occasional yellowish discoloration of the crown.	Annual radiography is advisable as secondary pulp necrosis possible. ⁷ Obliteration of the pulp chamber and canal seen.	Normal exfoliation is usual.
Internal root resorption	Uncommon sequela.	Possible persistent signs of infection, ie swelling, sinus and tooth discoloration.	Oval-shaped enlargement within the pulp chamber.	Endodontic treatment or extraction of the primary tooth.
External root resorption (inflammatory)	Related usually to intrusive and lateral luxation injuries. ²⁰ Other types of external root resorption; surface and replacement resorption (ankylosis) rare in traumatized primary teeth.	Possible persistent signs of infection, ie swelling, sinus, exudate from the root canal and discoloration. Ankylosis is rare.	Progressive loss of tooth substance associated with a radiolucency in the adjacent alveolar bone. Note: it is important to distinguish between pathological and physiological external root resorption, where physiological is without any signs of infection.	Extraction of the primary tooth. In case of ankylosis, spontaneous exfoliation may be delayed, but is usually noted.

Table 1. Sequelae of injury to the primary dentition.



Figure 4. Clinical signs of pulp necrosis of a maxillary primary lateral incisor.



Figure 5. Severe enamel hypoplasia of the maxillary permanent central incisors subsequent to traumatic injury to the deciduous central incisors.



Figure 6. Crown dilaceration of the maxillary permanent left incisors and right lateral incisor subsequent to trauma to the deciduous predecessors.

surgical exposure and bonding of a gold chain or orthodontic bracket for orthodontic extrusion. In some severe cases, the affected dilacerated portion of the permanent crown, when sufficiently extruded, may need

removal to prevent bacterial ingress into the pulp of the tooth. The tooth can be restored with a provisional crown until a definitive restoration can be provided following complete eruption.

Odontoma-like malformations

These are rare and occur following injury at less than 1 to 3 years of age.¹ An odontoma appears as a radio-opaque mass on radiographic examination, and treatment, if needed, is usually its removal by surgical intervention.

Disturbances in eruption

A delay in eruption of permanent successors may occur as a consequence of the premature loss of deciduous teeth following trauma. Space loss for permanent incisors with early loss of deciduous incisors is rare. Permanent teeth with malformation of the crown or the root may be impacted as aforementioned. The treatment for impacted teeth is generally surgical exposure followed by orthodontic realignment, if necessary.

There are a few other rare sequelae such as root duplication, dentigerous cyst formation and sequestration of permanent tooth germ and partial or complete arrest of root formation.

Conclusion

The main objectives of diagnosis and management of the traumatic injuries to the deciduous teeth are:

- To comfort the child in the immediate post injury period and provide adequate analgesia and treatment;
- To minimize dental fear and anxiety in young children;
- To minimize the risk of damage to the permanent teeth.¹

Conservative treatment is important, however, sometimes treatment may be difficult owing to the young age of the child and limited co-operation for dental procedures. It is important to avoid inducing fear during the treatment provided and hence reduce the chance of developing dental anxiety in the future.

Regular review appointments are vital following any injury in the deciduous dentition. This helps with prompt diagnosis of any sequelae and attempts can be made to avoid subsequent damage to the permanent dentition. Follow-up should be particularly aimed to check for pulpal

necrosis, infection, possible loss of space, deciduous tooth exfoliation and permanent tooth eruption.

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