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# The art and science of managing traumatic injuries to primary teeth

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Managing traumatic dental injuries to both primary and permanent teeth has become increasingly standardized over the past four decades. This is primarily due to the large body of literature documenting the biological and clinical determinants of various treatment modalities. The International Association of Dental Traumatology (IADT) currently establishes and periodically updates well referenced guidelines which are available in print (1-3) and online (4, 5). Turkistani and Hanno (6) recently reviewed the literature on the recent trends in the management of injuries to primary and young permanent teeth (116 references) which is an excellent resource to supplement the 2007 IADT guidelines. These advances and guidelines have moved the management of traumatic dental injuries from previously an art ['a skill at doing a specific thing, typically one acquired through practice rather than science' (7)] towards science ['knowledge or a system of knowledge covering general truths or the operation of general laws especially as obtained and tested through scientific method' (8)].

Applying these guidelines to manage traumatic dental injuries to children in either the primary or early mixed dentition is often more challenging than doing so for older individuals. In general, the biological factors that guide and help to establish protocols for managing particular dental injuries to a permanent tooth can also be applied to a primary tooth. However, the IADT has separate guidelines for managing both permanent (37 references) (1, 2) and primary teeth (22 references) (3). Many of the factors responsible for these differences, some of which are obvious, are only briefly mentioned in the material accompanying these guidelines. In order to render the most appropriate treatment for any particular traumatic dental incident to a child's primary tooth/ teeth, numerous general considerations must be included in the decision-making process. The integration of these factors often moves the management of the traumatized

child and primary tooth away from a science back toward an art.

Table 1 contains a side-by-side comparison of the 2007 IDAT trauma management guidelines for injuries to permanent (1, 2) and primary (3) teeth. The third column lists in relative order of importance relevant general treatment factors. The aim of this article is to outline these general considerations and discuss how they affect the guidelines for managing dental injuries to primary teeth.

# Patient factors

The most significant factor affecting the application of the various treatment option guidelines for managing traumatic injuries to primary teeth is that the patient is a child. Not only does the clinician have to manage the specific dental trauma that presents itself, but also constantly has to manage the child's behavior before, during and even after the actual treatment has been rendered. If treatment is deemed complex, has a guarded prognosis, and/or if the child is either uncooperative and/or has special needs (behavioral and/or medical), extraction of the involved tooth is an option to be seriously considered. In addition, the clinician must always consider the possibility that the child's injuries were non-accidental, i.e. child abuse (9-15). An unusual history of the present illness and presentation of the injury itself may make the treating clinician suspicious that someone inflicted these injuries upon the child in which case reporting to the appropriate agency is essential.

#### Behavioral management

Children can be difficult to manage under any circumstance but, when children have been physically

Injury	Permanent tooth	Primary tooth	General considerations (in order of importance)
Fractures			
Uncomplicated crown	If tooth fragment is available, it can be bonded to the tooth. Urgent care option is to cover the exposed dentin with a material such as glass-ionomer or a permanent restoration using a bonding agent and composite resin. Definitive treatment for the fractured crown may be restoration with	Smooth sharp edges. If possible the tooth can be restored with glass-ionomer material or composite.	Behavioral Management Developmental issues Parental – psychosocial/financial
Complicated crown	In young patients with immature, still developing teeth, it is advantageous to preserve pulp vitality by pulp capping or partial pulpotomy. This treatment is also the choice in young patients with completely formed teeth. Calcium hydroxide and MTA (white) are suitable materials for such procedures. In older patients, root canal treatment can be the treatment of choice, although pulp capping or partial pulpotomy may also be selected. If too much time elapses between accident and treatment and the pulp becomes necrotic, root canal treatment is indicated to preserve the tooth. In extensive crown fractures a decision must be made whether treatment other than extraction is feasible	In very young children with immature, still developing roots, it is advantageous to preserve pulp vitality by pulp capping or partial pulpotomy. This treatment is also the choice in young patients with completely formed roots. Calcium hydroxide is a suitable material for such procedures. Both treatments should be considered whenever possible, otherwise extraction is indicated.	Behavioral Management Developmental issues Anatomy Parental – psychosocial/financial
Crown-root	Treatment recommendations are the same as for complicated crown fractures (See above). In addition, attempts at stabilizing loose segments of the tooth by bonding may be advantageous, at least as a temporary measure, until a definitive treatment plan can be formulated.	Treatment recommendation is tooth extraction. Care must be taken to prevent trauma to the subjacent tooth bud.	Behavioral Management Developmental issues (?agenesis) Anatomy Parental – psychosocial/financial
Root	<ul> <li>Reposition, if displaced, the coronal segment of the tooth as soon as possible. Check position radiographically. Stabilize the tooth with a flexible splint for 4 weeks. If the root fracture is near the cervical area of the tooth, stabilization is beneficial for a longer period of time (up to 4 months).</li> <li>It is advisable to monitor healing for at least one year to determine pulpal status. If pulp necrosis develops, root canal treatment of the coronal tooth segment to the fracture line is indicated to preserve the tooth</li> </ul>	If the coronal fragment is displaced, extract only that fragment. The apical fragment should be left to resorbed.	Behavioral Management Developmental issues (?agenesis) Anatomy Parental – psychosocial/financial
Alveolar	Reposition any displaced segment and then splint. Stabilize the segment for 4 weeks.	Reposition any displaced segment and then splint. General anesthesia is often indicated. Monitor teeth in fracture line.	Behavioral Management Developmental issues Parental – psychosocial/financial
Luxations Concussion	No treatment is needed. Monitor pulpal condition for at least one year	No treatment is needed. Observation	None
Subluxation	A flexible splint to stabilize the tooth for patient comfort can be used for up to 2 weeks.	No treatment is needed. Observation	None

# Table 1. Comparison of IADT trauma management guidelines for injuries to permanent (1, 2) and primary (3) teeth

#### Table 1. (Continued)

Injury	Permanent tooth	Primary tooth	General considerations (in order of importance)
Extrusive	Reposition the tooth by gently re-inserting it into the tooth socket. Stabilize the tooth for 2 weeks using a flexible splint. Monitoring the pulpal condition is essential to diagnose root resorption. In immature developing teeth, revascularization can be confirmed radiographically by evidence of continued root formation and pulp canal obliteration and usually return to positive response to sensibility testing. In fully formed teeth, a continued lack of response to sensibility testing should be taken as evidence of pulp necrosis together with periapical rarefication and sometimes crown discoloration.	Treatment decisions are based on the degree of displacement, mobility, root formation and the ability of the child to cope with the emergency situation. For minor extrusion (<3 mm) in an immature developing tooth, careful repositioning or leaving the tooth for spontaneous alignment are acceptable treatment options. Extraction is the treatment of choice for severe extrusion in a fully formed primary tooth.	Behavioral Management Developmental issues Parental – psychosocial/financial
Lateral	Reposition the tooth with forceps to disengage it from its bony lock and gently reposition it into its original location. Stabilize the tooth for 4 weeks using a flexible splint. Monitor the pulpal condition. If the pulp becomes necrotic, root canal treatment is indicated to prevent root resorption. In immature, developing teeth, revascularization can be confirmed radiographically by evidence of continued root formation and possibly by positive sensibility testing. In fully formed teeth, a continued lack of response to sensibility testing indicates pulp necrosis, along with periapical rarefication and sometimes crown discoloration.	If there is no occlusal interference, as is often the case in anterior open bite, the tooth is allowed to reposition spontaneously. When there is occlusal interference, with the use of local anesthesia, the tooth can be gently repositioned by combined labial and palatal pressure. In severe displacement, when the crown is dislocated in a labial direction, extraction is the treatment of choice. If minor occlusal interference, slight grinding is indicated	Behavioral Management Developmental issues Anatomy/occlusion Parental – psychosocial/financial
Intrusive	<ol> <li>Teeth with incomplete root formation: Allow spontaneous repositioning to take place. If no movement is noted within 3 weeks, recommend rapid orthodontic repositioning.</li> <li>Teeth with complete root formation: The tooth should be repositioned either orthodontically or surgically as soon as possible. The pulp will likely be necrotic and root canal treatment using a temporary filling with calcium hydroxide is recommended to retain the tooth.</li> </ol>	If the apex is displaced toward or through the labial bone plate, the tooth is left for spontaneous repositioning. If the apex is displaced into the developing tooth germ, extract.	Behavioral Management Developmental issues Anatomy/occlusion Parental psychosocial Financial
Avulsion	Flores et al. 2007 (2)	It is not recommended to replant avulsed primary teeth.	Behavioral Management Developmental issues Anatomy/occlusion Parental psychosocial Financial

traumatized, their ability to cooperate is further diminished. There are a wide range of behavioral management techniques that can be employed to aid the clinician with rendering treatment. These include: 'tell, show and do', voice control, non-verbal communication, distraction, parental absence/presence, positive reinforcement, modeling, and protective stabilization (16). In addition, pharmacological techniques such as nitrous oxide inhalation analgesia, sedation (minimal, moderate and deep) and even general anesthesia (17) need to be considered and available when the behavioral techniques are insufficient to allow the proper delivery of treatment. These potentially riskier procedures themselves can dictate which treatment alternative is reasonable to consider. The risk inherent in applying these more invasive techniques must be weighed against the potential benefit of any proposed treatment outcome.

### **Developmental issues**

The age of the child and his/her stage of dental development is a significant factor. Obviously, the younger the child, the more difficult it becomes to manage their behavior. Primary teeth are not 'permanent' and will obviously be replaced by their corresponding successors unless agenesis exists, in which case long-term success becomes more important. The stage of the primary tooth's root resorption and its readiness for exfoliation may dictate extraction of the involved tooth rather than treatment for its preservation. The earlier the stage of the succedaneous tooth's development at the time of injury and treatment, the more likely that poor treatment outcomes, such as periapical infection, can result in disruption of normal enamel development with resultant enamel opacities and/or hypoplasia (18–22).

#### **Parental factors**

Parents must be involved with all phases of treatment rendered to their child. Since multiple treatment options may exist for any particular injury to a primary tooth, as well various postoperative sequalae, it is imperative that the parent/s be involved with the selection of the ultimate treatment approach. A triangle of dialogue among the treating clinician, parent and child adds a complex paradigm to the rendering of ideal treatment of traumatic injuries to children.

#### Psychosocial

Parents bring their own set of fears and previous dental experiences to bear on the dentist's ability to quickly and effectively choose and proceed with optimal treatment. The emotional impact of the physical and psychological trauma to their child can impact upon the parent's ability to listen to proposed treatment options and can prevent them from helping the clinician select an appropriate treatment option. Parents may place an inappropriate amount of importance on the psychological impact of the actual treatment itself, as well as the long-term impact of various treatment modalities. The importance of dental care in general varies greatly among parents and must be assessed early in the treatment planning process.

Cosmetics involving the anterior primary teeth are clearly not as critical as it is for permanent teeth. The treating clinician always needs to evaluate the potential psychological effects of the treatment itself (especially if complex) on the child in comparison to the cosmetic/ psychological importance of maintaining the tooth for both the short and long term. While cosmetics are not a concern to younger children (23), parents often overemphasize its psychosocial importance and use this rationale to influence decisions in an attempt to salvage traumatized primary teeth that might best removed. Parents often fell guilty for the trauma sustained by their child, whether or not they were directly or indirectly responsible. The absence the tooth can be a reminder of the incident itself and the parent's possible involvement. Opting not to remove the traumatized tooth may lessen their guilty feelings at the time of the decision-making process and during the lifetime of that primary tooth.

#### Financial

The costs of managing traumatic injuries can be considerable (24). The financial ability for parents to pay for complex treatment to maintain an injured primary tooth if not covered by third parties must be considered when selecting from among various treatment options. The cost benefit of the proposed treatment, whether perceived or real, has to be discussed and carefully weighed.

#### **Dentist factors**

The formal training, experience and acquired skills of the treating clinician in managing children and dental trauma are critical in both choosing treatment options and enhancing optimal outcomes. It is important that the treating dentist be conversant with the complete armamentarium of behavioral modification techniques (16) in order to optimize the child's ability to cooperate. In addition, the clinician should be comfortable with and have access to a full complement of pharmacological techniques such as nitrous oxide/oxygen analgesia, sedation, and general anesthesia (17).

Pediatric dentists are ideal clinicians for treating children with traumatic injuries. Pediatric dentistry is the only dental specialty defined by age rather than by technique and involves 2–3 years of postdoctoral training with exposure to the full complement of child behavioral management techniques and dental trauma. Oral and maxillofacial surgeons have a broad range of experiences and training in managing acute dental trauma, but may lack the ability to use the full range of behavioral modification techniques. At the time of the injury's initial presentation it is of critical importance that the treating clinician has the experience and comfort level with children and dental trauma. If well-trained dentists or physicians are not involved with the initial emergency care, the definitive treatment and long-term prognosis of the traumatized tooth can be compromised. Many injuries such as complicated fractures, luxations and avulsions require the appropriate treatment to be rendered within strict time constraints, otherwise optimal treatment outcomes are compromised.

#### Anatomic and occlusal factors

The biological considerations used to develop the guidelines for the management of dental trauma to the permanent teeth can be generally applied to the primary teeth. However, there are anatomic and occlusal differences that distinguish primary from permanent teeth that need to be taken into consideration in selecting appropriate treatment options.

#### Anatomy

The pulp chambers of primary teeth are larger with corresponding thinner outer layers of enamel and dentin than those of permanent teeth (25). This makes primary teeth more likely to have pulpal exposures and can make endodontic treatment more complex. The root canals of primary teeth are thinner and more torturous than in permanent teeth (26), making extirpation and obturation of the root canal system more difficult and more-time consuming with poorer outcomes. Thus, extraction of traumatized primary teeth may be a more practical treatment option than various complex pulp therapies when compared with treatment options for permanent teeth. The roots of the primary teeth are longer and more flared (25), which can make their extraction more difficult and increases the likelihood of fracturing root tips. The clinician must always take into account the stage of root resorption of the primary tooth during the eruption of its succedaneous teeth when deciding if treatment to maintain the tooth in the dental arch is worthwhile.

The proximity of the succedaneous tooth to the root/s of the primary tooth is an important factor. The smaller this distance, the more likely that the trauma itself or inadequate treatment will affect the development of the tooth, e.g. 'Turner's hypoplasia' or root dilaceration. Radiographs can help determine if a primary tooth is impinging on the developing tooth, as in cases of intrusion injuries, in which case treatment may require extraction rather than allow for spontaneous eruption (27).

#### Occlusion

The post-trauma position of the involved tooth/teeth within the dental arch may play a role in treatment selection. With luxation injuries, if the displaced primary tooth is in crossbite, repositioning or extracting the tooth is necessary. However, unlike permanent teeth, mildly luxated primary teeth that are not in crossbite may be left for self-correction (6). This is especially true if the child has an oral habit such as digit or pacifier sucking which can 'naturally' reposition the affected tooth/teeth.

#### Summary

The selection of an appropriate treatment protocol and the rendering of treatment to children with traumatic injuries of their primary teeth are often more challenging than doing so for the permanent teeth of older individuals. Numerous general considerations involving patient, parent, dentist, dental anatomy and occlusion are responsible for the differences between the treatment protocols for the management of traumatic dental injuries to primary teeth and those for permanent teeth.

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