Guidelines

Guidelines for the management of traumatic dental injuries. I. Fractures and luxations of permanent teeth

Flores MT, Andersson L, Andreasen JO, Bakland LK, Malmgren B, Barnett F, Bourguignon C, DiAngelis A, Hicks L, Sigurdsson A, Trope M, Tsukiboshi M, von Arx T. Guidelines for the management of traumatic dental injuries. I. Fractures and luxations of permanent teeth.

Abstract – Crown fractures and luxations occur most frequently of all dental injuries. An appropriate treatment plan after an injury is important for a good prognosis. Guidelines are useful for delivering the best care possible in an efficient manner. The International Association of Dental Traumatology (IADT) has developed a consensus statement after a review of the dental literature and group discussions. Experienced researchers and clinicians from various specialties were included in the group. In cases where the data did not appear conclusive, recommendations were based on the consensus opinion of the IADT board members. The guidelines represent the current best evidence, based on literature research and professional opinion. In this first article of three, the IADT Guidelines for management of fractures and luxations of permanent teeth will be presented.

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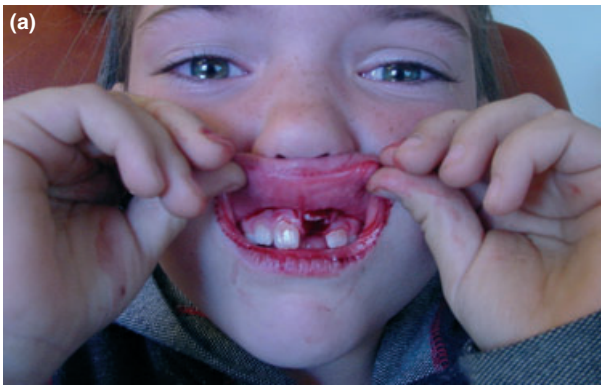
Trauma to the oral region occurs frequently and comprises 5% of all injuries for which people seek treatment (1, 2). In preschool children the figure is as high as 18% of all injuries (1, 2). Amongst all facial injuries, dental injuries are the most common (1, 2) of which crown fractures and luxations occur most frequently (1, 3). An appropriate treatment plan after an injury is important for a good prognosis.

Guidelines are useful for dentists and other health care professionals in delivering the best care possible in an efficient manner. The International Association of Dental Traumatology (IADT) has developed a consensus statement after a review of the dental literature and group discussions. The first set of guidelines was published by IADT in 2001 (4). Experienced researchers and clinicians from various specialties were included in the group. In cases where the data did not appear conclusive, recommendations were based on the consensus opinion of the IADT board members. The guidelines represent the current best evidence, based on literature research and professional opinion. As is true for all guidelines, the health care provider must apply clinical judgment dictated by the conditions present in the given traumatic situation. The IADT does not guarantee favorable outcomes from following the Guidelines,



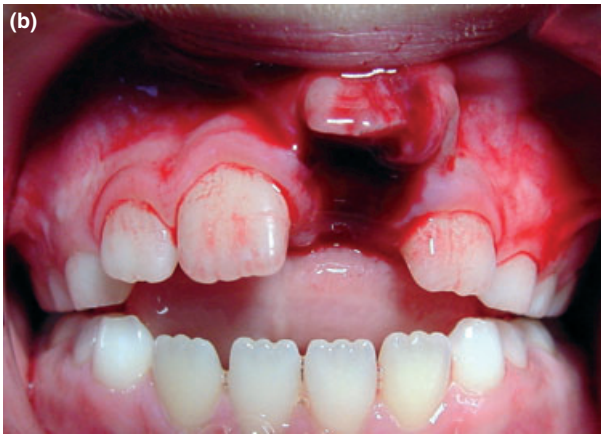


Fig. 1. (a) A 9-year-old girl visiting the emergency dental clinic 30 min after falling from a bicycle. (b) (close up view of Fig. 1a) Clinical examination showing lateral luxation of the left central incisor with fracture of the alveolar process. The incisor is luxated to a superior and labial position.

Fig. 2. Crown fracture of right central incisor and crown-root fracture of left central incisor.

but using the recommended procedures can maximize the chances of success. Because management of permanent and primary dentition differs significantly, separate guidelines for management of permanent and primary teeth have been developed. Updating the Guidelines is an ongoing process, and the Guidelines are available on the IADT web page http://www.iadt-dentaltrauma.org. In addition to the clinical guidelines there is also a forum for discussion

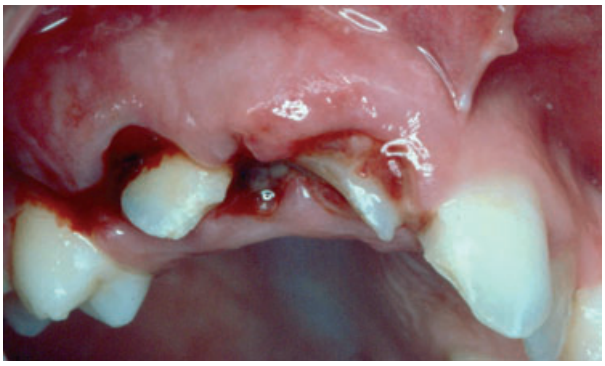


Fig. 3. Intrusive luxation of right lateral and central incisors. Crown fractures are seen on both intruded incisors and the adjacent left central incisor.

on this web page and a possibility to download information material for professionals and the public.

The publication of the IADT guidelines in the journal Dental Traumatology will be divided into three parts.

Part I: *Fractures and luxations of permanent teeth* in the present issue.

Part II: *Avulsion of permanent teeth* will be published in Dental Traumatology issue 3; 2007.

Part III: *Guidelines for injuries in the primary dentition* will be published in Dental Traumatology issue 4; 2007.

Guidelines contain recommendations for diagnosis and treatment of specific traumatic dental injuries using proper examination procedures. Below are some general recommendations:

Clinical examination

Detailed description of procedures such as clinical examination in the emergency situation (Figs. 1–3) and classification of injuries can be found in current textbooks (1, 5).

Radiographic examination

As a routine, several projections and angles are recommended:

- 90° horizontal angle, with central beam through the tooth in question.
- Occlusal view.
- Lateral view from the mesial or distal aspect of the tooth in question.

For more detailed information see current textbooks (1, 5).

Sensibility tests

Sensibility testing refers to tests (electric pulp test or cold test) to determine the condition of the tooth pulp. Initial tests following an injury frequently give negative results, but such results may only indicate a

transient lack of pulpal response. Follow-up controls are needed to make a definitive pulpal diagnosis.

Patient instructions

Good healing following an injury to the teeth and oral tissues depends, in part, on good oral hygiene. Patients should be advised on how best to care for teeth that have received treatment after an injury. Brushing with a soft brush and rinsing with chlorhexidine 0.1% is beneficial to prevent accumulation of plaque and debris.

For further reading we recommend some recent good review articles and original papers on treatment delay (6) fractures (7–11), intrusive luxations (12–14), and splinting (15–17). All relevant new and old references can be found in the recent textbook and atlas by Andreasen et al. (1).

Treatment guidelines for fractures of teeth and alveolar bone

Clinical findings	Radiographic findings	Treatment
Uncomplicated crown fracture		
Fracture involves enamel or dentin and enamel; the pulp is not exposed. Sensibility testing may be negative initially indicating transient pulpal damage; monitor pulpal response until a definitive pulpal diagnosis can be made	The 3 angulations described in radiographic examination to rule out displacement or fracture of the root. Radiograph of lip or cheek lacerations is recommended to search for tooth fragments or foreign material	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 accepted dental restorative materials
Complicated crown fracture		
Fracture involves enamel and dentin and the pulp is exposed. Sensibility testing is usually not indicated initially since vitality of the pulp can be visualized. Follow-up control visits after initial treatment includes sensibility testing to monitor pulpal status	The 3 angulations described in radiographic examination to rule out displacement or fracture of the root. Radiograph of lip or cheek lacerations is recommended to search for tooth fragments or foreign material. The stage of root development can be determined from the radiographs	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
Crown-root fracture		
Fracture involves enamel, dentin and root structure; the pulp may or may not be exposed. Additional findings may include loose, but still attached, segments of the tooth (Fig. 2). Sensibility testing is usually positive	As in root fractures, more than one radiographic angle may be necessary to detect fracture lines in the root (see radiographic examination)	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
Root fracture		
The coronal segment may be mobile and may be displaced. The tooth may be tender to percussion. Sensibility testing may give negative results initially, indicating transient or permanent pulpal damage; monitoring the status of the pulp is recommended. Transient crown discoloration (red or grey) may occur	The fracture involves the root of the tooth and is in a horizontal or diagonal plane. Fractures that are in the horizontal plane can usually be detected in the regular 90° angle film with the central beam through the tooth. This is usually the case with fractures in the cervical third of the root. If the plane of fracture is more diagonal, which is common with apical third fractures, an occlusal view is more likely to demonstrate the fracture including those located in the middle third	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). It is advisable to monitor healing for at least 1 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

Clinical findings	Radiographic findings	Treatment
Alveolar bone fracture		
The fracture involves the alveolar bone and may extend to adjacent bone. Segment mobility and dislocation are common findings. An occlusal change due to misalignment of the fractured alveolar segment is often noted. Sensibility testing may or may not be positive	Fractures lines may be located at any level, from the marginal bone to the root apex. The panoramic technique is of great help in determining the course and position of fracture lines	Reposition any displaced segment and then splint. Stabilize the segment for 4 weeks

Follow-up procedures for fractured permanent teeth and alveolar fractures

Time	4 weeks	6–8 weeks	4 months	6 months	1 year	5 years
Uncomplicated crown fracture		C(1)			C(1)	
Complicated crown fracture		C(1)			C(1)	
Crown-root fracture		C(1)			C(1)	
Root fracture	S + C(2)	C(2)	S(*) + C(2)	C(2)	C(2)	C(2)
Alveolar fracture	S + C(3)	C(3)	C(3)	C(3)	C(3)	C(3)

S, splint removal.
S (*), splint removal in cervical third fractures.
C, clinical and radiographic examination.

Favorable and unfavorable outcomes include some, but not necessarily all of the following

	Favorable outcome	Unfavorable outcome
1	Asymptomatic; positive response to pulp testing; continuing root development in immature teeth. Continue to next evaluation	Symptomatic; negative response to pulp testing; signs of apical periodontitis; no continuing root development in immature teeth. Root canal treatment is indicated
2	Positive response to pulp testing (false negative possible up to 3 months). Signs of repair between fractured segments. Continue to next evaluation	Negative response to pulp testing (false negative possible up to 3 months). Clinical signs of periodontitis. Radiolucency adjacent to fracture line. Root canal treatment is indicated only to the line of fracture
3	Positive response to pulp testing (false negative possible up to 3 months). No signs of apical periodontitis. Continue to next evaluation	Negative response to pulp testing (false negative possible up to 3 months). Signs of apical periodontitis or external inflammatory resorption. Root canal treatment is indicated

Treatment guidelines for luxation injuries

Clinical findings	Radiographic findings	Treatment
Concussion		
The tooth is tender to touch or tapping; it has not been displaced and does not have increased mobility. Sensibility tests are likely to give positive results	No radiographic abnormalities	No treatment is needed. Monitor pulpal condition for at least 1 year
Subluxation		
The tooth is tender to touch or tapping and has increased mobility; it has not been displaced. Bleeding from gingival crevice may be noted. Sensibility testing may be negative initially indicating transient pulpal damage. Monitor pulpal response until a definitive pulpal diagnosis can be made	Radiographic abnormalities are usually not found	A flexible splint to stabilize the tooth for patient comfort can be used for up to 2 weeks

Clinical findings	Radiographic findings	Treatment
Extrusive luxation		
The tooth appears elongated and is excessively mobile. Sensibility tests will likely give negative results. In mature teeth, pulp revascularization some times occurs. In immature, not fully developed teeth, pulpal revascularization usually occurs	Increased periodontal ligament space apically	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 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 rarification and sometimes crown discoloration
Lateral luxation		
The tooth is displaced, usually in a palatal/lingual or labial direction (Fig. 1a, b). It will be immobile and percussion usually gives a high, metallic (ankylotic) sound. Sensibility tests will likely give negative results. In immature, not fully developed teeth, pulpal revascularization usually occurs	The widened periodontal ligament space is best seen on eccentric or occlusal exposures	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 rarification and sometimes crown discoloration
Intrusive luxation		
The tooth is displaced axially into the alveolar bone. It is immobile and percussion may give a high, metallic (ankylotic) sound (Fig. 3). Sensibility tests will likely give negative results. In immature, not fully developed teeth, pulpal revascularization may occur	The periodontal ligament space may be absent from all or part of the root	1. *Teeth with incomplete root formation*: Allow spontaneous repositioning to take place. If no movement is noted within 3 weeks, recommend rapid orthodontic repositioning. 2. *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

Avulsion (will be covered in the next issue of Dental Traumatology).

Follow-up procedures for luxated permanent teeth

Time	Up to 2 weeks	4 weeks	6–8 weeks	6 months	1 year	Yearly for 5 years
Concussion/subluxation		C(1)	C(1)		C(1)	NA
Extrusive luxation	S+C (2)	C(3)	C(3)	C(3)	C(3)	C3)
Lateral luxation	C(3)	S	C(3)	C(3)	C(3)	C(3)
Intrusive luxation	C(4)		C(4)	C(4)	C(4)	C(4)

S, splint removal.
C, clinical and radiographic examination.
NA, not applicable.

Favorable and unfavorable outcomes include some, but not necessarily all of the following

	Favorable outcome	Unfavorable outcome
1	Asymptomatic; positive response to pulp testing (false negative possible up to 3 months); continuing root development in immature teeth; intact lamina dura	Symptomatic; negative response to pulp testing (false negative possible up to 3 months); no continuing root development in immature teeth, periradicular radiolucencies

	Favorable outcome	Unfavorable outcome
2	Minimal symptoms; slight mobility; no excessive radiolucency periradicularly	Severe symptoms; excessive mobility; clinical and radiographic signs of periodontitis. Root canal treatment is indicated in a closed apex tooth. In immature teeth, apexification procedures are indicated
3	Asymptomatic; clinical and radiographic signs of normal or healed periodontium; positive response to pulp testing (false negative possible up to 3 months). Marginal bone height corresponds to that seen radiographically after repositioning	Symptoms and radiographic sign consistent with periodontitis; negative response to pulp testing (false negative possible up to 3 months); breakdown of marginal bone. Splint for additional 3- to 4-week period; root canal treatment is indicated if not previously initiated; chlorhexidine mouth rinse
4	Tooth in place or erupting; intact lamina dura; no signs of resorption. In mature teeth, start the root canal treatment within the first 3 weeks	Tooth locked in place/ankylotic tone; radiographic signs of apical periodontitis; external inflammatory resorption or replacement resorption

Splinting guidelines for tooth/bone fractures and luxated/avulsed teeth

Splinting times

Type of injury	Splinting time
Subluxation	2 weeks
Extrusive luxation	2 weeks
Avulsion	2 weeks
Lateral luxation	4 weeks
Root fracture (middle third)	4 weeks
Alveolar fracture	4 weeks
Root fracture (cervical third)	4 months

Type of splints

Acid-etch bonded composite splints are recommended, e.g. wire-composite splints and TTS (titanium trauma splint). For detailed description of splinting see current textbooks and articles (1, 5, 15–17).

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