Traumatic Dental Injury: description, etiology, diagnosis, treatment, prognosis and prevention
Introduction

• The prevalence of dental trauma in children is very high. It varies types of trauma also varies with age and gender
• Prof Andreasson and his team has worked extensively on dental trauma and have developed the dental trauma guide – an excellent resource material.
• This slides will link you up to that website
Common causes of TDI

Most commonly reported causes of TDI include:

• Falls
• Collision
• Contact sports
• Road traffic accidents
• Child abuse
• Recently, environmental factors such as natural disasters have been implemented in TDI
History of dental trauma research

http://www.dentaltraumaguide.org/history.aspx
Patient examination

http://www.dentaltraumaguide.org/Examination.aspx
Trauma to the primary tooth

http://www.dentaltraumaguide.org/Primary_teeth.asp
Trauma to the permanent tooth

http://www.dentaltraumaguide.org/Permanent_teeth.aspx
Sequelae of dental trauma

Pulp necrosis

• Can be coagulation/ischemic necrosis (uninfected) or infection-related (liquefaction) necrosis.
• Results where the neurovascular supply to the pulp has been totally severed and revascularization fails.
• The pulp tissue will undergo necrosis and usually becomes infected. In rare cases it may remain sterile indefinitely.
Pulp necrosis

Diagnostic indicators for pulp necrosis:

- Periapical radiolucency
- Grey (blue or red) discoloration of the tooth crown
- Infection-related external root resorption
- No response to pulp sensitivity test
Pulp necrosis - 2

Diagnostic indicators for pulp necrosis:

• Tenderness to percussion and palpation in the vestibule develops after an asymptomatic period
• Presence of a fistula (sinus tract)
• Unchanged thickness of dentinal walls (arrested development) in cases where the neurovascular supply has been severed by the trauma and revascularisation has been attempted.
Sequelae of dental trauma - 2

Pulp canal obliteration

• A condition where hard tissue is deposited along the wall of the root canal and fills most of the pulp canal.

• In traumatic dental injuries where the neurovascular supply to the pulp has been severed and revascularization is successful, these teeth will show an accelerated deposition of hard tissue along the pulp canal walls.
Sequelae of dental trauma - 3

Pulp canal obliteration

• Within one year most teeth show a partial or totally obliterated pulp canal.

• However, even in these teeth a small diameter pulp canal still exists.

• These restricted pulp canals do have a small risk of developing infection-related pulp necrosis.

• This is a common sequelae in all types of luxation injuries that include displacement.
External surface resorption (repair-related external resorption)

- It is the result of removal of injured periodontal ligament tissue next to the root surface by macrophages and osteoclasts.
- It results in a saucer-shaped cavity on the root surface mostly involving cementum.
- Surface resorption is the first part of a healing process.
External surface resorption

• The resorption cavity will subsequently be fully or partially repaired by new cementum with insertion of new Sharpey’s fibers.

• If the initial cavity is deep enough to come in contact with dentinal tubules that communicate with an infected pulp, there is a risk of developing an infection-related resorption
External surface resorption

• Although it may occur after all types of luxation injuries, it is frequently found after lateral luxations.
• It may affect all parts of the root.
• In root fractures, surface resorption is common near the fracture site.
Ankylosis-related resorption (osseous replacement resorption)

• It is a tooth partially or totally anchored to the alveolar socket by a bridge or bridges of bone extending from the root dentine to the socket wall.

• Ankylosis is a progressive resorptive process seen in traumas where the tooth has received extensive damage to the innermost layer of the periodontal ligament and sometimes also the cementum.
Ankylosis-related resorption

- Competitive healing events occur between bone formation and regeneration of new periodontal ligament tissue.
- From the socket wall, bone will be formed by bone marrow derived cells.
- From the intact periodontal ligament, new cementum and Sharpey’s fibers will be formed.
Ankylosis-related resorption

- If the injury site is between 1-4 mm\(^2\) in size, a transient ankylosis can result in which the initial ankylosis subsequently is resorbed and replaced with new cementum and periodontal ligament.
- This process may be hampered if the tooth is rigidly splinted.
- In contrast, if the tooth is splinted with a flexible splint or not splinted, small movements of the tooth during the healing period may lead to a break-up of the initially formed, small ankylosotic sites.
Ankylosis-related resorption

- In injuries producing damaged areas larger than 4 mm\(^2\), healing with new periodontal ligament is unlikely.
- In these areas ankylosis with progressive resorption of root dentin and its replacement of with osseous tissue occurs.
- In effect, the tooth root becomes an integral part of the bone remodelling system.
Ankylosis is a very serious complication that inevitably leads to tooth loss.

In children and adolescents 8-16 years old, tooth loss occurs rapidly and is expected within 1-5 years.

In contrast, in adults the tooth may remain functional for many years.
Infection related resorption (inflammatory resorption)

- Resorption involving the root and the adjacent alveolar bone.
- Infection-related resorption is a progressive resorption that leads to tooth loss, unless endodontic therapy is initiated to eliminate the etiological agents (bacteria and necrotic tissue) responsible for the resorption process.
Infection related resorption

- Infection-related resorption may occur after an initial surface resorption has penetrated through the cementum, exposing dentinal tubules in a tooth with infected pulp necrosis.

- The osteoclastic process and the associated inflammation at the resorption site are fueled by toxins created by bacteria located in the pulp and/or dentinal tubules.
Infection related resorption

• The toxins travel by diffusion through the exposed dentinal tubules to the resorption site where they trigger osteoclastic activity and lead to resorption of the root surface and the adjacent socket bone.

• Infection-related resorption can be arrested if the infected pulp is removed and endodontic therapy performed.
Infection related resorption

• A healing process will be initiated in which new cementum, bone and periodontal ligament will be formed.

• If infection-related resorption affects a large surface area, healing with normal periodontal ligament may not occur. Instead ankylosis may occur.
Sequelae of dental trauma - 16

Traumatic or infection-related loss of marginal bone

• Loss of crestal bone around a traumatized tooth.
• When an area of periodontal ligament tissue and alveolar socket bone are injured, resorption occurs as part of a repair process.
Sequelae of dental trauma - 17

Traumatic or infection-related loss of marginal bone

• Sometimes this causes permanent loss of tooth supporting bone and gingival attachment.
• Alternately, the bone loss may be transient as the periodontium may recover by forming new alveolar bone tissue and periodontal ligament over a period of 2-3 months.
Transient marginal breakdown

- When contusion of the marginal supporting bone occurs, resorption of avascular bone must take place before bone regeneration can occur.
- During this phase the clinical and radiographic appearance of transient marginal breakdown is similar to that seen in a permanent loss of marginal bone.
Transient marginal breakdown

• However, in the case of transient marginal breakdown, the condition normalizes over several months when bone and periodontal ligament regenerate.

• If regeneration fails, the marginal breakdown becomes permanent.
Sequelae of dental trauma - 20

Pulp metaplasia

• A condition in which normal pulp tissue has been replaced with other tissue types such as loose or dense fibrous connective tissue, bone, cementum or periodontal ligament.
Sequelae of dental trauma - 21

Gingival reattachment

• A healing process in which lacerated, displaced or lost gingiva is regenerated with a normal sulcular attachment and new gingival collagenous fibers.
Periodontal ligament regeneration

- Ruptures of the periodontal ligament are typically seen after luxation injuries.
- They usually heal by a regenerative process where newly formed Sharpey’s fibers and fibroblasts splice the ruptured periodontal ligament.
- This process is far advanced by 2 weeks after the injury.
Tooth discolouration

- Most discolorations are internal in traumatized teeth.
- White discoloration may be seen in disturbances of enamel formation in permanent teeth where trauma to their primary predecessors influences enamel formation or enamel maturation.
Sequelae of dental trauma - 24

• Yellow discoloration of the tooth crown is a common finding after pulp canal obliteration. It also may be seen in the permanent dentition as a sequel to traumatic injuries affecting the primary predecessors.
• Grey discoloration is a common finding in trauma induced pulp necrosis and develops weeks or months after the injury. It is caused by the incorporation of pigments released from necrotic pulp tissue and degraded blood into the dentinal structure. In rare cases it may be reversible.
• *Red* discoloration may appear almost instantaneously after a luxation injury. This discoloration is anticipated to occur when a minor luxation injury severs the veins in the apical foramen and the arteries continue to carry blood into the pulp. Subsequent decomposition of the blood gradually results in a *bluish* or *bluish/brown* discoloration.
Pulp testing

• The aim of pulp testing is to assess the circulatory or sensory status of a traumatized tooth.
• An immediate negative response after trauma should not be considered pathognomonic for pulp necrosis as initial rupture of the neurovascular supply in many cases can be repaired.
Pulp testing - 2

- If reinnervation of the pulp has not occurred over a 3 month period, and sensibility tests still give negative results, the revascularization process has probably failed.
- A lack of response after 3 months should be considered a sign of pulp necrosis.
Pulp testing - 3

• The Laser Doppler Flowmetry (LDF) method is based directly on the circulation of blood in the pulp. Therefore, it can measure the vascular status directly.

• Comparisons between thermal, electrometric and LDF methods have shown that LDF is the most reliable test for circulatory status.
Treatment options

Dentine coverage

• Covering of exposed dentinal tubules with a suitable filling material (e.g. glass ionomer, composite or calcium hydroxide-containing cement) to prevent bacteria from entering the tubules and subsequently the pulp.
Pulp capping

- A covering over an exposed pulp to encourage the formation of new dentine to wall off the exposure.
- Commonly used materials are calcium hydroxide, calcium hydroxide-containing cement or mineral trioxide aggregate (MTA).
Partial pulpotomy (Chek’s pulpotomy)

• This is the surgical removal of the coronal portion (2 mm) of an exposed vital pulp as a means of preserving the vitality of the remaining pulp in the crown and root. The exposed pulp is then covered with a material that induces formation of a hard tissue barrier.

• Calcium hydroxide or MTA usually is used for this purpose.
Treatment options - 4

Decoronation

• The intentional removal of the crown, leaving the root portion of the tooth intact in order to preserve the alveolar bone structure.

• The root canal filling is removed and the canal allowed to fill with blood.

• The remaining root portion usually undergoes ankylosis, but may retain a normal periodontal ligament in some areas.
Decoronation

- The remaining root portion appears to maintain not only the labial-lingual/palatal dimension of the alveolar process, but also partially allow the development of the vertical height of the alveolar process.
- Preservation of the ridge enhances esthetic tooth replacement procedures.
Apexification

• An apical healing event in which an open apex is closed with newly formed hard tissue.

• Traditionally, calcium hydroxide has been used to induce the barrier which usually consists of an irregular cementum-like tissue.

• In rare cases a new apex is formed (apexogenesis), a finding related to the presence of a viable Hertwig’s epithelial root sheath.
Osseous integration

• A term used in connection with implants.
• It describes the condition where new bone forms directly against the implant material and fuses to the surface of the alveolar socket.
Osseous integration

- A similar healing event takes place in cases of tooth replantation where some or all of the periodontal ligament is damaged.

- In this situation the term is ankylosis or osseous replacement resorption.
Splinting

- Stabilization of loosened teeth, bone fractures or a combination of both with various splinting materials including sutures, acid-etch flexible resin splints, acid-etch-wire composite splints, acid-etch composite nylon line splints, acid-etch orthodontic wire splints, titanium trauma splints, arch bars, cap splints, or steel wire splints.
Repositioning

Repositioning a displaced tooth, alveolar fracture, root fracture or jaw fracture into its anatomically correct position. This can be done:

- **Manually:** with finger or hand pressure.
- **Surgically:** with forceps or by surgical exposure of a fracture site.
- **Orthodontically:** with orthodontic appliances.
Pulp extirpation (pulpectomy)

• The complete removal of the pulp
• Indicated following reimplantation of an avulsed tooth.
• Also indicated when there is possibility of surface and infection related resorption.
Effect of trauma to primary teeth on succedaneous teeth

- White or yellow-brown discoloration of enamel
- Crown dilaceration
- Odontoma-like malformation
- Root duplication
- Dilaceration
- Partial or complete arrest of root formation
- Sequestration of permanent tooth germ
Effect of trauma to primary teeth on succedaneous teeth - 2

Disturbances in permanent tooth eruption

• Ectopic eruption of permanent successors
• Impaction very common among teeth with malformations confined to either the crown or the root.
• When the permanent tooth does erupt, it is often in facio- or linguo-version.
Prevention

General principles of prevention of TDI

• Target risk group population
• Raise public awareness of emergency management and prevention
• Promote use of protective devices during sports
• Promote use of seat belts
• Improve playground and school environment
Prevention - 2

High risk groups for TDI:

• Children with increased overjet
• Children who already sustained previous trauma are at 8.4 times higher risk if trauma occurred before age 9yrs
• Children with risk taking behavior
• Children who attend schools with poor playground environment
Prevention - 3

Raise public awareness:

• Educate children about first aid when TDI occur using simple posters and information about
  • Avulsion: replace avulsed permanent teeth immediately or store in milk
  • Fracture: Look for tooth fragments

• Educate people who care for children including parents, school teachers, sports coaches
Use of protective devices

- These devices act by either preventing the impact from reaching the tissues, by absorbing the energy of the impact (cushioning), or by restraining the individual from making impact with a force
Types of protective devices

• Faceguards
• Helmets
• Mouthguards
Prevention - 6

Faceguards

- Cage of metal or composite attached to a helmet
- Either prefabricated or custom made
- It protects the face and the teeth but can’t protect the teeth if the hit is below the chin
- Particularly useful in protection while playing hockey
Helmets

- Helmets are encouraged during bicycle and motor cycle sports.
Prevention - 8

Mouthguards

- Prevent tooth injury by absorbing and deflecting blows to teeth
- Shield the lips, tongue, gingiva from laceration
- Prevent opposing teeth from coming into violent contact
- Provide mandible with support preventing fracture of angle or condyle
- The thicker the better protection up to 4mm
- The thicker the less the athlete comfort
Types of mouthguards:

- Stock (prefabricated)
- Mouth formed
- Custom made
Stock mouthguards

• Made from plastic or rubber
• Available in three sizes
• Advantages include being inexpensive, readily available if need replacement
• Disadvantages include being loose fit with limited possibility for modification. It can also be uncomfortable and can obstruct speech and breathing. It offers the lowest protection of all the types
Mouth-formed mouthguards

• Disadvantages: Bulky and may be rough
• Advantages: better fit, inexpensive, available
• First type: Consists of outer hard layer and an inner soft liner, the outer layer is made of vinyl, the inner layer is self curing methyl methacrylate or sillicone rubber
• Second type is made of PVA or PVC that is softened in hot water and adapted to the mouth
Prevention - 12

Custom mouthguards

• More comfortable form of mouthguards and most costly
• No evidence that they protect better than other types of mouthguards
• Should be replaced regularly as protective ability reduces over time
Custom mouthguards

• Most common material for fabrication is ethylene vinyl acetate (EVA) copolymer which is an elastomeric material with good clarity, gloss, low temperature toughness, stress crack resistance, little odor.
Mouthguards:

• Will absorb and disperse the energy of the impact by covering the whole maxillary arch
• Should allow mouth breathing
• Should protect soft tissues
• Should reproduce occlusal relationship
• Should be made on an impression of the athletes teeth
Care of mouthguards

- Should be washed with water and soap after each use
- Should be dried thoroughly and stored in a box
- Should be rinsed in mouthwash or mild antiseptic before wear.
- Should be inspected regularly to check its fit
- Replace regularly
Mouthguard should be worn for the following sports:

- Baseball
- Basketball
- Boxing
- Field and ice hockey
- Horseback riding
- Rugby
- Soccer
- Handball
Quiz 1

Luxation means the following tooth displacement

• Concussion
• Subluxation
• Lateral luxation
• Extrusive luxation
Quiz 2

The healing of root fractures can occur with:

• Calcified tissue
• Connective tissue
• Bone and connective tissue
• Fibrous tissue
Luxation outcomes:

- Pulpal necrosis
- Pulp calcification
- Root resorption
- Hypercementosis
Acknowledgement

• The materials for this slide was derived from the dental trauma guide.
• Permission was received to link the content of this slide to the webpages.
• Materials were adapted from the slides by Dr Suhad al-Jundi – Prevention of dental trauma and child abuse (2011).