

Ontario Dental Association

Diagnosis and Treatment of Oral Trauma

Jane A. Soxman, DDS
Diplomate, American Board of Pediatric Dentistry

Anticipatory Guidance

- Most parents and lay persons do not know how to manage acute dental trauma.
- Information regarding immediate injury management for injuries such as avulsion and reattachment of enamel fragments can be included in the examination.

Ozer S, Yilmaz EI, et al. Parental knowledge and attitudes regarding the emergency treatment of avulsed permanent teeth. Eur J Dent 2012;6:370-375.

Smartphone APP

- Can purchase app. for avulsion, subluxation, displacement, etc.
- Dental Trauma is name of app.

Al-Musawi A, Al-Sane M, Andersson L. Smartphone app as an aid in the emergency management of avulsed teeth. Dent Traumatol. 2017; 33:13-18.

- Documentation/Litigation
- What you started with
- May find something that was initially missed
- The precision of diagnosis of trauma from a photograph was comparable to clinical examination.

de Almeida GR, Rezende LVML et al. Remote diagnosis of traumatic dental injuries using digital photographs captured via a mobile phone. Dent Traumatol 2017;33:350-357.

Traumatic Injury Form

American Academy of Pediatric Dentistry. Assessment of Acute Traumatic Injuries. Pediatr Dent 2017/18;39(special issue):480-481.

SOAP Note

- S: Subjective in patient/parents words
- O: Objective - Clinical and radiographic findings
- A: Assessment
- P: Plan - Maintain good OH, Diet: as tolerated, soft, no incising, Notify for....., Follow-up in

Name _____ Age _____ Date _____

- Chief complaint - Now "Area of Concern"
- Medical history/Allergies
- Tetanus protection
- Past dental history/trauma
- Place, date and time of injury
- Time elapsed since injury
- Treatment for injury
- How injury occurred

Tetanus Toxoid

- Booster recommended every 10 years to restimulate the immune response.
- Immunization ages 5 and 11.
- Spores of *Clostridium tetani* live in soil.
- Wounds to head and face are more dangerous.
- Needed if dirty wound and more than 5 years since last tetanus shot within 48 hours.

Suspected Abuse

- Injury to head and associated areas 50% of the time.
- Bruises and injury to upper lip and labial frenum.
- Delay in seeking treatment.
- Child very quiet and parent will not permit child to be alone with healthcare provider.

Katner DR, Brown CE. Mandatory reporting of oral injuries indicating possible child abuse. *JADA* 2012;143:1087-1092.

- Falls are the most common cause of maxillofacial injuries in children.
- The mandible, especially the condyle, was most often the fracture site.

Boffano P, Roccia F et al. European maxillofacial trauma in children: A multicenter and prospective study. *Oral Surg Oral Med Oral Pathol Oral Radiol*; 2015;119:499-504.

- From what did patient fall?
- How far?
- How did patient land?
- What type of surface did he/she hit?

- Color (pale or good)
- Skin temperature (cool, clammy)
- Airway status/respirations
- Palpate head for hematoma

- PERLLA-Pupils equal, round, reactive to light and accommodation
- Diplopia, nystagmus, blurred vision
- Conjunctival hemorrhage- suggests orbital floor or zygomatic fracture
- Ecchymosis/swelling/active bleeding
- Check ears and nose for blood or CSF from hole in dura with head injury

Pediatric Concussion Syndrome

A child who is pale, drowsy, with continuous vomiting and/or has a headache should have a neurological evaluation in a hospital.

If no vomiting, and only headache, “watch” for first 30 minutes.

- Pediatric and adolescent age group sustain majority of concussions.
- Girls more often than boys (weaker neck musculature & smaller head mass).
- Physical and cognitive rest is the primary management.

Halstead ME, WalkerKD, et al. Sport related concussion in children and adolescents. *Pediatrics* 2010;126:597-615.

Traumatic Brain Injury

- Leading cause of death and disability in children older than one year of age.
- Majority of injuries were a fall from a standing position or while walking or running.
- 5% of all mild injuries showed traumatic brain injury on CT Scan.

Quayle KS, Holmes JF et al. Epidemiology of blunt head trauma in children in US emergency departments. *N Engl J Med* 2014;371:1945-1947.

Handlebar Impact

- Abdominal injuries, such as liver contusions or rupture of the liver and/or spleen, may not become evident until up to 24 hours after blunt abdominal trauma.
- Third most common trauma for pediatric trauma-related deaths.

Klimek PM, Lutz T, Stranzinger E, et al. Handlebar injuries in children. *Pediatr Surg Int.* 2013;29:269-273.

Moderate to severe penetrating injuries of the oropharynx area, particularly those of the hard and soft palate, should be covered with an antibiotic that is effective against gram negative bacteria ex: Clindamycin, in order to avoid a mediastinal infection or abscess.

Sasaki T, Toriumi S, et al. The toothbrush: A rare but potentially life-threatening cause of penetrating oropharyngeal trauma in children. *Pediatrics* 2006; 118:1284-1286.

- 1% of children who have penetrating palatal trauma may have a stroke.
- The puncture may cause internal carotid artery compression with resulting thrombosis and cerebrovascular injury.
- Sticks most often the source of the injury.

Hennelly K, Kimia A, Lee L, et al. Incidence of morbidity from penetrating palate trauma. *Pediatrics* 2010;126:e1578-e1584.

Jaw Fracture in Child

- Low incidence due to elasticity of bone.
- Thicker adipose tissue and collagen covering the bone.
- Usually automobile accidents or falls.
- Concern with growth centers and developing teeth.

- Pain
- Trismus
- Swelling
- Facial symmetry
- Change in occlusion
- Limited range of motion –ROM

- Mental nerve paresthesia
- Steps in bone may be palpated
- Ecchymosis lower third molar area
- Ecchymosis floor of mouth-sub-lingual

- CT scans are superior for detecting mid-facial fractures.

Thoren H, Iso-Kungas P, Lizuka T et al. Changing trends in causes and patterns of facial fractures in children. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2009; 107:318-324.

Greenstick Fracture

- Common in children due to elasticity of bone.
- Incomplete fracture without displacement.
- Non-displaced are managed with close observation, dietary and activity limitations.

Aizenbud D, Hazan-Molina H et al. The management of mandibular body fractures in young children. *Dent Traumatol* 2009;25:565-570.

Condylar Fracture

- Panoramic
- CT Scan
- Reverse Townes'

Cameron AC, Widmer RP. 2008. Orofacial Trauma. In: Handbook of Pediatric Dentistry, 3rd edition. Mosby: Sydney.

- Infracapsular fractures occur most often in children under age six.
- Subcondylar fractures occur predominately in children age six and older.
- Mandible deviates to affected side on opening with condylar fracture.

- Non-surgical management is the treatment of choice.
- Soft diet

Theologie-Lygidakis N, Chatzidimitriou K, Tzerbos F et al. Nonsurgical management of condylar fractures in children: A 15-year clinical retrospective study. J Craniomaxillofac Surg 2016;44:85-93.

Antibiotic Coverage

- If there is skin contamination in the wound, the drug must cover for staph as well.
- Use Augmentin (amoxicillin-clavulanic acid) or clindamycin.

Augmentin (Amoxicillin-Clavulanic Acid)

25-45mg/kg/24 hr given in divided doses

200, 400mg/5ml suspension

200, 400mg chewable

875mg tablet

BID dosage

Clindamycin

■ 10-30mg/kg/24 hr in divided doses TID or QID PO

■ 75mg/5ml (100ml) suspension

75, 150, 300mg capsules

Radiographs

- Occlusal, panoramic, cone beam-computed tomography for more serious injury..
- Obtain different periapical views of incisors by changing the angle of the cone by 10 degrees. Periapical central angle, periapical mesial eccentric and periapical distal eccentric.
- May also obtain a PA of the opposite arch.

www.dentaltraumaguide.org

American Association of Endodontists The Treatment of Traumatic Dental Injuries, Summer 2014

- The accuracy of predicting a root fracture was the same for both conventional and digital radiography.
- Obtaining several images from different angles is the best method to for diagnostic accuracy with a suspected root fracture.

Tofangchiha M, Bakhshi M et al. Conventional and digital radiography in vertical root fracture diagnosis: A comparison study. Dent Traumatol 2011;27:143-146.

Periapical RL

Periradicular RL

PDL intact

Internal Resorption

External Resorption

Calcific Metamorphosis

- Pulp canal obliteration not likely to progress to necrosis.

Andreasen FM, Kahler B. Pulpal response after acute dental injury in the permanent dentition. J Endod 2015;41:299-308.

- Pulp canal obliteration progresses rapidly and can not be stopped.
- Recognizable evidence is apparent during the first year after trauma.

Abd-Elmeguid A, ElSalhy M, Yu DC. Pulp canal obliteration after replantation of avulsed immature teeth. Abd-Elmeguid A, ElSalhy M, Yu DC. Dent Traumatol 2015;6:437-441.

- Endodontic treatment should be instituted on teeth with pulpal obliteration (calcific metamorphosis) only when periapical pathology is evident.

Oginni AO, Adekoya-Sofowora CA, Kolawole KA. Evaluation of radiographs, clinical signs and symptoms associated with pulp canal obliteration: An aid to treatment decision. Dent Traumatol 2009;25: 620-625.

Internal, Inflammatory & External Resorption

- Internal resorption occurs within the root.
- External resorption occurs on the outer surface of the root.
- Inflammatory resorption occurs when necrotic pulp toxins travel to root surface and create an inflamed PDL.

External Resorption/ Replacement Resorption

- PDL destroyed by tearing away with avulsion or from toxins in the infected pulp.
- Bone is now in direct contact with cementum.
- Osteoclasts (resorption) and osteoblasts (lay down bone) create union with bone.
- This leads to ankylosis and eventually infraocclusion.

- The interdental fibers are connected to the infraoccluded incisor *and* the adjacent teeth.
- Ankylosis interferes with eruption of the adjacent teeth.
- The adjacent incisors tip as they erupt.
- No marginal bone development occurs adjacent to the infraoccluded incisor.

Malmgren B. Ridge preservation/decoronation. *Pediatr Dent* 2013;35:164-169.

- Progression of resorption is slower after full growth is reached.
- No known endodontic treatment to stop replacement root resorption.

Sigurdsson A. Decoronation as an approach to treat ankylosis in growing children. *Pediatr Dent* 2009;31:123-128.

Color

Thermally induced pain/Spontaneous pain

Mobility

Masticatory pain

Buccal plate expansion

Quality of restoration

Pulp vitality testing

Percussion

Pulp Vitality Testing

- Recently traumatized teeth give unreliable results.
- Young permanent teeth with open apices, erupting permanent teeth and primary teeth unreliable results.

Sensitivity Tests

- Patient perception subjectively limits validity.
- Best methods: Endo-Ice and electric vitalometer beginning 10-14 days post trauma.

- Thermal - Stimulates expansion or contraction of the fluid in the dentinal tubules. Endo-Ice
- Place size 2 saturated cotton pellet in center of facial surface of incisor.
- Better test for immature permanent incisor.

- Electric Pulp Testing - High rate of false positives because it indicates only functional neurons, not pulpal health.
- Place on incisal edge of incisor.
- The development of nerve fibers in the peripheral tissue is relatively late, so immature permanent incisors give invalid results with EPT.
- EPT is preferred method for older, mature incisors with canal obliteration because it does not rely on flow of fluid in the dentinal tubules.

Levin LG. Pulp and periradicular testing. *Pediatr Dent* 2013;35:113-119.

- Vascular supply, not innervation, is the most reliable method to determine pulpal status.

Pozzobon MH, de Sousa Vieira R, et al. Assessment of pulp blood flow in primary and permanent teeth using pulse oximetry. *Dent Traumatol* 2011;27:184-188.

Percussion Testing

- Percussion is a good indicator of pulpitis at follow-up, indicating that infection has traveled from the radicular tissue, causing inflammation of the PDL.
- Sensitivity may indicate undetected alveolar fracture if persists at follow-up.

Levin L G. Pulp and periradicular testing. *Pediatr Dent* 2013;35:113-119.

- Monofilament fishing line-50pound.
- Flexible splint of .016" stainless steel arch wire, with or without orthodontic brackets, for 1-2 weeks to re-establish the PDL support of the tooth for both OPEN & CLOSED apex.
- Bond into place with flowable resin.
- Bonded on buccal surfaces to enable endodontic access.
- Also avoids occlusal interferences. (unless CI III)
- Keep clean! Chlorhexidine rinses wick through sulcus.

Splint

- Two weeks: Subluxation, extrusive luxation, lateral luxation and avulsion
- Four weeks: Avulsion dry longer than 60 minutes, middle third root fracture and alveolar fracture
- Four to eight weeks: Intrusion repositioned surgically or orthodontically
- Four months: Cervical third root fracture

Pediatric Dental Trauma Card

American Academy of Pediatric Dentistry

Dental Trauma Categories

Andreasen, JO et al. Effect of treatment delay upon pulp and periodontal healing of traumatic dental injuries-a review article. Dent Traumatol 2002;18:116-128.

Recommended Guidelines of the American Association of Endodontists for the Treatment of Traumatic Dental Injuries Summer 2014

To Optimize Pulpal and Periodontal Healing

- Acute Priority-within a few hours
- Subacute Priority-within 24 hours
- Delayed Priority-more than 24 hours

Recommended Guidelines of the American Association of Endodontists for the Treatment of Traumatic Dental Injuries 2004

- Treat within a few hours for most favorable response:

Avulsion-unless tooth replanted at the time of the avulsion, then subacute

Alveolar fracture

Extrusion

Lateral luxation

Root fracture-may also be subacute

- Delaying treatment for several hours does not affect the outcome:

Intrusion

Concussion

Subluxation

Crown fracture with pulp exposure

- Delaying treatment more than 24 hours may still have good response:

Crown fracture with no pulp exposure

- Consent includes risk of root resorption and ankylosis, possible need for endodontic treatment, surgical extraction, bone graft, interim prosthetics, implant and future prosthetics.
- Even after experiencing all of the consequences of replanting a permanent incisor, 80% of parents still would choose replanting the incisor.

Nguyen, P-MT et al. Economic burden of permanent incisor replantation on children and parents. Dent Traumatol 2004;20:123-133.

Instructions for Parents

- Hold the tooth by the crown--not the root.
- Gently rinse tooth for 10 seconds in running water. Plug the sink and do not scrub!
- ***Place the tooth in the socket or in milk (cold preferable). Make sure in correct position.

Avoid crushing PDL cells on root

- Replace depleted cell metabolites.
 - When the blood supply is cut off with an avulsion, the metabolites begin to be depleted within 5 minutes.
- Osmolality of PDL cells ranges from 280-320mOs (milliosmols) of pressure.
- Osmolality of milk is 230mOs of pressure and will preserve PDL cells for up to 8 hours.

- Inside the lip or cheek if patient conscious but saliva loaded with bacteria & osmolality very low (average 49 mOs & PDL 280-320mOs).
- Physiologic saline
- Hank's Balanced Salt Solution-Save-A-Tooth

American Academy of Pediatric Dentistry. Guideline for the management of traumatic dental injuries: 2. Avulsion of permanent teeth. Pediatr Dent 2017;18; 39(special issue): 412-428.

- Whole milk - not skim milk or heavy cream

- Soy milk, gatorade, egg white, coconut water, whole milk, distilled water and Hank's Balanced Salt Solution tested.
- Soy milk maintained fibroblast viability and was as effective as whole milk and HBSS.
- Distilled water had least viability.

Silva EJNI. Use of soy milk as a storage medium for avulsed teeth. Acta Odont Scand 2013;71:1101-1104.

- When placed in water, the PDL cells attempt to equalize with the surrounding environment.
- Water 17mOS
- PDL cell fluid moves to outside pressure environment in attempt to equalize the pressure.

- Avulsed teeth submerged in egg white, whole milk and Hank's Balanced Salt Solution for one hour.
- Teeth submerged in milk demonstrated thin PDL that could lead to ankylosis.
- Egg white maintained adequately thick PDL & has good availability.

Hasan MR, Takebe H, et al. Effects of tooth storage media on periodontal ligament preservation. Dent Traumatol 2017;33:383-392.

- Coconut milk and Probiotic milk evaluated for preserving vitality of PDL cells.
- Coconut milk not a good choice.
- Probiotic milk and Hanks Balanced Salt solution performed equally well.

Saini D, Gadicheria P et al. Coconut milk and probiotic milk as storage media to maintain periodontal ligament cell viability: An in vitro study. Dent Traumatol; 2017;33:160-164.

Hanks Balanced Salt Solution

- Debris may be soaked away from PDL with gentle agitation.
- Similar osmolality to PDL cells.
- Lost PDL nutrients replenished: Provides metabolites & glucose.
- 90% of cells maintain normal viability after 24 hours and 70% viable after 4 days.

Phoenix-Lazerus, Inc. 1-888-788-6684
www.save-a-tooth.com

- Desiccation ideally should not be more than 15 minutes.
- Replant within 30-40 minutes.
- By 30 minutes, most cells are dead.
- Dry for more than 60 minutes, ankylosis likely.
- Teeth that have been dry for 15 to 60 minutes will demonstrate less resorption if soaked for 30 minutes in HBSS prior to replantation.

Dry More Than 60 Minutes

- Goal is to preserve the tooth for esthetics and maintain alveolar bone contour.
- Prognosis is poor with eventual ankylosis and root resorption.
- 40-45% of PDL is torn off with avulsion.

- Removing the remaining PDL with gauze (scaler or pumice) may remove the stimulus for inflammation and infection-related resorption.

American Academy of Pediatric Dentistry. Guideline for the management of traumatic dental injuries: 2. Avulsion of permanent teeth. *Pediatr Dent* 2017/18; 39(special issue):415.

- Because the PDL is torn away with an avulsion, the cementum is now in contact with bone.
- A union between cementum and bone occurs resulting in *ankylosis* and then *infraocclusion*.
- The surrounding alveolar process continues vertical growth and the ankylosed tooth submerges.

- When ankylosis was diagnosed under 10 years of age, there was a high risk of severe infraocclusion during the adolescent growth spurt.

Malmgren B, Malmgren O. Rate of infraocclusion of replanted ankylosed incisors related to age and growth in children and adolescents *Dent Traumatol* 2002; 18:28-36.

- Endodontic treatment necessary with closed apex or open less than 1mm.
- Observe very immature tooth with wide open apex when revascularization is possible.

Apex open at least 1mm

Garcia-Godoy, F and Murray, PE. Recommendations for using regenerative endodontic procedures in permanent immature traumatized teeth. *Dental Traumatology*. 2012;28:33-41.

For Both Open & Closed Apex

- Remove clot from socket with gentle rinse of sterile saline and/or curette.
- Check for fractured of socket wall and reposition with appropriate instrument such as a sterile mirror handle.
- Replant slowly with slight digital pressure.

- May loosely suture gingival lacerations, particularly in the cervical area.
- PA to verify the replanted position of the tooth.
- PA to check root status of adjacent teeth and opposite arch.

Criteria for Splint Only

- Apex open at least 1.1 millimeter
- PDL preserved in proper transport medium
- *Less* than 60 minutes extra-oral-unless in HBSS
Revascularization is possible
without additional intervention

Criteria for Apexification

- Open apex *more* than 60 minutes extra-oral and not stored in proper transport medium.
Apexification: Non-vital Apexogenesis: Vital
- After 60 minutes, pulp is non-vital.
- Hope is to preserve the tooth and complete root formation/apexification.

- CaOH (HJ Kaiser 1964 and popularized by AL Frank 1966)
 - Multiple visits to replace the CaOH at 3-6 month intervals over 9-20 months
 - Short, weakened roots with thin dentinal walls. Subject to fracture during obturation or with additional trauma.

McTigue DJ, Subramanian K, Kumar A. Management of immature permanent teeth with pulpal necrosis. *Pediatr Dent* 2013;35:55-60.

- MTA may strengthen roots after obturation.
- Incisors obturated with MTA showed more resistance to vertical fracture than teeth obturated with gutta percha. (closed apices)

El-Ma'aita AM, Qualtrough AJ, Watts DC. Resistance to vertical fracture of MTA-filled roots. *Dent Traumatol* 2014;30:36-42.

- Biodentine can be used in a single appointment and has no aluminum so no discoloration like other tricalcium silicate-based cements. (Angelus MTA, MM-MTA, MTA-Caps, ProRoot MTA)
- Good choice for esthetic zones

Setbon HM, Devaux J et al. Influence of composition on setting kinetics of new injectable and/or fast setting tricalcium silicate cements. *Dent Mater* 2014;30:1291-1303.

- Permanent tooth root growth is usually complete 3 years after eruption.
- The majority of permanent tooth apices are closed 4 years after eruption.
- If the apex is closed, there is no chance for revascularization and cellular necrosis begins.

- Endodontic treatment required.
- If dry longer than 60 minutes, RCT can be performed prior to replantation.

Endodontics Colleagues for Excellence. The Treatment of Traumatic Dental Injuries. Summer 2014

Clinical & Radiographic F/U

- 4 weeks
- 3 months
- 6 months
- 1 year
- yearly thereafter

www.dentaltraumaguide.org

Home Instructions

- Brush teeth with soft toothbrush after each meal - Maintain good oral hygiene
- Use chlorhexidine gluconate (0.12%) mouth rinse twice daily for one week
- Return 1-2 weeks for splint removal and initiate RCT (closed apex) or monitor for revascularization (open apex)
- Avoid contact sports
- Soft diet for two weeks

- Remove splint
 - 1-2 weeks if tooth kept in appropriate storage media and extra-oral dry time less than 60 minutes
 - 4-6 weeks if extra-oral dry time more than 60 minutes
- Endodontic treatment at time of replantation or in 1-2 weeks for closed apex--before splint removed for stabilization of incisor

Doxycycline - Multiple formulations - must check individual formulation for use, dosage & administration

- Preferable to PCN for children >8 years
- For patient allergic to PCN
- Take for 7 days
- Less than 45kg: 2.5-5mg/kg/24 hr PO BID
- Greater than 45 kg: 100mg capsule BID

American Academy of Pediatric Dentistry. Useful Medications for Oral Conditions. *Pediatr Dent* 2017/18;39(special issue):494.

- Doxycycline taken for 10 days or less does not cause visible staining of permanent teeth in children under 8 years of age.

Todd SR, Dahlgren FS, et al. No visible staining in children treated with doxycycline for suspected rocky mountain spotted fever. *J Pediatr* 2015; 166:1246-1251.

Penicillin V Potassium - Liquid, tablet

- Take for 7 days
- Children <12years: 25-50mg/kg/24 hours in divided doses every 6-8 hours
- Max dose: 3Gm/24 hours
- >12 years of age: 250-500mg PO every 6-8 hours

American Academy of Pediatric Dentistry. Useful Medications for Oral Conditions. *Pediatr Dent* 2017/18;39(special issue):494.

Amoxicillin- Suspension, chewable tablet, tablet, capsule

- Take for 7 days
- Children <40kg: 20-40mg/kg/24 hours in divided doses every 8 hours. Maximum 500mg/dose.
- >12 years of age: 250-500mg every 8 hours or 500-875mg every 12 hours

American Academy of Pediatric Dentistry. Useful Medications for Oral Conditions. *Pediatr Dent* 2017/18;39(special issue):493.

The value of systemic antibiotics in treating avulsed teeth has not been proven.

Hinckfuss Se, Messer LB. An evidence-based assessment of the clinical guidelines for replanted avulsed teeth. Part II: Prescription of systemic antibiotics. *Dent Traumatol* 2009;25:158-164.

Andersson L, Andreasen JO, et al. International Association of Dental Traumatology Guidelines for the Management of Traumatic Dental Injuries: 2. Avulsion of Permanent Teeth. *Dent Traumatol* 2012;28:88-96.

American Academy of Pediatric Dentistry. Guideline for the management of traumatic dental injuries: 2. Avulsion of permanent teeth. *Pediatr Dent* 2017/18; 39(special issue):415.

Emergency Kit

- Mirror
- Monoject syringe
- Hanks Balanced Salt Solution (HBSS)
- Sterile saline or sodium hypochlorite
- .016 inch arch wire or 50 pd. monofilament fishing line
- Hard wire cutter or distal end cutter
- Phosphoric acid, composite, flowable composite
- Radiographic films
- (100mg Doxycycline mixed in 20ml saline)

- Treating the roots of avulsed incisors with Doxycycline was no better than rinsing with saline to prevent adverse outcomes of pulp survival and/or periodontal healing.

Tsilingaridis G, Malmgren B et al. Topical treatment of the roots of avulsed teeth with doxycycline compared to saline on 66 avulsed permanent teeth. *Dent Traumatol* 2015;31:171-176.

Primary Dentition Avulsion

- Primary incisor overjet - anticipatory guidance
- Consider timing for natural exfoliation
- Repeated injury is common

Malmgren B, Andreasen JO, et al. International Association of Dental Traumatology Guidelines for the Management of Traumatic Dental Injuries: 3. Injuries in the primary dentition. *Dent Traumatol*. 2012;28:174-182.

- Increased overjet is a significant risk factor for traumatic dental injuries in the primary dentition.

Feldens CA, Borges TS, et al. Risk factors for traumatic dental injuries in the primary dentition: Concepts, interpretation, and evidence. Dental Traumatol. 2016;32:429-437.

Alveolar Fracture-Permanent

- Bone segment involving the tooth/teeth is mobile. Reposition bone fragment if necessary.
- Take 1 occlusal, 1 PA central angle, 1 PA mesial eccentric, 1 PA distal eccentric. Panoramic may be indicated to follow the fracture line.
- Concomitant luxation of teeth-Splint for 4 weeks.

- Mobility of several teeth at the same time indicates alveolar fracture.

Levin LG. Pulp and periradicular testing. Pediatr Dent 2013;35:113-119.

- Clinical exam, PA and pulp vitality testing at 4 weeks (splint removal), 6-8 weeks, 4 months, 6 months, 1 year and yearly for 5 years.
- Pulp vitality may test negative up to 4 weeks.
- Teeth in fracture line may become necrotic.
- Inform patient of need to notify if any change in color or thermal sensitivity.

Extrusion/Partial Avulsion

- Tooth is displaced from the socket in an axial direction/excessive mobility.
- PDL is ruptured and apical vessels are damaged.
- PA/Occlusal shows increased PDL space apically.

- Delay of treatment usually makes repositioning difficult due to blood clot formation.
- Non-steroidal anti-inflammatory asap (maybe not for an asthmatic).
- If orthodontic appliances in place, have parent cut the wire to permit repositioning if possible.

- Local anesthesia prn for repositioning.
- Forceful reduction may cause additional injury.
- Slow orthodontic force may be necessary.

- Less than 3mm extrusion-moderate
- More than 3mm extrusion-severe
- Extrusion more than 3 mm with closed apex, endodontic treatment indicated.

Humphreys, K. et al. Factors affecting outcomes of traumatically extruded permanent teeth in children. *Pediatr Dent* 2003;25:475-478.

- I occlusal, I PA central angle, I PA mesial eccentric, I PA distal eccentric.
- Chlorhexidine/NS rinse prior to digital repositioning.
- Stabilize with a flexible splint for 2-3 weeks.
- Monitor for inflammatory root resorption and pulp necrosis with clinical and radiographic exam at 2 weeks, 4 weeks, 6-8 weeks, 6 months, 1 year and yearly for up to 5 years.

- If maxillary incisors were traumatized prior to orthodontic treatment, the incidence of pulpal necrosis may be increased with orthodontic intrusion.
- Obtaining a PA prior to treatment to determine pulpal obliteration is advised.

Bauss O, Rohling J, Rahman A, Kiliardis S. The effect of pulp obliteration on pulp vitality of orthodontically intruded traumatized permanent maxillary incisors. *J Endod* 2008;34:417-420.

Luxation

- Luxation injuries in the permanent dentition may result in inflammatory resorption.
- The PDL is broken inciting the osteoblasts to replace dentin with bone.
- The crown may appear normal with no mobility or may be displaced in a palatal or lingual direction. Re-position ASAP.

- Iocclusal and 3 periapical radiographs initially.
- Take one central angle PA after repositioning.
- PA to evaluate healing of marginal bone in 2 weeks, 4 weeks, 6-8 weeks, 6 months, 1 year and yearly for up to 5 years.
- Flexible splint 4 wks. or longer until bone healed.
- Monitor for pulp necrosis, especially with closed apex in permanent incisor.

- Can be immediately moved orthodontically.
- May have to open the bite slightly with orthodontic cement or composite on occlusal surface of molars if palatal displacement.

Fields HW, Christensen JR. Orthodontic procedures after trauma. *Pediatr Dent* 2013;35:175-183.

Luxation with Uncomplicated Crown Fracture

- In immature laterally luxated teeth, the risk of pulp necrosis increased from 5% to 40% with a concomitant uncomplicated crown fracture.
- The fracture should be restored as soon as possible after the injury.

Lauridsen E, Herman NV, et al. Combination injuries 3. The risk of pulp necrosis in permanent teeth with extrusion or lateral luxation and concomitant crown fractures without pulp exposure. *Dent Traumatol* 2012;28:379-385.

Luxation Injuries & Antibiotic Coverage

- Left to the discretion of the clinician.
- May be considered for medically compromised patients and/or those with accompanying injuries.

DiAngelis, AJ et al. International Association of Dental Traumatology guidelines for the management of traumatic dental injuries: I. Fractures and luxations of permanent teeth. *Dental Traumatol* 2012;28:2-12.

- There is no evidence to support the use of antibiotics for luxated teeth.

Diangelis AJ, Andreasen JO et al. International Association of Dental Traumatology Guidelines for the Management of Traumatic Dental Injuries: I Fractures and luxations of permanent teeth. *Dent Traumatol* 2012;28:2-12.

Root Fracture

- Trend is toward more conservative management.
- Coronal fragment is usually displaced. Apical fragment usually is not displaced.
- Loss of vitality twice as high with concomitant crown fracture.

- Crown fracture *not* protective against root fx
- Crown fractures twice as likely to have root fx
- No reason to suspect a complete root fx in pre-teens unless clinical signs are present.

Molina JR, Vann WF, McIntyre J et al. Root fractures in children and adolescents: diagnostic considerations. *Abstract J Ped Dent* 2007;29:153.

- Make sure film dark enough to see fracture.
- Root fractures tend to be M-D but we shoot B-L.
- Periapical shift shots- Change beam 15 degrees. First PA central angle, second mesial eccentric, & third distal eccentric for cervical third.
- Occlusal may also be obtained to locate fx in apical and middle third.

- Reposition tooth and stabilize the coronal fragment.
- The location of the fracture has not been shown to affect pulp survival.
- Preservation of the tooth with root fractures in the cervical third should be attempted.
- Cervical root fracture may require flexible splint for up to 4 months.

- 78% of all root fractures healed spontaneously.
- 18% of roots that healed required endodontic treatment.
- 30% of cervical third root fractures healed, but most often sustained new luxation injury to the coronal fragment.

- No difference in healing between splinted and non-splinted teeth when no dislocation of root fragments & cervical portion stable.
- Mid and apical third root fractures had no benefit by splinting for more than 4 weeks.
- AAE guideline now recommends splint for 2 weeks instead of 4 weeks. (AAE Summer 2014)

- The most successful healing of a root fracture occurs with hard tissue formation, which is more likely when using a flexible splint.

Andreasen FM, Kahler B. Pulpal response after acute dental injury in the permanent dentition. J Endod 2015;41:299-308.

- Open apex with root fracture may require splinting for up to 3 months with flexible splint depending on mobility of cervical portion.

Deshpande A, Deshpande N. Flexible wire composite splinting for root fracture of immature permanent incisors. Pediatr Dent 2011;33:63-66.

- Systemic antibiotics provide no therapeutic effect.

- Delay endodontic treatment until there is a radiolucency adjacent to fracture line.

Andreasen JO, Andreasen FM et al. Healing of 400 intra-alveolar root fractures. Dent Traumatol 2004; 20:203-211.

- Endodontic treatment if no response after 3 months with thermal or electric pulp testing.

Dental Trauma Guide

- Incisors that have sustained a root fracture should not be loaded with orthodontic forces for at least one year.

Kindelan SA, Day PF, Kindelan JD, Spencer J, et al. Dental Trauma: An overview of its influence on the management of orthodontic treatment. Part I. J Orthod 2008;35:68-78.

- Obliteration of the pulp chamber occurred in 45% of healed teeth, but had no effect on their survival.

Cvek M, Tsilingaridis G, Andreasen JO. Survival of 534 incisors after intra-alveolar root fracture in patients aged 7-17 years. Dent Traumatol 2008;24:379-387.

Follow-Up

- Splint removal, PA, vitality testing-false negative possible.
- Root Fracture: Clinical and radiographic exam at 4 weeks, 6-8 weeks, 6 months, 1 year and yearly for 5 years.
- Crown-Root Fracture-Uncomplicated and Complicated: Clinical and radiographic exam 6-8 weeks and 1 year.

- Check for signs of repair of fractured segments at each radiographic evaluation.

- If pulp does become infected or necrotic, endodontic treatment is indicated.

- Necrotic tissue is usually limited to the coronal segment and RCT can be confined to that segment. Apical segment may remain untreated.

Endodontics Colleagues for Excellence. American Association of Endodontists, Spring 2006

Intrusion of a Permanent Incisor

- Apical displacement of tooth into the alveolar bone with fracture of the alveolar socket.
- Very bad injury because strips PDL cells from root when pushed into a bony area of smaller diameter.
- Occlusal, PA and lateral views (make sure not into nasal cavity).

- Onset and rate of resorption are related to the degree of intrusion and apical development.
- Antibiotic not indicated.
- Neurovascular bundle and bone are crushed.
- Need to shut down initial inflammatory response asap-RCT immediately.

Three Treatment Modalities

- Watchful waiting for re-eruption
- Surgical repositioning
- Orthodontic repositioning

Complete root formation - Closed Apex

- Intruded up to 3mm, permit spontaneous eruption. (under age 17)
- If no movement after 2 to 4 weeks, surgical or orthodontic repositioning to avoid ankylosis.
- 3 to 7mm surgical or orthodontic repositioning.
- More than 7mm, surgical repositioning.

DiAngelis et al. 2012

Endodontics Colleagues for Excellence. The Treatment of Traumatic Dental Injuries. Summer 2014

Complete root formation - Closed Apex -

With concomitant uncomplicated crown fracture, necrosis may occur within 3 months.

Wang C, Quin M, Guan Y. Analysis of pulp prognosis in 603 permanent teeth with uncomplicated crown fracture. Dent Traumatol 2014;30:333-7.

Incomplete root formation - Open Apex

- Permit spontaneous re-eruption for 3 weeks if intrusion 7mm or less.
- If no movement w/in a few weeks, orthodontic repositioning.
- If more than 7mm intrusion, surgical or orthodontic repositioning is recommended.

Endodontics Colleagues for Excellence. The Treatment of Traumatic Dental Injuries. Summer 2014

Andreasen JO, Bakland LK, Andreasen FM. Traumatic intrusion of permanent teeth. Part 3. A clinical study of the effect of treatment variables such as treatment delay, method of repositioning, type of splint, length of splinting and antibiotics. Dent Traumatol 2006; 22:99-111.

Root development and degree of intrusion important factors for development of pulp necrosis and replacement resorption.

Awaiting re-eruption resulted in the lowest risk for developing replacement resorption.

Tsilingaridis G, Malmgren B, Andreasen JO et al. Scandinavian multicenter study on the treatment of 168 patients with 230 intruded permanent teeth--a retrospective cohort study. Dental Traumatology 2016, Wiley Online Library.

Surgical repositioning favored over orthodontic repositioning due to multiple visits, higher treatment costs and patient cooperation.

Kirzioglu Z, Karaylmaz H. Repositioning of a completely intruded permanent incisor with surgical extrusion: A 4-year follow-up case. *Pediatr Dent* 2009;31:253-6.

Fewest complications were seen with spontaneous re-eruption.

No clear difference in outcome between surgical or orthodontic repositioning.

AlKhalifa JD, AlAzemi AA. Intrusive luxation of permanent teeth: A systemic review of factors important for treatment decision-making. *Dent Traumatol* 2014;30:169-175.

- Occlusal, periapical central angle, periapical mesial eccentric, periapical distal eccentric.
- Lateral exposure indicated if completely intruded to evaluate penetration into nasal cavity.
- PA and clinical exam at 2 weeks, 4 weeks, 6-8 weeks, 6 months, 1 year and yearly for 5 years.

www.dentaltraumaguide.org

- Soft diet for one week.
- Maintain good OH, chlorhexidine 0.1% rinse.
- Remove splint in 4 weeks if surgically repositioned.
- PA and clinical exam at 2 weeks, 4 weeks, 6-8 weeks, 6 months, 1 year and yearly for 5 years.

www.dentaltraumaguide.org

Endodontics Colleagues for Excellence. The Treatment of Traumatic Dental Injuries. Summer 2014

Intrusion of Primary Incisor

- With complete intrusion, may appear to have been avulsed
- Palpable facial bulge
- PA will confirm status
- Determine relationship to permanent incisor follicle with periapical & lateral radiographs

- Permit spontaneous re-eruption if primary incisor root is directed away from the developing permanent incisor.
- 90% will spontaneously re-erupt in 2-6 months.
- Extract if not re-erupted within 6 months.

- In children 1- 4 years of age, 53% of permanent successors experienced enamel hypoplasia or eruption disturbance after an intrusive injury.
- Pulp necrosis and premature loss were most frequent complications. (80%)

Carvalho V, Jacomo DR, Campos V. Frequency of intrusive luxation in deciduous teeth and its effects. Dent Traumatol 2010;26:304-307.

- Intrusion and avulsion injuries have highest incidence of damage to the permanent successor.
- Inform parents of possible damage to the developing permanent incisor.

Lenzi MM, Alexandria Ak, Ferreira DM et al. Does trauma in the primary dentition cause sequelae in permanent successors? A systematic review. Dent Traumatol; 2015;31:79-88.

Concussion of Permanent Incisor

- PDL absorbs injury. Tooth tender to touch/ percussion.
- Ibuprofen for PDL inflammation.
- No mobility/displacement/marginal bleeding.

- Obtain 1 central angle PA and one occlusal radiograph to check PDL space/confirm no displacement.
- Typically no radiographic abnormalities.
- Follow for evidence of pulpal necrosis with closed apex.
- Follow-up 4 weeks, 6-8 weeks & 1 year with clinical and radiographic exam.

Concussion of Primary Incisor

- Usually discolor - days, weeks or months
- Color change does not indicate need for pulpectomy.

Soxman JA, Nazif M, Bouquot J. Pulpal pathology in relation to discoloration of primary anterior teeth. ASDC Journal Dent Child; 1984;51:282-284.

Cardoso M, deCarvalho Rocha MJ. Association of crown discoloration and pulp status in traumatized primary teeth. Dent Traumatol 2010;26:321-324. Strongly associated with pulp necrosis.

- Monitor clinically: Mobility, buccal plate expansion, symptomatic.

Subluxation of Permanent Incisor

- Abnormal loosening but *no* tooth displacement.
- PDL absorbs the injury.
- Bleeding from the sulcus confirms the diagnosis.
- Obtain one central angle periapical and one occlusal radiograph. Usually no findings.

- Check incisor and adjacent teeth for enamel craze (infracture)/mobility.
- Flexible splint optional. Use for comfort or Class III mobility for 1-2 weeks or if occlusal interferences.
- Soft Diet.
- Parent to notify for discoloration/thermal changes.

- Clinical exam with PA and vitality check at 2 weeks, 4 weeks, 6-8 weeks, 6 months, 1 year, and yearly for up to 5 years.

Endodontics Colleagues for Excellence. The Treatment of Traumatic Dental Injuries. Summer 2014

Dental Trauma Guidelines follow-up does not include 6 months or yearly for up to 5 years

Class II Crown Fracture

Complicated is always Subacute -
within 24 hours

Uncomplicated may be Subacute or Delayed -
within 24 hours or more than 24 hours

AAE Guidelines

- The maxillary central incisors were most commonly involved in primary tooth fractures.
- Fractures were associated with increased overjet and incompetent lip posture.
- Children with fractures had a 1.3-fold greater risk of incurring another fracture.

Correa-Faria P, Palva SM et al. Incidence of crown fracture and risk factors in the primary dentition: A prospective longitudinal study. Dent Traumatol;2016;450-456.

Hyperactivity in school-aged children was significantly associated with more traumatic dental injuries. Increased overjet was also found to be a significant risk factor.

Mota-Veloso I, Soares MEC et al. Signs of attention deficit/hyperactivity disorder as a risk factor for traumatic dental injury among school children: A case-control study. Int J Paediatr Dent 2016;26:471-476.

- Overjet greater than or equal to 6mm increased the incidence of trauma by fourfold.

Schatz J-P, Hakeberg M, et al. Injuries to permanent dentition and its association with overjet in a Swiss child population. Dent Traumatol 2013;29:110-114.

Complicated & Uncomplicated Crown Fracture

- Periapical central, eccentric and occlusal films:
 - Root fracture
 - Root development - open/closed apex
 - Proximity to pulp chamber
- Clinical exam and periapical radiograph at 6-8 weeks and 1 year

www.dentaltraumaguide.org

Crown Fracture with Pulp Exposure

Complicated Crown Fracture

- Size of the pulp exposure
- Time elapsed since trauma
- Root development - Open or closed apex

Direct Pulp Capping

- Glass ionomer not recommended due to hydrophilic
- Calcium hydroxide
- MTA-use white (but may still discolor with cure)

Two best pulp capping agents: CaOH & MTA
AAE Treatment of Traumatic Dental Injuries Summer 2014

- Bleeding must be controlled prior to placing the pulp capping agent.
- Disinfecting agent is flushed away with sterile saline or anesthetic solution.
- Thorough rinsing reduces the residual bacteria and removes blood that would provide an excellent medium for bacterial growth.

Calcium Hydroxide

- Dycal and other formulations preferable to USP powder.
- Addition of methylcellulose holds the CaOH in suspension and adheres to the pulp tissue and dentin.
- USP powder has no binders/fillers and will be absorbed into the open blood vessels causing congestion, infarcts and pulp necrosis.

- For non-contaminated exposure of short duration and no spontaneous bleeding
- Clean with chlorhexidine solution
- Place cap agent of choice
- Place a layer of resin-modified glass ionomer cement (RMGIC)
- Restore with composite

Oliveira GMS, Ritter AV. Composite resin restorations of permanent incisors with crown fractures. *Pediatr Dent* 2009;31:102-109.

Cvek or Partial Pulpotomy

Dr. Miomir Cvek 1978 Success if tx. w/in 30 hrs.

- By removing only the inflamed pulp tissue with the Cvek technique, the pulp is permitted to remain vital.
- The procedure allows for continued dentin deposition and root apex maturation.

Cvek M.A clinical report on partial pulpotomy and capping with calcium hydroxide in permanent incisors with complicated crown fracture. J Endod 1978;4:232-237. CLASSIC ARTICLE

- Cvek pulpotomies are more successful than direct pulp capping for complicated crown fractures.

Andreasen FM, Kahler B. Pulpal response after acute dental injury in the permanent dentition. J Endod 2015;41:299-308.

- Time is not a critical factor. Success rates of up to 90% with Cvek pulpotomy have been shown after one week.
- Exposures <4mm in diameter have high success rates.
- Increased success with open apices.

Bimstein E, Rotstein I. Cvek pulpotomy revisited. Dent Traumatol 2016; 32:438-442.

- Obtain pulpal anesthesia
- Place rubber dam
- Cleanse with chlorhexidine solution
- Use sharp curette or small sterile round diamond bur at high speed to remove superficial pulp layer, while flushing with sterile saline.

- Cvek opens entire incisal area from mesial to distal the full width of the pulp chamber.
- The pulp tissue is abraded away to a depth of 2-4mm with sterile curette.
- Dry with sterile cotton pellets.

- After complete hemostasis, apply calcium hydroxide or white MTA to pulp stump.
- Cover with RMGIC (resin-modified glass ionomer cement).
- Place flowable composite or glass ionomer.
- Follow-up clinical and radiographic exam 6-8 weeks and 1 year. (Dental Trauma Guide)

Class I Crown Fracture

- Enamel only involved- Smooth edges if sharp.
- Periapical central, eccentric and occlusal to rule out root fracture or luxation.
- Clinical exam and periapical radiograph at 6-8 weeks and one year.

www.dentaltraumaguide.org

- Keep the fragment moist with saline or water.
- Reattachment of a dry fragment is not recommended.

Sharmin DD, Thomas E. Evaluation of the effect of storage medium on fragment reattachment. Dent Traumatol;2013;29:99-102.

- If the fragment is dry, soak in distilled water or saline for 30 minutes prior to reattachment.

- Enhanced durability due to wear at same rate as other incisor.
- Natural translucency and surface finish with original esthetics.
- A 45 degree circumferential bevel does not enhance retention of crown fragment.
- A fracture sloping toward the cervical will be more retentive.

- The use of calcium hydroxide along the fracture line significantly reduces bond strength.

- May function for up to seven years.

Macedo GV, Ritter AV. Essentials of rebonding tooth fragments for the best functional and esthetic outcomes. Pediatr Dent 2009; 31:110-116.