Complex therapy of traumatic injuries of permanent teeth

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Statistics of Traumatic Dental Injuries (TDI)

- Most frequent traumas for pediatric patients
- 25% of children suffer TDI (in case of boys more frequent)
- Most of the cases between age 8-11
- Root maturation ceases at age 11 radiologically, but histologically only at age 14-15
- Most cases (80%) are not treated

Risk factors

- Sport: contact sports, skateboard, extreme sport etc., horse riding
- Playground
- Car accident
- Child abuse

Classification of dental injuries
WHO 1995

1. Injuries of the hard dental tissues and the pulp
- Enamel infraction
- Enamel fracture
- Enamel-dentin fracture
- Enamel-dentin-pulp fracture

2. Injuries of the hard dental tissues, the pulp and the alveolus
- Crown and Root fracture
- Root fracture
- Alveolar fracture

3. Injuries of the periodontal tissues
- Concussion
- Subluxation
- Lateral luxation
- Intrusive luxation (Intrusion)
- Extrusive luxation (Extrusion)
- Avulsion (Exarticulation)

4. Injuries of the gingiva or the oral mucosa
- Laceration
- Contusion

Examination of the patient

1) History records
   1) General medical history (medications, allergies, immunization(vaccines, tetanus!), general health)
   2) History of trauma
      a. When?
      b. Where?
      c. How?
      d. Previous dental treatments?
      e. Previous dental injuries?
      f. Did the patient find all parts of the fractured tooth/the whole exarticulated tooth/teeth?
      g. Was there a period of unconsciousness? If so, for how long? Amnesia, nausea and vomiting are all signs of brain damage and require medical attention.
2) Clinical examination:
   a) extraoral,
   b) intraoral (soft tissues, vitality, percussion, mobility)
3) Radiographic examination

Classification of the injuries

Injuries of the periodontal tissues

- Concussion
- Subluxation
- Extrusion
- Lateral luxation
- Intrusion
- Avulsion
- Alveolar fractures

Injuries of the hard dental tissues and the pulp

- Infraction
- Enamel fractures
- Uncomplicated enamel-dentin fractures
- Complicated enamel-dentin fractures
- Uncomplicated crown-root fractures
- Complicated crown-root fractures

Concussion

An injury of the tooth-supporting structures without increased mobility or displacement of the tooth

- Gingival bleeding: -
- Percussion: tender
- Mobility: normal
- Sensibility test
  - +
  - If -: higher possibility of necrosis of the pulp later
  - Pseudo-negative: can be for 3 months
- Radiographic: No radiographic abnormalities.
  - ➥ Normal root formation should be checked for 1 year
- Treatment:
  - ➥ No need for specific tx
  - ✓ 1-2 week soft food
  - ✓ Brush with a soft brush after every meal and apply chlorhexidine 0.1 % topically to the affected area with cotton swabs twice a day for 1 week.
- ✓ Parents should be further advised about possible complications that may occur, like swelling, dark discoloration of the crown, increased mobility or a fistula.
- ✓ Follow-up clinical : 4 weeks, 6-8 week, 1 year later

Subluxation

Injury of the periodontal structures with increased mobility and bleeding of the sulcus

- Gingival bleeding
- Mobility
- Percussion: +
- Vitality:
  - +
  - If -: higher possibility of necrosis of the pulp later
  - Pseudo negative: can be for 3 months
- Radiograph: no sign
- Tx:
  - No need for etxra tx
  - 2 weeks of flexible splinting might be for the comfort of the patient
  - Usual instructions (soft food, soft toothbrush, CHX)
- Follow-up clinical : 4 weeks, 6-8 week, 1 year

https://dentaltraumaguide.org/dental-guides/permanent-subluxation/permanent-subluxation-treatment/

Extrusion

Partial, axial displacement of the tooth

- Percussion: +
- Mobility: extreme
- Vitality: - (except the very mild cases)
- Radio: Enlarged periodontal space
- Open apex: higher possibility of revasculation

https://dentaltraumaguide.org/dental-guides/permanent-extrusion/permanent-extrusion-etiology/

Extrusion

- Alveolar bone: intact (not like in lateral luxation)
- Periodontal ligaments: disattached partially or totally
- Might come with retrusion or protrusion

https://dentaltraumaguide.org/dental-guides/permanent-extrusion/permanent-extrusion-etiology/

Extrusion- treatment

- Clean the exposed root surface with physiological saline solution
- Reposition
- Flexible splinting: 2 weeks
  - Open apex:
    - follow-up
    - for any pathologic sign or stop in the formation of the root : Apexification
  - Closed apex: if negative response to pulp testing after 3 months; or any sign of pathology (resortbion, inflammation): root canal treatment
- Constant monitoring of the pulp (internal or external resorption)
- Instructions
- Control: 2, 4, 6-8 weeks, 6 months, 1, 5 year later

https://dentaltraumaguide.org/dental-guides/permanent-extrusion/treatment-1/
https://dentaltraumaguide.org/dental-guides/permanent-extrusion/treatment-2/

https://www.blackwellpublishing.com/content/BPL_Images/Content_store/Sample_chapter/9781405129541/9781405129541_sample.pdf

Lateral luxation

Displacement of the tooth other than axially.

Percussion: +, ankylotic sound

- Mobility: usually –
- Sensibility test: -
- Radiographic: enlarged periodontal space
  - Coronal, periapical, and excentric X-ray

- Alveolar bone: fractured on either labial or palatal side
- Periodontal ligaments: disattached partially or totally

https://pocketdentistry.com/33-luxations-and-avulsion/

Lateral luxation - treatment

- Reposition
- Avoid early contacts !! Bite raising, grindig
- Flexible splint: 4 weeks (bc of bone fracture)
  - Open apex:
    - follow-up
    - for any pathologic sign or stop in the formation of the root : Apexification
  - Closed apex: if negative response to pulp testing after 3 months; or any sign of pathology (resortbion, inflammation): root canal treatment
- Instructions
- Removal of the splint: fix the teeth with your finger!
- Follow up: 2, 4, 6-8 weeks, 6 months, 1 year later, annually for 5 years

Calculating the prognosis:

https://dentaltraumaguide.org/dental-guides/permanent-lateral-lux/permanent-lateral-lux-prognosis/

https://www.intechopen.com/books/trauma-in-dentistry/dental-traumatology-in-pediatric-dentistry

https://dentaltraumaguide.org/dental-guides/permanent-lateral-lux/treatment-2/

Intrusion

Axial displacement of the tooth, trending towards the inside of the alveolar bone; usually with the fracture of either side of the cortical bone

- Percussion: +, ankylotic sound (high)
- Sensibility test: +/-
- Mobility: not mobile, apex stucked in the bone
- Radiographical: period. space not recognisable
  - Occlusal, periapical, excentric X-ray
  - If you cannot see the tooth, lateral X-ray (might be in the nasal cavity)

www.intechopen.com/books/trauma-in-dentistry/dental-traumatology-in-pediatric-dentistry

Intrusion- treatment

	Degree of intrusion	Repositioning		
		Spontaneous	Orthodontic	Surgical
OPEN APEX	Up to 7 mm	x		
	More than 7 mm		x	x
CLOSED APEX	Up to 3 mm	x		
	3-7 mm		x	x
	More than 7 mm			x

- Depends on the stage of the root formation
- If there is no spontaneous eruption after 2-4 weeks: orthodontic extrusion is required to prevent ankylosis
- Surgical repositioning: only right after the injury
- 2-4 weeks of flexible splint: also after Surgical/ orthod. Reposition
- Closed apex: RCT, 3-4 weeks later (to prevent extrenal root resorbtion)
- Open apex: apexification (if otherwise not developping)
- Instructions
- Follow-up: 2, 4, 6-8 weeks, 6 months, 1 year, later annually for 5 years
- Endo. Tx.: if not vital after 3 moths, inlflammation, resorbtion

https://dentaltraumaguide.org/dental-guides/permanent-intrusion/treatment-2/
https://dentaltraumaguide.org/dental-guides/permanent-intrusion/treatment-3/

Avulsion

Total displacement of the tooth from the alveolus

How to save the tooth?

- The best if the patient can carry the tooth in his/her own mouth (good osmotic and pH circumstances)
- Milk (cold, pasteurized) could be a good option also
- Hanks Balanced Salt Solution (HBSS)
- Dentosafe zahnrettungsbox
- Miradent SOS zahnbox

Avulsion - PDL

- ✓ If the replantation is in **15 mins**.-> PDL can regenerate
- In 1 hour: if the tooth was held properly (in the mouth) it must be replaced
- After 1 hour, or if it was carried outside of the mouth (napkin, jewelry box etc.)-> chance of successful replantation is low, bc the PDLs are dried out, contaminated…

Management of avulsion

Immediately:

- replantation on the spot

In dental office:

- replantation or not
- Instructions
- ANTIBIOTICS (+tetanus)

Avulsion – treatment – open apex

Less than 1 hour extraoral

- Clean (tooth, socket)
- Local anesthesia
- Replant, sutures
- Splinting
- ANTIBIOTICS (+/- tetanus)

More than 1 hour extraoral

<-Same

- poor long-term prognosis
- possible outcome: ankylosis and resorption of the root
- Aim: esthetic reasons, preserve the alveolar bone

- For immature teeth, root canal treatment should be avoided unless there is clinical or radiographic evidence of pulp necrosis.
- Splint removal and clinical and radiographic control after 4 weeks.
- Clinical and radiographic control 4 weeks, 3 months, 6 months, 1 year later and then yearly.

Avulsion – treatment – closed apex

Less, than 1 hour extraoral

- Clean (tooth, socket)
- Local anesthesia
- Replant, sutures
- Splinting
- ANTIBIOTICS (+/- tetanus)
- Root canal treatment 7-10 days after replantation. Ca(OH)2 as an intra-canal medicament for up to 1 month followed by root canal filling with an acceptable material

More, than 1 hour extraoral

<- same

- possible outcome is ankylosis and resorption of the root and the tooth will be lost eventually.

Avulsion – treatment
Management of the root surface

- Keep it constantly wet
- Don’t touch!!
- Hold only by grabbing the coronal part
- If the surface looks clean
  - Rinse it with HBSS/ physiological saline solution
  - **Replant the tooth**
- Periapical X-ray (to control the replantation)
- Flexible splint: 2-4 weeks
- ANTIBIOTICS
- 0,1 % CHX rinse for 1 week
- Tetanus shot!- if the previous shot was more, than 5 years ago
- Instructions

Avulsion- treatment
Management of the alveolar bone

- Don’t perform curettage
- Rinse it with physiological saline solution if it is filled with clump
- Surgical flap is not necessery, only if it need further tx
- After replantation squeeze the alveolus to the tooth

Avulsion- treatment Splinting

- Flexible splint for 2 weeks, or 4 weeks if needed (No more to avoid ankylosis)
- If the alveolar bone is also fractured: max. 2-8 weeks of splinting
- With composite, elastic wire, or bracket and SS wire (passively!!!)

Avulsion – possible complications

- Ankylosis („Sinking” of the tooth)
- Inflammation and root resorbtion

Alveolar fracture

Fracture of both sides of the alveolar bone

- Most of the time, there is no displacement: spontaneous healing
- If there is displacement
  - Reposition
  - Flexible splint: 4 weeks (to avoid ankylosis)
  - Instructions
  - Follow-up (clinical and radio):
    1 week, 1, 2, 4, 6 months, 1 year later, than yearly
  - In case of fever: antibiotics
  - Tetanus if needed (5 years!)

https://www.researchgate.net/figure/Dento-alveolar-fracture_fig6_45422449

Infraction

An incomplete fracture (crack) of the enamel without loss of tooth structure

- Fracture lines in enamel
- Percussion: -
- Mobility: normal
- Radiographic: only in case of percussion + (Luxation, root fracture)
- Tx: etch+ bond (only in visible cases, protects from discoloration)
- Follow-up: not necessary

Enamel fraction

The fracture affects only the enamel

- Percussion: -
- Mobility: Normal
- Sensibility test: usually +
- Radiographic: only in case of tenderness or to exclude fragments in soft tissues
- Tx.: smoothig the surfaces, fluoride application, rebond the fragment to the tooth, composite restoration
- Follow-up (clinical and radiological): 6-8 weeks, 1 year later

https://www.researchgate.net/figure/6-Enamel-fracture-of-maxillary-central-permanent-incisors_fig6_327057475

Enamel-dentin fracture

Fracture confined to enamel and dentin with loss of tooth structure, but not involving the pulp

- Percussion: -
- Sensibility test: usually + (might be – first, if the pulp is also affected, higher risk of later necrosis)
- Mobility: normal
- Radiographic: periapical, excentric, and coronal x-ray to exclude root fracture
- Follow-up: 6-8 weeks, 1 year later

https://www.dentaltown.com/magazine/article/3489/restoration-of-a-central-incisor-with-tetric-evoceram

Enamel-dentin fracture – treatment

Open apex:

- Temporary tx:
  - Ca(OH)2, GIC cement (protective crown)
- Definitive tx:
  - Rebond the fragment or composite restoration

Closed apex

- Definitive tx

Enamel-dentin-pulp fracture = Complicated crown fracture

The pulp is exposed

- Percussion: -
- Sensibility test: usually + (temporary loss of vitality enhances the risk of later necrosis)
- Mobility: normal
- Radiographic: periapical, excentrical, occlusal (to exclude any displacement, root fracture)
  - ➥ Loss of tooth material

https://pediatriconcallblog.wordpress.com/2015/12/10/dental-injuries-and-traumas/

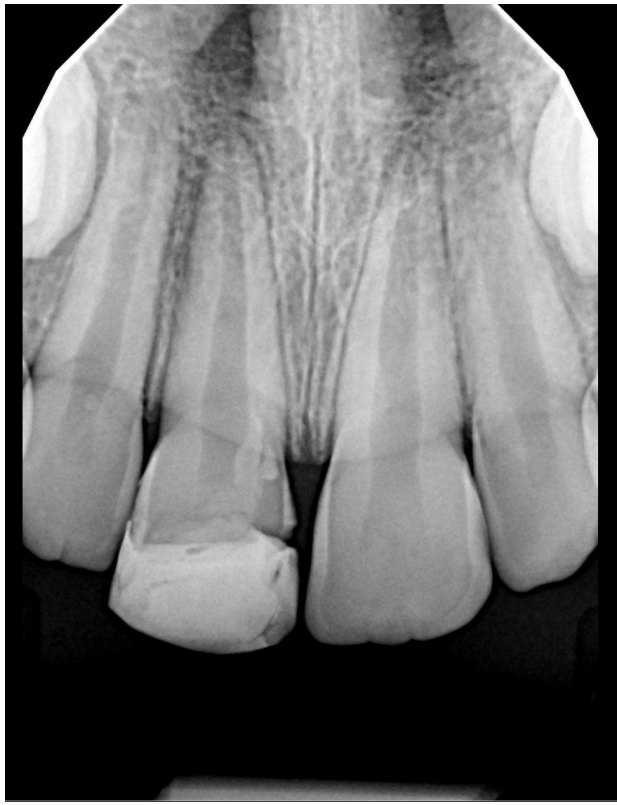
Apexogenesis

- Indication: Immature, vital permanent teeth
- Pulp exposed along deep caries or fracture line
- Asymptomatic or reversible pulpitis
- No changes in the periodontal ligament on periapical X-ray

- Bleeding must be controlled in case of pulp exposure
- Appropriate coronal sealing must be achieved

american association of endodontists
www.aae.org



Complicated crown fracture- treatment

- Aim: To keep he tooth vital
- Open/Closed apex: Partial pulpotomy-> Ca(OH)/MTA+ GIC crown
- Follow-up: 6-8 weeks, 1 year

- Closed apex and dislocation: root canal treatment

3 mm pulpotomy, Biodentine and 18 months controll ->

http://www.jcd.org.in/viewimage.asp?img=JConservDent_2015_18_1_73_148901_f2.jpg

- **Case 1:** A 9-year old male experienced dental trauma while playing a game at school.
- Tooth no 11 was fractured.
- The patient presented at our clinic 1 hour after the trauma, together with the broken tooth fragment.
- In the clinical and radiological examination, a complicated crown fracture was determined and the pulp had opened.
- In the same session the no 11 tooth was amputated with mineral trioxide agent (MTA) and it was closed with glass ionomer cement.
- The restoration was completed by attaching the fractured tooth fragment with composite resin (Figures 1-3)

Contr. 2 months

https://symbiosisonlinepublishing.com/dentistry-oraldisorders-therapy/dentistry-oraldisorders-therapy72.php

Crown-root fracture without pulp involvement (= uncomplicated crown fracture)

The fracture involves only the enamel, dentin and cement, pulp is not affected

- Fracture line goes under the gingiva (the crown may split to pieces)
- Percussion: + (subgingival root fracture)
- Sensibility test: + (usually, in the apical fragment)
- Radiographic: periapical, occlusal, excentric, CBCT may be necessary to define the fracture line

https://pediatrics.aappublications.org/content/133/2/e466

Crown-root fracture, without pulp involvement- treatment

- Emergency tx: stabilization of a loose segments to adjacent teeth
- Definitive tx: options are technique sensitive, so better to do it later
  - Fragment removal and gingivectomy (sometimes ostectomy)
    - with palatal subgingival extension
    - endodontic treatment and restoration with a post-retained crown
  - Orthodontic extrusion of apical fragment
    - remaining root with sufficient length after extrusion
  - Surgical extrusion
  - Decoronation (root submergence)
    - implant solution is planned
    - fragment may be left in situ after *decoronation* in order to avoid alveolar resorption
  - Extraction
    - very deep crown-root fractures, the extreme being a vertical fracture
    - Implantation, or conventional bridge
- Instructions
- Follow-up: 6-8 weeks, 1 week later

Crown-root fracture with pulp involvement (= complicated crown fracture)

Enamel, dentin, cement, pulp is also affected

- The fracture line goes under the gingiva
- Percussion: +
- Mobility: coronal fragment +
- Sensibility test: apical fragment usually +
- Radiographic: Periapical, occlusal (CBCT)

Crown-root fracture with pulp involvement- treatment

- Emergency tx:
  stabilization of the loose segments to the adjacent teeth
- Definitive tx:
  - Immature teeth (open apex), young children: the aim is to preserve pulp's vitality: pulpotomy (Ca(OH)2/ MTA)
  - Mature teeth (closed apex): root canal treatment

http://www.dentalindia.com/ccf.html#.XoBb1nJS-00

https://childrensoralcare.ca/faq-emergency-dental-care-for-kids/

Crown-root fracture with pulp involvement- treatment

- Definitive tx:
  - Fragment removal and gingivectomy (sometimes ostectomy)
    - with palatal subgingival extension
    - endodontic treatment and restoration with a post-retained crown
  - Orthodontic extrusion of apical fragment
    - remaining root with sufficient length after extrusion
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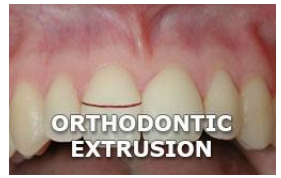


https://dentaltraumaguide.org/dental-guides/permanent-crown-root-fracture-with-pulp-involvement/treatment_1/
https://dentaltraumaguide.org/dental-guides/permanent-crown-root-fracture-with-pulp-involvement/treatment_2/
https://dentaltraumaguide.org/dental-guides/permanent-crown-root-fracture-with-pulp-involvement/treatment_3/

Root fracture

The root is separated, including the layers of the cement, dentin and enamel.

- The crown may be segmented into two or more parts. The displacement of the coronal segment defines the subclassification of this facture type.
- Percussion: The tooth may be tender
- Sensibility testing: may give negative reults initially indicating transient or permant neural damage. Monitoring the status of pulp is recommended. Transient crown discoloration (red or grey) may occur.
- Mobility: depends on the displacement of the coronal segment.
- Radiographic: periap., excentric, occlusal

https://pocketdentistry.com/13-diagnosis-and-management-of-dentoalveolar-injuries/

Root fracture

Treatment

- If the coronal segment left the alveolar process → the treatment is the same as with avulsion
- In other cases:
  - Rinsing the root surface with physiological saline
  - Reposition the displaced coronal segment
  - Check the 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.
  - Instructions as mentioned above.

https://dentaltraumaguide.org/dental-guides/permanent-root-fracture/treatment-2/

https://dentaltraumaguide.org/dental-guides/permanent-root-fracture/treatment-1/

Root fracture

- Follow up:
  - 4 weeks – Splint removal, clinical and radiographic examination.
  - 6-8 weeks – Clinical and radiographic examination.
  - 4 months – Splint removal in cervical third fractures, clinical and radiographic examination.
  - 6 months – Clinical and radiographic examination.
  - 1 year – Clinical and radiographic examination.
  - 5 years – Clinical and radiographic examination
- If sensibility testing after 3 months or the radiographic findings show pathological pattern, root canal treatment of the coronal tooth segment to the fracture line is indicated (Ca(OH)2/MTA and if the fracture line closed, definitive RCT).

https://dentaltraumaguide.org/dental-guides/permanent-root-fracture/treatment-2/

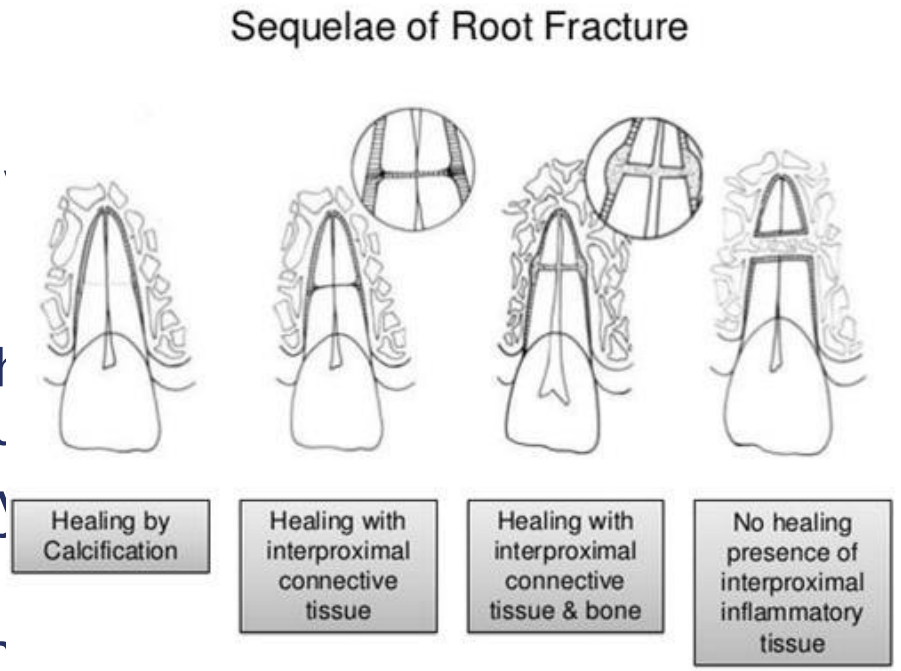
https://dentaltraumaguide.org/dental-guides/permanent-root-fracture/treatment-1/

Root fracture – cervical third

- Treatment of the cervical third root fracture
- 4 months rigid splinting
  - Crown extraction → root canal treatment → post-reatined crown
  - Orthodontic extrusion
  - Implant therapy later

Healing of the root fracture

- Aims: hard tissue formation between the fragments (with vial pulp)
- 3 types
  I. Hard tissue formation (30%)
  II. Connective tissue or connecti tissue and bone interposits between the two frements
  III. Granulation tissue connects th two fragments → unsuccessfu
- Pulp necrosis with immobility → RCT
- Open apex has better healir properties



Thank you for the kind attention!