Endodontic Considerations in Traumatized Teeth

ชัยเลิศวณิชกุล

รศ ปทุมา ชัยเลิศวณิชกุล
Prevalence of dental injuries

- Permanent dentition (50%<15 yr)
- Boys (12-33%)
- Girls (4-19%)

Andreasen 1972
Incidence

- Most common 8-12 yr
- Bicycle, skateboard, playground or sport accident
- Maxillary central incisor is the most vulnerable (80%)
- Followed by maxillary lateral, mandibular central & lateral
Etiology

*Child physical abuse (Non-accidental injuries, NAI)*
Etiology

♦ Falls & Collisions
♦ Sports
• Automobile Injuries
• Assaults
• Torture
• Mental retard
• Epilepsy
• Drug-related injuries
• Dentinogenesis Imperfecta
Mechanism of dental injuries

♦ Direct Trauma
♦ Indirect Trauma
Examination

1. Patient history
   ♦ How did the injury occur?
   ♦ Where did the injury occur?
   ♦ When did the injury occur?
   ♦ Has there been previous injury to the teeth?
   ♦ Is there any disturbance in the bite?
Examination

1. Patient history

♦ Is there any reaction in the teeth to cold and/or heat?
♦ Has there been any treatment before?

Time is essential because it affects prognosis

Storage medium for avulsed tooth
2. Clinical examination
   - Chief complaint
   - Neurologic examination
   - External examination
   - Intraoral soft tissue examination
   - Examination of hard tissue
   - Mobility testing
   - Percussion testing
   - Thermal & Electrometric testing
Cold test: The most effective

- CO₂ snow = -108.4°F or -78°C
- Difluorodichloromethane = -85°F or -50°C
Laser doppler flowmetry (LDF)
3. Radiographic exam

- Soft tissue
- Periapical bisecting angle exposure of each traumatized tooth
- Occlusal radiographic exposure of the traumatized region

**Necessary to take x-ray from 3 different angles (45-90-110°) in root fracture**
Radiographic examination
Classification

- Injuries to the hard dental tissue & the pulp
- Injuries to the periodontal tissue
- Injury to the supporting bone
- Injury to gingiva & oral mucosa
Classification of injuries to dental tissue & pulp

FRACTURE

♦ Enamel infraction/ fracture
♦ Crown fracture without pulpal involvement
♦ Crown fracture with pulpal involvement
♦ Crown-root fracture
♦ Root fracture (rarely in immature teeth)
Classification of injuries to dental tissue & pulp

- Concussion
- Subluxation
- Extrusive luxation
- Lateral luxation
- Intrusive luxation
- Avulsion
- Soft tissue injury & fracture of alveolar bone
Problems (Fracture)

- Calcification
- Pulp necrosis
- Apical periodontitis

Color changed
Problems (Luxate)

- Calcification
- Pulp necrosis
- Apical periodontitis
- Loss of epithelial attachment
- Ankylosis

{ Color changed }
Core concept 3.5  Pulpal response to trauma

- Traumatic injuries to teeth may result in both immediate and late effects on the pulp.
- If pulp survives the trauma, inflammatory responses develop due to the tissue damage induced and due to any microbial irritants that accessed the pulp subsequently.
- Ischemic injury may develop in the pulp due to more or less extensive internal bleeding or rupture of the neurovascular supply at the apex. This complication may lead to pulpal necrosis.
- Repair is possible in young teeth with open apices. Such repair frequently is accompanied by hard tissue repair, resulting in more or less complete obliteration of the pulpal chamber.
Enamel infraction

♦ Incomplete fracture of enamel without enamel defect (crack)

♦ Polish or observe
Enamel fracture / Uncomplicated crown fracture

- Restore with CR
Prognosis

♦ Pulpal complications are extremely rare.
♦ Occur 0.1%
Complicated crown fracture

Treatment plan depend on

- Stage of development of the tooth
- Time between the accident & treatment
- Concomitant attachment damage
- Restoration treatment plan
Complicated crown fracture

- **Complete root formation**
  - Pulpectomy

- **Incomplete root formation**
  - Vital → **Apexogenesis**
  - Nonvital → **Apexification**
Apexogenesis

- Small exposure → Pulp capping
- Large exposure → Partial pulpotomy
Pulp capping

- Success relies on the ability of $\text{Ca(OH)}_2$ & enamel-boned CR.
- Prognosis: approximately 80%
Partial pulpotomy

Cvek Pulpotomy

- Indication: zone of inflam pulp has extended $>2$ mm in the apical direction but has not reached the root pulp
- A traumatic exposure a few days post-injury in a large, young pulp
Partial pulpotomy

- Technique: A 1-2 mm deep cavity by sterile diamond bur with water cooling (high speed)
- If bleeding is excessive, the pulp is amputated deeper until only moderate is seen
Partial pulpotomy
Partial pulpotomy

- Follow up; maintenance of positive sensitivity test & x-ray check root development.
- Prognosis; 94–96%
Pulpectomy

- Indication: complicated crown fracture of mature teeth
- Prognosis: 90%
Crown fracture combined with luxation
Treatment plan

- Pulp WNL; restoration
- Nonresponse to EPT after few months;
  - close apex: RCT
  - open apex: Apexification
Apexification

A: Ca(OH)$_2$
B: Cotton pellet
C: IRM
D: Tissue barrier
Apexification

- Non-vital pulp therapy
- Immature tooth
- Prognosis: periapical healing & formation of a hard-tissue barrier can occur predictably 79-96%.
Crown-root fracture

- **Margin above** gum level
- **Margin under** gum level:
  - Intra-alveolar transplantation
  - Orthodontic extrusion
Margin above gum level

- Removal of loose tooth fragment
- Reattachment of the tooth fragment
- RCT with calcium hydroxide
Reattachment of fragment
Intra-alveolar transplantation

- Simple
- Extrusion & rotation

- Failure
- Limited to round-shaped roots
At least 4 mm of sound tooth structure should be preserved coronal to alveolar margin.
Orthodontic extrusion

Gingiva & alveolar bone move: periodontal surgery is required
Root fracture

Treatment plan depend on:
- Position of the tooth
- Mobility of the tooth
- Status of the pulp
- Position of the fracture line
Root fracture

Deep fracture
- Repositioning & semi-rigid splint for 3-4 wk
- Clinical & radiographic exam

Pulp necrosis & inflam of fracture sites

RCT with Ca(OH)$_2$
Root fracture

Shallow fracture & the remaining root is adequate to support a crown

♦ Extraction the crown
♦ Extrude the root
♦ RCT with Ca(OH)$_2$
Status of the pulp of root fracture

Revascularization & reinnervation or not depend on

♦ Severity of trauma
♦ Healing capacity
Healing of root fractures

Calcified tissue

♦ Reposition & splint to original position without irreversible pulpal injury

■ Apposition of dentine inside the pulp & cementum outside the root
Healing of root fractures

CNT

- Cannot reposition properly: blood clots in the fracture site
- Granulation tissue derived pulp or PDL invade to blood clot
Healing of root fractures

CNT & bone
- Fracture occurs during eruption
- Wound heals by CNT
- Coronal continues to erupt
- Bone invades space between fragments
Healing of root fractures

Granulation tissue without healing
- Result from pulp necrosis
- Clinical symptoms
- RCT
- Healing by CNT
Concussion/Subluxation

- Injury to periodontal tissue with (subluxation), without mobility (concussion)
- Chance vitality loss: 15% (pulp necrosis is rare in immature roots)
- Check occlusal interference, observe & check EPT
Subluxation

Semi-rigid splint for 7-10 d

- Follow up
- Development of pulp necrosis: RCT with Ca(OH)$_2$
Prognosis of Subluxation

- Pulp necrosis 6-47%
- Canal obliteration 10-26%
- Root resorption 4%
Extrusion

- Examination & diagnosis: it is important to know the stage of root formation because pulpal healing may occur in immature tooth
Extrusive luxation
Semi-rigid splint for 3-4 wks
Extrusive luxation

RCT with Ca(OH)$_2$
Prognosis of Extrusion

- Pulp necrosis 64%
- External root resorption 7%
Lateral luxation

- Chance vitality loss: 75% (pulpal blood supply is usually completely severed)
- Semi-rigid splint for 3–4 wks
Lateral luxation

RCT with Ca(OH)$_2$
Prognosis of Lateral luxation

♦ Pulp necrosis
  - 77 % in mature tooth
  - 58 % in immature tooth
♦ Pulp canal obliteration 33%
♦ External root resorption 36%
Intrusion

♦ The more extensive trauma involving multiple teeth & fracture of alveolar bone

♦ Extensive trauma to PDL & cementum
Treatment plan of Intrusion

♦ Administer anesthesia
♦ Surgical repositioning or transplantation of the intruded tooth
Intrusion

Semi-rigid splint for 1-2 mths
Prognosis of Intrusion

- Pulp necrosis: mature tooth
  100%: $\text{Ca(OH)}_2$ within 1-3 wks
- Highly occur in inflammatory external root resorption
- Recommend to prophylactic pulp extirpation in mature tooth
Patient Instructions

♦ Soft diet
♦ Brush teeth with a soft toothbrush after each meal
♦ Use of chlorhexidine mouthrinse (0.1%) twice a day for 2 wk
♦ Follow-up
Avulsion (Exarticulation)

Incidence

♦ 0.5-16% in permanent dentition (fight & sport injuries)
♦ 7-13% in primary dentition (falls)
♦ Maxillary central incisors are the most frequently
♦ Occurs most often in 7-9 yr
Storage media

- **Viaspan** (tissue transplant media)
- **HBSS** *(Hank’s Balance salt sol.)*: Cell culture media; **Save-A-Tooth™** *(up to 12 h)*
- **Milk**
- **Normal Saline**
- **Tap water**
- **Saliva**
- **Dry** *(Not recommend)*
Milk

- Practical
- Compatible osmolarity
- Neutral pH
- Free of bacteria
- Essential nutrients
Milk

- Maintain vital PDL cells for 3 hr (Blomlof 1981)
- Sigalas et al. (2004) recommended iced low-fat milk
- Low-fat: maintain viability > higher fat content
### Table 9-1: Survival rate of periodontal membrane in a dry condition

<table>
<thead>
<tr>
<th>Drying time (min)</th>
<th>Survival rate of periodontal membrane (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>70.5 ± 17.3</td>
</tr>
<tr>
<td>30</td>
<td>28.2 ± 18.9</td>
</tr>
<tr>
<td>60</td>
<td>21.2 ± 13.4</td>
</tr>
<tr>
<td>90</td>
<td>15.2 ± 6.2</td>
</tr>
</tbody>
</table>

### Table 9-2: Survival rate of periodontal membrane in a moist condition

<table>
<thead>
<tr>
<th>Physiologic saline solution (min)</th>
<th>Survival rate of periodontal membrane (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>80.0 ± 13.0</td>
</tr>
<tr>
<td>30</td>
<td>71.3 ± 18.2</td>
</tr>
<tr>
<td>60</td>
<td>71.4 ± 14.2</td>
</tr>
<tr>
<td>120</td>
<td>61.7 ± 11.4</td>
</tr>
<tr>
<td>Tap water (min)</td>
<td></td>
</tr>
<tr>
<td>120</td>
<td>33.2 ± 12.2</td>
</tr>
</tbody>
</table>
Avulsion

Closed apex
- Extra-oral dry time < 60 min
- Extra-oral dry time > 60 min

Open apex
- Extra-oral dry time < 60 min
- Extra-oral dry time > 60 min
Closed apex < 60 min

- Gently cleansing of avulsed tooth & socket with NSS
- Replant immediately
- Semi-rigid splint for 1 wk
Preparation of the socket for gentle repositioning of the tooth

♦ Removed obstacles
♦ Light aspirate of blood clot is present
♦ Reposition
Management of soft tissues

♦ Suture soft tissue lacerations, particularly in the cervical area
Closed apex > 60 min

Replant is not indicated

• If replant is decided:
  • Immerse the tooth in 2.4% NaF (pH 5.5) > 5 min
  • Endo can be done extra-orally
  • Fill socket with Emdogain®
Treating avulsed teeth

now means saving them.

Emdogain® treatment technology and its application of enamel matrix proteins in periodontal therapy have resulted in successful outcomes for hundreds of thousands of patients worldwide. Now this proven treatment for moderate to severe periodontal defects is providing possibilities to the trauma patient.

Emdogain®Gel is a premixed and prefilled formulation that requires no preparation. With a single gel application onto the root surface of the avulsed tooth and directly into the alveolar socket, the prognosis of replanted teeth has been shown to improve through prevention or retardation of resorption and ankylosis.

Care courtesy of Drs. Edward Barrett and Daniel Korng, The Hospital for Sick Children, Toronto, Canada © 2001

Before Treatment 6-Month Follow-up
Emdogain®

Enamel matrix proteins

• Compose of amelogenin & proteins (derived from porcine tooth buds)
• Important in development of acellular cementum, periodontal ligament & bone
Closed apex: Prescription

Doxycycline 2x per d for 7 d
- Tetanus booster
- RCT after 7-10 d with Ca(OH)$_2$
- Soft diet for 2 wk
- Chlorhexidine for 1 wk
Open apex < 60 mins

- Cleansing of avulsed tooth & socket with NaCl
- Place the tooth in doxycycline (1 mg/20 ml NaCl)
- Replant & Semi-rigid splint for 1 wk
Open apex < 60 mins

♦ No endodontic Rx initially
♦ If revascularization is a possibility avoid endodontic treatment unless obvious signs of failure are present.
Open apex > 60 mins

Replant is **not** indicated
- Pen V 1000 mg & 500 mg 4x per d for 7 d or doxycycline 100 mg 2x per d for 7 d
- Tetanus booster
- Soft diet for 2 wk
- Chlorhexidine for 1 wk
Delayed re plantation

Ankylosis

• During growth & development: resorb < 2 yr
• After growth & development: resorb > 10 yr
When to FRC?

Ca(OH)$_2$ can be replaced by gutta-percha when intact lamina dura can be traced around the entire root surface.
Healing

Depends on area of damaging

• Cementum repair ผิวขารพันธุ์ที่คลาด < 20%
• Ankylosis ผิวขารพันธุ์ที่คลาด > 20%
Traumatized teeth

- Crown fracture
- Crown-root fracture
- Root fracture
- Luxation
- Avulsion
Crown fracture

Enamel infraction

Uncomplicated crown fracture

Enamel fracture

Enamel - dentin fracture

Vital

Non vital

Corrective grinding

Restoration with CR

Reattachment of fragment

Restoration with CR

Restoration with CR

Restoration with CR

Pulp capping

Pulpectomy

Pulpectomy

Endodontic treatment

Apexification

Radiographic & sensitivity test
3, 6, 12 months & yearly

Radiographic & sensitivity test
3 weeks, 3, 6, 12 months & yearly

Routine recall evaluation
Crown-root fracture

Fracture does not involve pulp
- Gingivectomy & osteotomy
- Orthodontic extrusion
- Restoration
- Radiographic & pulpal sensitivity test 3, 6, 12 months & yearly

Fracture involves pulp
- Proper treatment
  - Y
    - Endodontic treatment
    - Gingivectomy & osteotomy
    - Orthodontic extrusion
    - Restoration
  - N
    - Extracion
    - Routine recall evaluation
Root fracture

Remove coronal fracture
( located very close to gingiva)

Endodontic treatment

Gingivectomy & osteotomy

Orthodontic extrusion

Restoration

Routine recall evaluation

Reposition & splinting for 4-8 weeks
( fracture contaminate to oral fluid)

Radiographic & sensitivity test
3, 6, 12 months & yearly

Within normal limit

Pulpal degenerative

Endodontic treatment through tooth length

Endodontic treatment only coronal part

Endodontic treatment only apical part

Keep apical part inside

Surgically remove apical part

Gingivectomy & osteotomy

Orthodontic extrusion

Restoration

Routine recall evaluation

Extraction
( fracture contaminate to oral fluid & not restorable)
Luxation

Concussion
- Relief occlusion if necessary
- Radiographic & pulpal sensitivity test every 3, 6, 12 months & yearly

Subluxation
- Same as concussion

Extrusion
- Reposition & splinting for CR (3-4 weeks)
- Radiographic & pulpal sensitivity test every 3, 6, 12 months & yearly

Lateral luxation
- Same as extrusion
- Radiographic & pulpal sensitivity test every 3, 6, 12 months & yearly

Intrusion
- Reposition & splinting for 4-8 weeks
- Spontaneous extrusion
- Orthodontic extrusion
- Radiographic & pulpal sensitivity test every 3, 6, 12 months & yearly

Same as spontaneous extrusion
Avulsion

Prepare socket

Prepare the root

Extra - oral dry time <20 mins

Closed apex

Gentle washing with NSS

Replant

Splint for 1 week

Endodontic treatment in 7-10 days

Obturation after short term Ca (OH)₂ medication

Extra - oral dry time 20-60 mins

Open apex

Soak in 1 mg doxycycline in 20 cc NSS for 5 mins rinse with NSS

Replant

Splint for 1 week

Endodontic treatment delay after 7-10 days

Obturation after Ca(OH)₂ medication 6-20 months

Extra - oral dry time >60 mins

Closed & open apex

Gentle washing with NSS

Replant

Splint for 1 week

Soak in citric acid 5 mins & 2% stannous fluoride 5 mins

Replant

Splint for 1 week

Close apex (same as dry time < 20 mins)

Open apex (same as dry time < 20 mins)

Apexification

Routine recall evaluation
Clinical examination

Oral examination

Cracked tooth

Laboratory examination

Cracked line

Radiographic finding

Staining

Translumination

Biting

Observe

Orthodontic band or adhesive restoration

Reversible pulpitis

Irreversible pulpitis

Restoration

Endodontic treatment

Restoration
<table>
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<tr>
<th>Condition</th>
<th>1 wk</th>
<th>2-3 wk</th>
<th>3-4 wk</th>
<th>6-8 wk</th>
<th>6 mth</th>
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Recommend readings

♦ Textbook & Color Atlas of Traumatic Injuries to the Teeth

♦ Treatment Plan for Traumatized Teeth
ฟันได้รับอุบัติเหตุ:
การตรวจ วินิจฉัย และรักษา

♦ ฟันได้รับอุบัติเหตุ: การตรวจ วินิจฉัย และรักษา

Recommend readings