Management of Avulsed Permanent Teeth

By: James Kim

1. Avulsion of permanent teeth
   • 0.5-3% of all dental injuries
   • Causes: Road traffic accidents (Including cycling accidents) > Fall > Sports > Hit/Collision > Fight > Others
   • Avulsion frequently presents with other concomitant injuries: Soft tissue lacerations > Multiple teeth trauma > Alveolar fractures > Skeletal fractures > Head and neck trauma

2. Prognostic factors
   • Prognosis depends on the type and the timing of the treatment
   • Contraindications to replantation: Severe caries, periodontal diseases, non-cooperative patient, severe medical conditions (immunosuppression and severe cardiac conditions)
   • Immediate replantation results in better treatment outcome
   • Immature root (open apex) usually has worse prognosis and higher failure rate
   • Appropriate storage media increases the success rate of replantation
   • Replanted teeth with root canal treatment within **7-14 days** have significantly higher survival rate
   • Patient compliance (post-replantation management, follow-up appointments) plays important role in determining the prognosis of replanted teeth

3. First Aid for avulsed teeth
   • Need to educate the public. Can give first aid instructions to patients over the phone
   • Never replant primary teeth. ONLY permanent tooth

**First Aid Instructions**

1) Calm the patient
2) Pick the tooth by the crown (white part)
3) If the tooth is dirty, clean gently under cold running water for no more than 10 seconds, and reposition the tooth back into the socket. Stabilize the tooth by holding it in position or biting onto a soft cloth
4) If immediate replantation is not an option, store the tooth in milk or other storage medium and seek emergency dental clinic as soon as possible
   If storage medium is not available, may place the tooth inside the mouth against lip or cheek (be aware of the possible aspiration risk)
   If patient is at a risk of swallowing a tooth, alternative is to transport the tooth in a container with saliva
   Do NOT store tooth in water
Treatment of Avulsed Permanent Tooth

- Treatment is based on the maturity of the tooth and how long the tooth has been out of the socket (i.e. viability of PDL cells)
- PDL cells become non-viable when the tooth is dried for more than 60 minutes
- Avulsed tooth PDL cell viability classification:
  1) **Most likely viable** – Replantation of tooth immediately or shortly after the avulsion
  2) **May be viable** – Tooth was kept in a storage medium and replantation is within 60 minutes
  3) **Non-viable** – Extra-oral drying time > 60 minutes (Doesn’t matter if the tooth was stored in the medium or not)

4. Treatment guidelines (Based on the International Association of Dental Traumatology (IADT))

![Diagram showing treatment guidelines for avulsed teeth](Figure created by James Kim (HDR) based on the IADT Guidelines)
Permanent Tooth with a Closed Apex

1) Patient arrives to the clinic with the tooth replanted
   • Leave the tooth in the socket
   • Clean the area with water spray/saline/chlorhexidine
   • Suture any gingival lacerations
   • Check normal position of the tooth (confirm with the patient), verify with a radiograph
   • Flexible splint for 2 weeks
   • Systemic antibiotics (1st choice: Tetracycline for 7 days. For patients < 12 years, Pen V or amoxicillin)
   • Tetanus update
   • Patient instructions (No contact sports, soft diet 2 weeks, brush with soft bristle toothbrush, chlorhexidine mouth-rinse)
   • Root canal treatment 7-10 days post replantation (before splint is removed)
   • Follow-up (2 weeks, 4 weeks, 3 months, 6 months, yearly afterwards)

2) Patient arrives to the clinic within 60 minutes after the accident with the tooth in a storage medium
   • Gently rinse the root surface and apical foramen with saline
   • Local anesthesia
   • Irrigate socket with saline
   • Replant tooth slowly with a finger pressure. Avoid excessive force.
   • Suture any gingival lacerations
   • Check normal position of the tooth (confirm with the patient), verify with a radiograph
   • Flexible splint for 2 weeks
   • Systemic antibiotics (1st choice: Tetracycline for 7 days. For patients < 12 years, Pen V or amoxicillin)
   • Tetanus update
   • Patient instructions (No contact sports, soft diet 2 weeks, brush with soft bristle toothbrush, chlorhexidine mouth-rinse)
   • Root canal treatment 7-10 days post replantation (before splint is removed)
   • Follow-up (2 weeks, 4 weeks, 3 months, 6 months, yearly afterwards)

3) Patient arrives to the clinic later than 60 minutes after the accident/suspected non-viable PDL cells

NOTE: Poor long-term prognosis. It is expected that the tooth will be ankylosed and the root will be resorbed
   • Remove attached non-viable soft tissue with gauze
   • Perform root canal treatment on a tooth extra-orally. Root canal treatment can be postponed after the replantation within 7-10 days
- Local anesthesia
- Irrigate socket with saline
- Replant tooth slowly with a finger pressure. Avoid excessive force
- Suture any gingival lacerations
- Check normal position of the tooth (confirm with the patient), verify with a radiograph
- Flexible splint for 4 weeks
- Systemic antibiotics (1st choice: Tetracycline for 7 days. For patients < 12 years, Pen V or amoxicillin)
- Tetanus update
- Patient instructions (No contact sports, soft diet 2 weeks, brush with soft bristle toothbrush, chlorhexidine mouth-rinse)
- Follow-up (2 weeks, 4 weeks, 3 months, 6 months, yearly afterwards)

**Permanent Tooth with an Open Apex**

1) Patient arrives to the clinic with the tooth replanted
   - Leave the tooth in the socket
   - Clean the area with water spray/saline/chlorhexidine
   - Suture any gingival lacerations
   - Check normal position of the tooth (confirm with the patient), verify with a radiograph
   - Flexible splint for 2 weeks
   - Systemic antibiotics (1st choice: Tetracycline for 7 days. For patients < 12 years, Pen V or amoxicillin)
   - Tetanus update
   - Patient instructions (No contact sports, soft diet 2 weeks, brush with soft bristle toothbrush, chlorhexidine mouth-rinse)
   - Monitor the tooth for potential revascularization of the pulp space. If not root canal treatment is recommended
   - Follow-up (2 weeks, 4 weeks, 3 months, 6 months, yearly afterwards)

2) Patient arrives to the clinic within 60 minutes after the accident with the tooth in a storage medium
   - Gently rinse the root surface and apical foramen with saline
   - Apply topical antibiotics (Minocycline or doxycycline 1 mg/20 ml of saline for 5 minutes) on root surface if available. Application of topical antibiotics on the root surface known to increase the success of pulp revascularization.
   - Local anesthesia
   - Irrigate socket with saline
   - Replant tooth slowly with a finger pressure. Avoid excessive force.
   - Suture any gingival lacerations
   - Check normal position of the tooth (confirm with the patient), verify with a radiograph
• Flexible splint for 2 weeks
• Systemic antibiotics (1st choice: Tetracycline for 7 days. For patients < 12 years, Pen V or amoxicillin)
• Tetanus update
• Patient instructions (No contact sports, soft diet 2 weeks, brush with soft bristle toothbrush, chlorhexidine mouth-rinse)
• Monitor the tooth for potential revascularization of the pulp space. If not root canal treatment is recommended.
• Follow-up (2 weeks, 4 weeks, 3 months, 6 months, yearly afterwards)

3) Patient arrives to the clinic later than 60 minutes after the accident/suspected non-viable PDL cells

NOTE: Poor long-term prognosis. It is expected that the tooth will be ankylosed and the root will be resorbed

• Remove attached non-viable soft tissue with gauze
• Perform root canal treatment on a tooth extra-orally. Root canal treatment can be postponed after the replantation within 7-10 days
• Local anesthesia
• Irrigate socket with saline
• Replant tooth slowly with a finger pressure. Avoid excessive force
• Suture any gingivallacerations
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5. Storage Medium
- The best outcome follows the immediate replantation
- When immediate replantation is not available, tooth must be stored in physiological solutions to maintain PDL cell vitality
- Ideal storage medium should closely resemble the socket environment:
  (1) Adequate osmolarity
  (2) Ideal pH
  (3) Adequate nutrition
  (4) Readily available and accessible
  (5) Low cost
- Systemic review (Roi et al., 2013):

<table>
<thead>
<tr>
<th>Storage Medium</th>
<th>Characteristics</th>
<th>Efficacy</th>
<th>Accessibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hank’s Balanced Salt Solution (HBSS)</td>
<td>Physiologic pH, osmolarity, nutrients</td>
<td>Excellent</td>
<td>--</td>
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<tr>
<td>Viaspan®</td>
<td>Physiologic pH, osmolarity, favourable cell growth</td>
<td>Excellent</td>
<td>--</td>
</tr>
<tr>
<td>Euro-Collins®</td>
<td>Physiologic pH and hypothermal capacity</td>
<td>Excellent</td>
<td>--</td>
</tr>
<tr>
<td>Minimum Essential Medium (MEM)</td>
<td>Nutrients, antimicrobial property, growth factor</td>
<td>Excellent</td>
<td>--</td>
</tr>
<tr>
<td>Saline</td>
<td>Physiological pH and osmolarity</td>
<td>Poor</td>
<td>+</td>
</tr>
<tr>
<td>Water</td>
<td>Microbial contamination, hypotonic, non-physiological pH and osmolarity</td>
<td>Very poor</td>
<td>++</td>
</tr>
<tr>
<td>Saliva</td>
<td>Microbial contamination, hypotonic, non-physologic pH and osmolarity</td>
<td>Very poor</td>
<td>++</td>
</tr>
<tr>
<td>Milk</td>
<td>Small bacterial contents, isotonic, physiological pH, osmolarity, growth factors, nutrients</td>
<td>Excellent</td>
<td>+</td>
</tr>
<tr>
<td>Propolis</td>
<td>Anti-inflammatory, antibacterial, antioxidant properties</td>
<td>Excellent</td>
<td>-</td>
</tr>
<tr>
<td>Green Tea</td>
<td>Anti-inflammatory, antibacterial, antioxidant properties</td>
<td>Excellent</td>
<td>-</td>
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</table>
Egg white | Low microbial contamination, contains nutrients and water | Good | +
--- | --- | --- | ---
Coconut water | Sterile, nutrients | Good | +
Gatorade (Sports drink) | Low pH and hypertonic | Poor | +
Contact lens solution | Antimicrobial, preservatives | Poor | +

Which one is the best storage medium?

- Currently there appears to be different opinions among scholars
- It is accepted that milk and HBSS are excellent for maintaining PDL cell viability
- HBSS is inaccessible for the public
- International Association of Dental Traumatology and American Academy of Pediatric Dentistry recommend milk as a temporary storage solution:
  1. Readily available
  2. Inexpensive
  3. Physiological osmolarity (230-270 mOsm/kg)
  4. Neutral pH (6.5-7.2)
  5. Low bacterial content
  6. Maintains viability of cells
  7. Essential nutrients and growth factors (120 mg/100 ml Calcium. Calcium inhibits osteoclastic activity and trigger osteogenic differentiation of PDL stem cells)
  8. Recent study (Bag and Yildiim, 2017) involving human PDL cells from third molar teeth showed that milk is superior storage medium for maintaining fibroblasts compared to HBSS (Fibroblasts are the main PDL cell group mostly responsible for PDL regeneration)

- Hasan et al. (2017) argued that viable cells stored in milk detach from PDL and migrate into the milk, resulting in thinner PDL cells, and this can increase ankylosis after replantation.
- Instead, Hasan et al. reported that egg white maintains adequate thickness of PDL, which makes egg white a better storage medium
- In certain parts of India, coconut water is considered the best natural storage media due to its availability (Navit et al., 2017).
- Best advice is to use the storage medium that is readily available and seek dentist as soon as possible

6. Treatment of root surface in delayed tooth replantation
- Regeneration of PDL in delayed tooth replantation is still a challenge
- In the absence of PDL regeneration, the aim of delayed replantation is to achieve ankylosis/replacement resorption and avoid inflammatory root resorption to retain teeth as long as possible
• The prognosis of delayed replantation is very poor and there will be eventual tooth loss
• The major cause of tooth loss after delayed tooth replantation is the necrotic periodontal ligament that trigger external root resorption
• Studies have shown that removal of necrotic periodontal ligaments using chemical or mechanical treatments reduce root resorption and promote tooth ankylosis. Nevertheless, the outcome is still the eventual tooth-loss (Panzarini et al, 2008)
• 2% Acidulated sodium phosphate fluoride decreases inflammatory root resorption and encourages ankylosis and replacement resorption (Panzarini et al., 2008)
• Emdogain® is an enamel matrix derivative which is thought to promote regeneration of periodontal cells. Treatment of root surface with Emdogain® in delayed root replantation was not able to regenerate PDL and prevent ankylosis after tooth replantation. However, Emdogain® treatment is associated with better post-replantation healing (Barrett et al., 2005)
• Current recommendation by International Dental Traumatology Association is the treatment of avulsed tooth with 2.4% Acidulated sodium phosphate fluoride (pH 5.5) for 5 minutes and fill the socket with Emdogain®.

7. Follow-up appointment: What are we looking for?

<table>
<thead>
<tr>
<th>Favourable</th>
<th>Unfavourable</th>
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<tbody>
<tr>
<td>Asymptomatic</td>
<td>Symptomatic</td>
</tr>
<tr>
<td>No mobility</td>
<td>Mobile or no mobility (Ankylosis – high pitched percussion sound)</td>
</tr>
<tr>
<td>No STP</td>
<td>STP</td>
</tr>
<tr>
<td>Radiograph: Absence of root resorption &amp; peri-radicular osteitis, lamina dura intact, pulp canal obliteration is expected especially for open apex</td>
<td>Radiograph: Root resorption, ankylosis</td>
</tr>
<tr>
<td></td>
<td>Tooth loss</td>
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8. Treatment options of lost replanted tooth
• Decoronation (Preserving the decoronated root in the alveolus maintains bone volume and allows vertical bone growth for implant placement)
• Auto-transplantation
• Resin retained bridge
• Denture
• Orthodontic space closure
• Sectional osteotomy
• Implant (After growth is completed)
Take Home Message

Avulsion refers to an injury where the complete tooth structure is displaced from its socket after trauma. Prognosis of avulsed tooth depends heavily on the type and timing of the treatment. The best management of avulsion is replantation of tooth immediately or within 60 minutes after avulsion. It is very important to receive professional help from a dentist as soon as possible. Never replant primary teeth, only permanent teeth.
References


