



Avulsed permanent teeth - new treatment guidelines

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Introduction

Approximately 0.5-16% (1) of traumatic injuries to the permanent anterior dentition result in tooth avulsion (2-4). When replantation occurs within 20 min (2,5,6) or if the avulsed tooth is placed in a suitable storage medium until a dentist can replant the tooth, chance for successful treatment of the tooth is maximized. The purpose of this *Clinical Update* is to review treatment objectives and recent revisions in managing avulsed permanent teeth from the "Recommended Guidelines of the American Association of Endodontists (AAE) for the Treatment of Traumatic Dental Injuries"(7).

Storage media

The prognosis for avulsions improves if the periodontal ligament (PDL) cells are preserved. (7,8,9). Soder *et al.* and Andreasen have shown that when a tooth is avulsed from the socket, PDL cells on the root surface will remain viable if they are hydrated (5,10). Vital PDL cells can reattach when replanted and viability is best maintained if the tooth is replanted within the first 15-20 minutes after avulsion (11). Tissue transport medium, such as Viaspan® (DuPont Pharmaceuticals, Wilmington, DE) and Hank's Balance Salt Solution (HBSS) (Mediatech, Herndon, VA) have exceptional ability to keep cells alive and are considered to be superior storage media. Readily available storage media for an avulsed tooth, in order of preference, are milk, saliva and saline (12,13,14). Another commercially available, antibiotic-free, protective medium is the emt TOOTHSAYER® (SmartPractice, Phoenix, AZ). Water is not recommended because the hypotonic environment damages the PDL cells. One study measured the average number of vital human lip fibroblasts remaining after 2-168 hours of storage in 3 media. This study showed that after 12 hours, Viaspan® was effective at keeping 72.9% of cells vital while HBSS and milk maintained the vitality of 70.5% and 43.4% cells, respectively (12).

Outcomes of avulsion

The speed with which the avulsed tooth is replanted is the most important factor for success (8,9). There are several possible effects on the root surface and attachment apparatus of an avulsed tooth.

- **Normal PDL healing:** complete regeneration of the PDL. Damage cannot be clinically or radiographically detected.
- **Surface resorption:** the crushing injury is restricted, inflammatory response is limited and repair can occur with replacement cementum. Clinically, the tooth presents asymptomatic, with normal mobility and percussion sounds. Radiographically, there are no periradicular radiolucencies and no loss of lamina dura (15).
- **Ankylosis and replacement resorption:** occurs when excessive drying damages the PDL cells and evokes an inflammatory response that results in the replacement of the cells with alveolar bone. Dentoalveolar ankylosis is the term used when precursor bone cells populate the damaged root resulting in a direct bone-root contact void of an attachment apparatus. Replacement resorption occurs when osteoclasts in contact with the root resorb dentin that is eventually replaced with new bone by osteoblasts. Clinically, the tooth will be immobile and have a high-pitched sound when percussed. Radiographically, there is absence of the lamina dura. With replacement resorption, the root surface appears moth-eaten (15). In young patients, infraocclusion or submergence results when replacement resorption interferes with the tooth's ability to move with the normal downward growth of the alveolar process.
- **External inflammatory root resorption:** the result of a combination of severely damaged attachment and bacterial contamination of a

necrotic pulp. It may rapidly progress. Clinically, it presents as radiolucencies in the root and adjacent bone (15).

Managing the emergency in the dental office

The use of a trauma checklist aids in the rapid and thorough assessment of a traumatic injury. It is critical to recognize the dental injury may be secondary to a more serious physical trauma. A patient's emotional distress can also complicate managing the injury. If the patient is the victim of a more serious injury, immediate referral to a higher echelon of care is appropriate.

Diagnosis and the clinical situation

Treatment guidelines for the avulsed tooth are dependent on whether the tooth has an open or closed apex and how long it takes to replant the tooth. At 60 minutes of extraoral dry time, viability of root surface PDL cells is unlikely (1).

Avulsed permanent tooth with closed apex

The patient will generally present with one of three clinical scenarios:

1. **The tooth has already been replanted.** Do not extract the tooth. Simply cleanse the area with water spray, saline, or a 0.1% chlorhexidine mouth rinse.
2. **The tooth has been kept in an appropriate storage media or the extra-oral dry time has been less than 60 minutes.** The contaminated root surface should be cleaned with saline. If needed, the tooth can be stored in a storage media such as HBSS or Viaspan while a trauma examination is quickly performed. Assessment of the socket and surrounding teeth and bone by palpating and radiographing the injured site will determine whether the socket is intact and suitable for replantation. Fractures of the socket wall should be repositioned prior to replantation. Coagulum can be removed from the socket with a stream of sterile saline to facilitate slow, slight digital pressure replantation.
3. **The tooth has an extra-oral dry time of more than 60 minutes.** The root surface PDL cells are not expected to survive. Assess the injured socket and surrounding area for fractures and reposition prior to replantation. Remove the coagulum with sterile saline only. Do not curette the socket. The PDL should be removed by soaking the tooth for 5 minutes in 2.4% sodium fluoride solution acidulated to a pH of 5.5. This procedure will remove the damaged tissue that would otherwise initiate an inflammatory response (7,8). The use of an enamel matrix protein, Emdogain® (Biora, Malmö, Sweden), is now recommended because recent studies demonstrate that it may make the root more resistant to resorption and promote the growth of a new PDL from the socket (16,17). The socket can be filled with Emdogain® prior to replantation of a tooth with an extra-oral dry time of greater than 60 minutes (7). It may also be valuable in cases where the extra-oral dry time is 20-60 minutes (8). Revascularization of the pulp in an avulsed tooth with a mature, closed apex is not possible. The root canal treatment can be done prior to replantation if the extra-oral dry time is greater than 60 minutes, but care must be taken to keep the canal space bacteria-free.

Pulpal tissue of teeth with closed apices cannot survive an avulsion injury and must be removed. Endodontic treatment for all avulsed permanent teeth with a closed apex should be initiated, and calcium hydroxide placed at 7-10 days. Usually after one month, when an intact lamina dura can be traced around the root surface, the calcium hydroxide can be replaced with gutta-percha. If endodontic treatment has been delayed, and there is radiographic evidence of root resorption, calcium hydroxide is needed for an extended period of time and the status of the lamina dura should be checked every 3 months.

Avulsed permanent tooth with open apex

The same concerns for viability of the PDL on avulsed permanent teeth with open apices apply to those with closed apices and treatment guidelines are also based on the tooth's extra-oral dry time (18,19).

1. The tooth has already been replanted. The area should be cleaned with water spray, saline or a 0.1% chlorhexidine mouth rinse.
2. The tooth has been kept in a storage media for less than 60 minutes. Clean the contaminated root surface with a stream of sterile saline. Prior to replanting, soak the tooth in a solution of doxycycline (1mg/20ml saline). Examine the socket for suitability, remove the coagulum with sterile saline, and replant slowly with slight digital pressure.
3. Current guidelines recommend that teeth with open apices and extra-oral dry times of greater than 60 minutes not be replanted. Studies and debate are ongoing to determine if there are situations when replanting a tooth can maintain the height and width of the alveolar bone in a growing child.

A replanted tooth is determined to have a satisfactory outcome if it is asymptomatic, has normal mobility and eruption pattern, normal sound to percussion, and tests positive to vitality tests. It is important to note that it may take up to 3 months to respond positively to vitality testing. Radiographically, continued root development is expected. An unsatisfactory outcome includes symptoms, high-pitched percussion sound, infra-occlusion, arrested development of the root and a pulp lumen unchanged in size. At the first definite signs of failure, the necrotic pulp must be removed and apexification treatment initiated (7,8).

Adjunctive treatment and follow-up

Soft tissue management: gingival tissue should be tightly secured in the cervical area of the replanted tooth to help prevent the ingress of bacteria (7,20). Lip lacerations must be thoroughly cleaned and approximated tension-free before suturing. It is best to consult an oral or plastic surgeon if the laceration extends through the vermilion border into the skin.

Splinting: a flexible (semi-rigid) splint is recommended for 7-10 days. There are many acceptable types of splints available and it is left to the provider to choose one that is effective and easy to use. The splint should allow physiologic movement of the tooth, should not have memory and not impinge on the gingiva. Proper repositioning of the replanted tooth should be verified with a radiograph. Avulsions that have concomitant alveolar fractures should be splinted for 4-8 weeks (1).

Systemic antibiotics: recommended. If the patient is not susceptible to tetracycline staining, the antibiotic of choice is doxycycline at an appropriate dose for patient age and weight (8,21,22). Penicillin V can be substituted for doxycycline. Adult dosage of doxycycline is 100mg b.i.d. x 7 days. Adult dosage of Penicillin V is 1-2g stat, then 500mg q.i.d. x 7 days. Fractures of the alveolus may have their own indications for antibiotic coverage.

Tetanus: refer the patient to a physician within 48 hours for a tetanus booster if the avulsed tooth contacted soil or if the status of the tetanus coverage is uncertain.

Analgesics: prescribe if needed. Typically, an over the counter non-steroidal anti-inflammatory drug suffices.

Diet: post-operative instructions should include a soft diet for 2 weeks.

Oral hygiene: instruct the patient to brush with a soft toothbrush after every meal and prescribe a 0.1% chlorhexidine mouth rinse 2x per day for 7 days.

Follow-up appointments: include splint removal and initiation of endodontic treatment, if required, at one week. Clinical and radiographic exams should be scheduled at 2-3 weeks, 3-4 weeks, 6-8 weeks, 6 months, 1 year and annually for 5 years.

Summary

The chart included on page 30 of this *Clinical Update* reflects the recent guidelines of the AAE (7).

References

1. Andreasen FM, Andreasen JO. Textbook and color atlas of traumatic injuries to the teeth. 3rd ed. St Louis: Mosby, Inc.;1994; 383-425.
2. Andreasen JO. Etiology and pathogenesis of traumatic dental injuries. A clinical study of 1298 cases. Scand J Dent Res 1970;78(4):329-42.

3. Hedegård B, Stålhane I. A study of traumatized permanent teeth in children aged 7-15 years. Part I. Swed Dent J 1973 Sep;66(5):431-52.
4. Lenstrup K, Skieller V. A follow-up study of teeth replanted after accidental loss. Acta Odontol Scand 1959;17:503-9.
5. Andreasen JO. Effect of extra-alveolar period and storage media upon periodontal and pulpal healing after replantation of mature permanent incisors in monkeys Int J Oral Surg 1981 Feb;10(1):43-53.
6. Cvek M, Granath LE, Hollender L. Treatment of non-vital permanent incisors with calcium hydroxide. III. Variation of occurrence of ankylosis of reimplanted teeth with duration of extra-alveolar period and storage environment. Odontol Revy 1974;25(1):43-56.
7. American Association of Endodontists. Recommended Guidelines of the American Association of Endodontists for the Treatment of Traumatic Dental Injuries. Chicago; 2003.
8. Trope M. Clinical management of the avulsed tooth: present strategies and future directions. Dent Traumatol 2002 Feb;18(1):1-11.
9. Diangelis AJ, Bakland LK. Traumatic Dental Injuries: current treatment concepts. J Am Dent Assoc 1998 Oct;129(10):1401-14.
10. Soder PO, Otteskog P, Andreasen JO, Modeer T. Effect of drying on viability of periodontal membrane. Scand J Dent Res 1977 Mar;85(3):164-8.
11. Barrett EJ, Kenny DJ. Avulsed permanent teeth: a review of the literature and treatment guidelines. Endod Dent Traumatol 1997 Aug;13(4):153-63.
12. Hiltz H, Trope M. Vitality of human lip fibroblasts in milk, Hank's balanced salt solution and Viaspan storage media. Endod Dent Traumatol 1991 Apr;7(2):69-72.
13. Trope M, Friedman S. Periodontal healing of replanted dog teeth stored in Viaspan, milk and Hank's balanced salt solution. Endod Dent Traumatol 1992 Oct;8(5):183-8.
14. Blomlof L. Milk and saliva as possible storage media for traumatically exarticulated teeth prior to replantation. Swed Dent J Suppl 1981;8:1-26.
15. Trope M, Chivian N, Sigurdsson A, Vann WF Jr. Traumatic injuries. In Cohen S, Burns RC, editors: Pathways of the pulp. 8th ed. Philadelphia: Mosby Inc.; 2002;623-631.
16. Iqbal MK, Bamaas N. Effect of enamel matrix derivative (EMDOGAIN®) upon periodontal healing after replantation of permanent incisors in beagle dogs. Dent Traumatol 2001 Feb;17(1):36-45.
17. Filippi A, Pohl Y, Von Arx T. Treatment of replacement resorption with Emdogain® - preliminary results after 10 months. Dent Traumatol 2001 Jun;17(3):134-8.
18. Cvek M, Cleaton-Jones P, Austin J, Lownie J, Kling M, Fatti P. Effect of topical application of doxycycline on pulp revascularization and periodontal healing in reimplanted monkey incisors. Endod Dent Traumatol 1990 Aug;6(4):170-6.
19. Yanpiset K, Trope M. Pulp revascularization of replanted immature dog teeth after different treatment methods. Endod Dent Traumatol 2000 Oct;16(5):211-7.
20. Tsukiboshi M. Autotransplantation of teeth: requirements for predictable success. Endod Dent Traumatol 2002;18:157-80.
21. Sae-Lim V, Wang CY, Choi GW, Trope M. The effect of systemic tetracycline on resorption of dried replanted dogs' teeth. Endod Dent Traumatol. 1998 Jun;14(3):127-32.
22. Sae-Lim V, Wang CY, Trope M. Effect of systemic tetracycline and amoxicillin on inflammatory root resorption of replanted dog's teeth. Endod Dent Traumatol 1998 Oct;14(5):216-20.

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AAE Treatment Guidelines for Avulsed Permanent Teeth (7)

	Replanted	Extra-oral dry time <60 minutes	Extra-oral dry time >60 minutes
Closed Apex	<ul style="list-style-type: none"> Clean area with water, saline or chlorhexidine mouth rinse. 	<ul style="list-style-type: none"> Clean contaminated root surface with saline. Remove coagulum from socket with saline. Reposition fractured socket. Replant with slow, digital pressure. 	<ul style="list-style-type: none"> Remove coagulum from socket with saline. Reposition fractured socket. Soak tooth in 2.4% sodium fluoride, pH 5.5 for 5 min. Fill socket with Emdogain®, if available. Replant with slow, digital pressure.
Open Apex	<ul style="list-style-type: none"> Clean area with water, saline or chlorhexidine mouth rinse. 	<ul style="list-style-type: none"> Clean contaminated root surface with saline. Soak tooth in doxycycline (1mg/20ml saline). Remove coagulum from socket with saline. Reposition fractured socket. Replant with slow, digital pressure. 	<ul style="list-style-type: none"> Do not replant.
Adjunct Treatment		<ul style="list-style-type: none"> Suture cervical area. Verify position of tooth with radiograph. Place non-rigid splint. 	
Medications (Dose appropriate for age and weight)		<ul style="list-style-type: none"> Adult: Doxycycline 100mg b.i.d. x 7 days <u>or</u> Penicillin V 1-2g stat, then 500mg q.i.d. x 7 days. Analgesics, as needed. 	
Post-op Instructions		<ul style="list-style-type: none"> Soft diet. Brush after every meal with soft toothbrush. 0.1% chlorhexidine mouth rinse b.i.d. x 7 days. Tetanus booster within 48 hrs. 	
Follow-up Appointments		7 days: remove splint, begin RCT. Clinical and radiographic exam: 2-3 wks; 3-4 wks; 6-8 wks; 6 mos; 1 yr; annually for 5 yrs.	