



Traumatic Dental Injuries – Avulsions

LT Allen D. Rasmussen, DC, USN and CAPT Terry D. Webb, DC, USN

Introduction

Avulsion of permanent teeth accounts for 0.5 – 3% of dental trauma and most frequently occurs among 7 – 9 year old children. Avulsions are more common due to the decreased mineral content in bone and still maturing periodontal ligament among newly erupted teeth.¹

The included chart titled *Treatment Guidelines for Avulsed Permanent Teeth* reviews step by step protocols by the International Association of Dental Traumatology and the American Association of Endodontists. Protocols are established based on root developmental status (open apex or closed apex) and tooth status at time of presentation to the dentist (already replanted, dry time less than 60 min, dry time greater than 60 min). Additional information and clarification for the protocols are given below.²

The purpose of this *Clinical Update* is to review the treatment guidelines and recent updates in managing avulsions from the *International Association of Dental Traumatology (IADT) guidelines for the management of traumatic dental injuries: 2. Avulsion of permanent teeth*¹ and *The recommended Guidelines of the American Association of Endodontists (AAE) for the Treatment of Traumatic Dental Injuries*.³

Updated Guidelines for Avulsions

Replantation of primary teeth is not indicated. Replantation of permanent teeth is recommended in all but a few specific instances such as significant periodontal disease or caries and significant medical conditions. The prognosis of replanted teeth relies primarily on time-dependent actions performed following the avulsion. Even in situations where the tooth is functionally preserved, the long-term survival is decreased and may result in ankylosis, resorption and/or loss.^{2,3}

The guidelines from the IADT and AAE support the best treatment available by evidenced-based and professional recommendation. However, there is no guarantee that the utilization of these guidelines will result in a favorable outcome. The individual circumstances of each situation require practitioners' best judgment in the application of these guidelines.^{2,3}

Initial Treatment at Place of Injury

The expeditious treatment of avulsed teeth increases the probability of success. Dentists should be ready to provide recommendations to the public for providing appropriate initial care for an avulsed tooth as conformity with these guidelines is lacking.⁴ The best management is immediate replantation. If circumstances do not allow this, the tooth should be maintained in an appropriate storage solution. Recommended guidance to the parent or guardian includes the following:²

- Confirm the tooth is a permanent tooth, as replantation of primary teeth is contraindicated.
- Hold the tooth by the crown so as not to touch the root. If soiled, wash the tooth with cold water for up to 10 seconds.
- Replant the tooth and have the patient bite on a napkin to keep it in place.
- When circumstances do not permit replantation, the tooth should be stored in an appropriate transport solution such as milk, saline, Hank's Balanced Salt Solution, or the patient's own saliva that has been expectorated into a cup (to prevent swallowing the tooth). Storage in water is contraindicated.
- Seek immediate dental treatment.

Treatment Guidelines For Permanent Teeth

Considerations for treatment are influenced by two factors: developmental status of the root (open or closed apex) and periodontal ligament (PDL) cell status. The viability of the PDL cells decreases as extraoral dry time increases. PDL cells are considered non-viable after 60 minutes dry time. Storage in an appropriate solution may help preserve viability of the PDL cells when the tooth is not replanted immediately. Storage of a tooth in a non-physiologic solution (water) does not preserve PDL cell viability and, thus, is contraindicated.²

Diagnostic Imaging

The AAE recommends two horizontally shifted diagnostic radiographs at the initial evaluation, and consideration for Cone Beam Computed Tomography (CBCT) as an adjunct for verification of correct tooth position and evaluation of fractures in the alveolar bone.³

CBCT field of view should be selected based on the area of trauma and in keeping with the goal of subjecting the patient to the least amount of radiation possible.⁵

Anesthesia

Replantation of avulsed teeth by dentists should be performed under local anesthesia. Block anesthesia may be beneficial when the degree or area of injury warrants it. Due to the lack of supporting literature, the exclusion of vasoconstrictors from local anesthetic is not necessary.²

Splinting

Short-term, physiologic (flexible) splinting is important for healing. Physiologic splinting maintains the tooth in proper position while allowing slight movement of the tooth. Maxillary teeth should be splinted on their facial surface to allow lingual endodontic access and prevent occlusal disturbance. Splints should be placed to allow clearance of food from the gingival margin and easy maintenance by the patient. AAE guidelines recommend the use of splinting material with a maximum diameter of 0.4 mm or 0.016". Physiologic splints may be placed for a maximum of 2 weeks for teeth with dry time less than 60 minutes and, per the IADT, splinting should occur for 4 weeks in teeth with dry time longer than 60 minutes. The AAE recommends splinting for a maximum of 2 weeks for teeth with closed apices and dry time longer than 60 minutes.^{2,3}

Antibiotics / Tetanus

An age and weight appropriate dose of systemic antibiotics should be administered for 7 days following replantation. Doxycycline is the antibiotic of choice for patients older than 12. Amoxicillin should be used for patients under the age of 12 to prevent tooth staining.^{1,2}

Topical use of doxycycline or minocycline (soak for 5 minutes with 1mg/20ml saline) may be appropriate for open apex teeth to promote revascularization of the pulp and healing of the PDL (experimental evidence).²

Tetanus status verification is important for avulsed teeth that had contact with soil.^{2,3}

Endodontic Treatment

Goals when replanting teeth with closed apices or open apices with non-viable PDL cells (dry time greater than 60 minutes) are to maintain function, bone height, esthetics and for psychological factors. The goal for teeth with open apices and viable PDL cells is pulpal revascularization.^{2,3}

Timing of root canal treatment is based on the intracanal medicament used and the viability of the PDL cells. When a combination corticosteroid-antibiotic is chosen as the intracanal medicament, it should be placed during

the initial appointment, or soon thereafter, then maintained in the tooth for 2 weeks minimum. If dechlorotetracycline is used, coronal staining may occur if it contacts pulp chamber walls. When calcium hydroxide is used (placed for a maximum of 4 weeks) root canal treatment should be initiated 7-10 days following the injury and prior to removing the splint for closed apex teeth with less than 60 minutes dry time. With dry time longer than 60 minutes, closed apex teeth may have root canal treatment initiated before replantation or after 7-10 days; open apex teeth may have treatment initiated before replantation (recommended by AAE) or after 7-10 days (IADT supports either time).²

Pulp revascularization can occur in teeth with open apices and viable PDL cells (less than 60 min dry time), but resorption due to infection can occur very quickly so this must be taken into consideration. Pulpal necrosis, as diagnosed by a minimum of two different signs or symptoms, is an indication for root canal treatment or a necrotic pulp revascularization procedure. In situations where the patient may not return for a timely follow-up, and the tooth apex is fully formed, a negative response to pulp testing at 3 months is highly suggestive of a necrotic pulp.^{2,3}

Follow-up

Patients who sustain an avulsion injury should have appropriate follow-up to initiate root canal therapy (7-10 days when not performed at initial visit), splint removal (1-4 weeks), and calcium hydroxide or corticosteroid removal and obturation (2-4 weeks). Regular follow-up appointments with clinical and radiographic evaluation should occur at 4 weeks, 3, 6, and 12 months, then yearly for 5 years.^{2,3}

Favorable Outcome

Both closed and open apex teeth should have clinical responses corresponding to health (asymptomatic, physiologic mobility, percussion sound normal) and radiographic evidence of health (closed apex: normal lamina dura, no resorption or periradicular radiolucency; open apex: root formation has continued or arrested, tooth eruption has continued or arrested, pulp canal obliteration is anticipated).²

Unfavorable Outcome

Both closed and open apex teeth may exhibit clinical responses corresponding to disease (symptomatic, abnormal mobility, high-pitched percussion sound) and radiographic signs of disease (closed and open apex: ankylosis/infra-position [see below]; inflammatory, infection-associated, or ankylosis-associated replacement resorption).²

The possibility of tooth loss dictates discussion with providers who can manage individual circumstances, especially in patients still growing. Treatment options for tooth loss include decoronation, auto-transplantation, fixed or removable prosthesis, space closure with orthodontics, space maintenance for future implant placement and sectional osteotomy.²

Infra-positioning

There is a high association of ankylosis and infra-position of the replanted tooth in patients with developing bones (children and adolescents). Infra-position may cause short to long term disturbance in bone growth not only in the alveolar bone, but also facial bones. Close follow-up is important along with advising the patient and their parent/guardian of this probability. Infra-position with greater than 1mm discrepancy warrants consideration for decoronation. The AAE Guidelines recommend taking height and weight measurements in all patients with developing bones at the 7-10 day follow-up, 3, 6, and 12 months, and subsequent yearly follow-ups. This information is important when deciding when to decoronate an infra-positioned tooth.^{2,3}

Conclusion

Replantation of avulsed permanent teeth provides opportunity for continued function of a patient's natural dentition. This allows for maintenance of bone height and esthetics, promoting the psychological health of the growing patient.^{2,3}

References

1. Anderasen JO, Anderasen FM, Andersson L. Textbook and Color Atlas of Traumatic Injuries to the Teeth. Copenhagen: Blackwell Publishing Ltd; 2007.
2. Andersson L, Andreasen JO. International Association of Dental Traumatology guidelines for the management of traumatic dental injuries: 2. Avulsion of permanent teeth. Dent Traumatol 2012;28:88-96.
3. The Recommended Guidelines of the American Association of Endodontists for the Treatment of Traumatic Dental Injuries. Updated 9/2013.
4. Bucher K, Neumann C, Hickel R, Kuhnisch J. Traumatic dental injuries at a German University Clinic 2004-2008. Dent Traumatol 2013;29:127-33.
5. AAE and AAOMR Joint Position Statement: Use of Cone-Beam-Computed Tomography in Endodontics. 2010.

LT Rasmussen is a second year endodontic resident at the Naval Postgraduate Dental School, Bethesda, MD and CAPT Webb is Chairman of the Endodontics Department and Director, Endodontics Residency Program at the Naval Postgraduate Dental School, Bethesda, MD.

Special thanks to COL Kathleen McNally & CAPT Gary Goodell for their editorial contributions.

The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the Department of the Navy, Department of Defense, nor the U.S. Government.



The Naval Postgraduate Dental School is affiliated with the Uniformed Services University of the Health Sciences' Postgraduate Dental College.

TREATMENT GUIDELINES FOR AVULSED PERMANENT TEETH

CLINICAL PRESENTATION	TOOTH ALREADY REPLANTED	TOOTH MAINTAINED IN PHYSIOLOGIC SOLUTION AND/OR DRY TIME < 60 MIN	TOOTH WITH > 60 MIN DRY TIME
TREATMENT	<ul style="list-style-type: none"> Cleanse injured area (water, chlorhexidine, or saline) Manage any gingival lacerations Confirm correct tooth position clinically & radiographically Place flexible splint (≤2 weeks) Rx: Systemic antibiotics Verify tetanus status Give post-treatment instructions CA: Begin RCT 7-10 days following replantation and prior to splint removal OA: Monitor for revascularization or necrosis 	<ul style="list-style-type: none"> CA: Cleanse root surface & apical foramen using saline while holding the crown of the tooth, then soak in saline OA: If contamination present, cleanse root surface & apical foramen using saline while holding the crown of the tooth OA: Apply topical antibiotic (<i>doxy or minocycline</i>) Provide local anesthetic CA: Rinse socket using saline Evaluate alveolar socket, repositioning displaced fragments OA: Clean clot from socket Replant tooth carefully with minimal pressure Manage any gingival lacerations Confirm correct tooth position clinically & radiographically Place flexible splint (≤2 weeks) Rx: Systemic antibiotics Verify tetanus status Give post-treatment instructions CA: Begin RCT 7-10 days following replantation and prior to splint removal OA: Monitor for revascularization or necrosis/resorption 	<ul style="list-style-type: none"> Carefully cleanse root of non-viable soft tissue with gauze CA: Begin RCT before replantation or 7-10 days following replantation OA: Begin RCT before replantation^{1,2} or 7-10 days following replantation¹ Prior to replanting: <ul style="list-style-type: none"> CA: Soak tooth for 20 min in 2% NaF to depress osseous resorption OA: Soak tooth for 20 min in 2% NaF to depress osseous resorption¹ Provide local anesthetic Rinse socket using saline Evaluate alveolar socket, repositioning displaced fragments Replant tooth carefully with minimal pressure Manage any gingival lacerations Confirm correct tooth position clinically & radiographically Place flexible splint (CA: ≤2 weeks² or 4 weeks¹; OA: 4 weeks^{1,2}) Rx: Systemic antibiotics Verify tetanus status Give post-treatment instructions If not initiated this appointment, begin RCT 7-10 days following replantation and prior to splint removal
ENDODONTIC CONSIDERATIONS	CA: When used, intracanal corticosteroid medicament (anti-clastic/anti-inflammatory) must be placed for ≥ 2 weeks at replantation visit or soon thereafter OA: Diagnosis of Pulp Necrosis following trauma necessitates ≥2 symptoms/signs; if necrosis occurs, necrotic pulp revascularization or apexification should be considered		Ultimate outcome: ankylosis, OA: resorption Consider decoronation if infraosition > 1mm (seen in ankylotic teeth of children and adolescents)
ANTIBIOTIC CONSIDERATIONS	Systemic: < 12 years old: 7 days of Amoxicillin; > 12 years old: 7 days of Doxycycline Tetanus status: physician referral is warranted to assure appropriate coverage if the tooth had contact with soil and/or tetanus status is unknown		
		OA: Topical antibiotic: Soak tooth for 5 minutes in solution of <i>doxycycline or minocycline (1mg mixed in 20ml saline)</i>	
POST-TREATMENT INSTRUCTIONS	For 2 weeks: no contact sports, eat a soft diet Use a soft toothbrush to clean teeth following every meal Twice daily, rinse with 0.12% chlorhexidine for 7 days Wear mouthguard when participating in contact sports		

GENERAL FOLLOW-UP CONSIDERATIONS

	CLOSED APEX WITH DRY TIME < 60 MIN	CLOSED APEX WITH DRY TIME > 60 MIN	ALL OPEN APEX AVULSED TEETH
7-10 Days	RCT with calcium hydroxide intracanal medicament (4 weeks max) if not performed previously		RCT teeth with > 60 min dry time if not done previously; all others, consider RCT or necrotic revascularization only when diagnosis is Pulp Necrosis
2 Weeks	Remove splint, clinical & radiographic evaluation	Remove splint ² (or at 4 weeks ¹), clinical & radiographic evaluation	Remove splint for teeth < 60 min dry time, clinical & radiographic evaluation
4 Weeks	Clinical & radiographic evaluation, root canal obturation		Remove splint for teeth > 60 min dry time, clinical & radiographic evaluation
3, 6, 12 Months, & Yearly For 5 Years	Clinical & radiographic evaluation		

CA: Closed Apex Tooth

OA: Open Apex Tooth

Italicized: optional, but recommended treatment

Where discrepancies exist between sources: **1** denotes recommendation by IADT and **2** denotes recommendation by AAE

This does not cover all situations and circumstances and differences between IADT and AAE guidelines but gives a general overview of considerations.