Guidelines

Guidelines for the management of traumatic dental injuries. II. Avulsion of permanent teeth

Flores MT, Andersson L, Andreasen JO, Bakland LK, Malmgren B, Barnett F, Bourguignon C, DiAngelis A, Hicks L, Sigurdsson A, Trope M, Tsukiboshi M, von Arx T. Guidelines for the management of traumatic dental injuries. II. Avulsion of Permanent Teeth.

Abstract – Avulsion of permanent teeth is the most serious of all dental injuries. The prognosis depends on the measures taken at the place of accident or the time immediately after the avulsion. Replantation is the treatment of choice, but cannot always be carried out immediately. An appropriate emergency management and treatment plan is important for a good prognosis. Guidelines are useful for delivering the best care possible in an efficient manner. The International Association of Dental Traumatology (IADT) has developed a consensus statement after a review of the dental literature and group discussions. Experienced researchers and clinicians from various specialties were included in the group. In cases in which the data did not appear conclusive, recommendations were based on the consensus opinion of the IADT board members. The guidelines represent the current best evidence based on literature research and professional opinion. In this second article of three, the IADT Guidelines for management of avulsed permanent teeth are presented.

Marie Therese Flores[1], Lars Andersson[2], Jens Ove Andreasen[3], Leif K. Bakland[4], Barbro Malmgren[5], Frederick Barnett[6], Cecilia Bourguignon[7], Anthony DiAngelis[8], Lamar Hicks[9], Asgeir Sigurdsson[10], Martin Trope[11], Mitsuhiro Tsukiboshi[12], Thomas von Arx[13]

[1]Pediatric Dentistry, Faculty of Dentistry, University of Valparaiso, Valparaiso, Chile; [2]Oral & Maxillofacial Surgery, Faculty of Dentistry, Kuwait University, Safat, Kuwait; [3]Department of Oral and Maxillofacial Surgery, University Hospital, Copenhagen, Denmark; [4]Endodontics, School of Dentistry, Loma Linda University, Loma Linda, CA, USA; [5]Department of Pediatrics, Karolinska Institute, Huddinge, Sweden; [6]Albert Einstein Medical Center, Philadelphia, PA, USA; [7]Private Practice, Paris, France; [8]Hennepin County Medical Center, Minneapolis, MN, USA; [9]Endodontics, University of Maryland, Baltimore, MD, USA; [10]Private Practice, Reykjavik, Iceland; [11]Endodontics, University of North Carolina, Chapel Hill, NC, USA; [12]Private Practice, Nagoya, Japan; [13]Oral Surgery and Stomatology, University of Berne, Berne, Switzerland

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MT Flores, The International Association of Dental Traumatology, PO Box 1057, Loma Linda, CA 92354, USA
Tel.: +56 32 250 8690
http://www.iadt-dentaltrauma.org
e-mail: mariateresa.flores@uv.cl

Trauma to the oral region occurs frequently and comprise 5% of all injuries for which people seek treatment (1, 2). In preschool children the figure is as high as 18% of all injuries (1, 2). Among all facial injuries, dental injuries are the most common (2) of which avulsions occur in 1–16% of all dental injuries (1, 3). Avulsion of permanent teeth is the most serious of all dental injuries. The prognosis depends on the measures taken at the place of accident or the time immediately after the avulsion. Replantation is the treatment of choice, but cannot always be carried out immediately. Furthermore, replantation should not be performed when primary teeth have been avulsed because of the risk of injury to the underlying permanent tooth germ (1).

An appropriate treatment plan after an injury is important for a good prognosis. Guidelines are useful for dentists and other healthcare professionals in delivering the best care possible in an efficient manner. The International Association of Dental Traumatology (IADT) has developed a consensus statement after a review of the dental literature and group discussions. The first set of

guidelines for the management of the avulsed tooth was published by IADT in 2001 (4). Experienced researchers and clinicians from various specialties were included in the group. In cases in which the data did not appear conclusive, recommendations were based on the consensus opinion of the IADT board members. The guidelines represent the current best evidence based on literature research and professional opinion. As is true for all guidelines, the healthcare provider must apply clinical judgment dictated by the conditions present in the given traumatic situation. The IADT does not guarantee favorable outcomes from following the guidelines, but using the recommended procedures can maximize the chances of success. Because management of permanent and primary dentition differs significantly, separate guidelines for management of permanent and primary teeth have been developed. Updating the guidelines is an ongoing process, and the guidelines are available on the IADT web page (http://www.iadt-dentaltrauma.org). In addition to the clinical guidelines, there is also a forum for discussion on this web page and a possibility to download information material for professionals and the public.

The publication of the IADT guidelines in the journal *Dental Traumatology* has been divided into three parts: *Part I*: *Crown fractures and luxations of permanent teeth* in *Dental Traumatology* issue 2, 2007; *Part II: Avulsion of permanent teeth* in the present issue; *Part III*: *Guidelines for injuries in the primary dentition* will be published in *Dental Traumatology* issue 4, 2007.

First aid for avulsed teeth

Dentists should always be prepared to give appropriate advice to the public about first aid for avulsed teeth. An avulsed permanent tooth is one of the few real emergency situations in dentistry. In addition to increasing the public awareness by, e.g. mass media campaigns, healthcare professionals, parents and teachers should receive information on how to proceed following these severe unexpected injuries. Also, instructions may be given by telephone to parents at the emergency site.

If a tooth is avulsed, make sure it is a permanent tooth (primary teeth should not be replanted)

- Keep the patient calm.
- Find the tooth and pick it up by the crown (the white part). Avoid touching the root.
- If the tooth is dirty, wash it briefly (10 seconds) under cold running water and reposition it. Try to encourage the patient/parent to replant the tooth. Bite on a handkerchief to hold it in position.
- If this is not possible, place the tooth in a suitable storage medium, e.g. a glass of milk or in saline. The tooth can also be transported in the mouth, keeping it between the molars and the inside of the cheek. Avoid storage in water.
- Seek emergency dental treatment immediately.

The poster 'Save a Tooth' is written for the public and is available in several languages: Spanish, English, Portuguese, French, Icelandic, Italian, and can be obtained at the IADT website: http://www.iadt-dentaltrauma.org.

Guidelines for the clinician

Guidelines contain recommendations for diagnosis and treatment of specific traumatic dental injuries using proper examination procedures. Some general recommendations are as follows:

A. *Clinical examination.* Detailed description of procedures such as clinical examination and classification of injuries can be found in current textbooks and manuals (1, 5) (Figs 1 and 2).

B. *Radiographic examination.* As a routine, several projections and angles are recommended:
- 90° horizontal angle, with central beam through the tooth in question;
- occlusal view;
- lateral view from the mesial or distal aspect of the tooth in question.

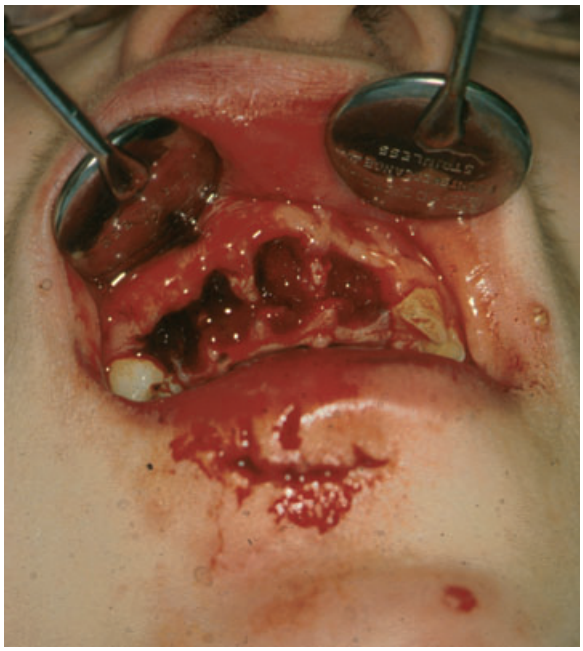

Fig. 1. Four permanent teeth avulsed in a 15-year-old boy coming to the clinic 30 min after the accident. There is bleeding from empty alveolar sockets. There is also a laceration injury in the lip.

Fig. 2. Replantation of an immature permanent tooth after 1 h of avulsion. A 7-year-old boy fell from the stairs at school. The avulsed tooth was found in the hand and stored in water before replanting at the Emergency Room. No splint was placed. (a,b) Extruded position of tooth 11 following replantation. (c) The X-ray reveals an immature tooth with one-third of root formation. (d) The tooth was repositioned and stabilized with a flexible wire-composite splint. The splint is extended to the primary canines because of the absence of adjacent teeth during early mixed dentition. (e,f) Clinical and radiographic appearance at 1 year follow-up control and arrest of root formation is seen. No root canal treatment is indicated. (g,h) Control after 6 years shows normal color of the crown and normal position of the tooth. Pulp canal obliteration of tooth 11 is seen at the radiographic examination.

For more detailed information see current textbooks (1, 5).

C. *Sensibility tests*. Sensibility testing refers to tests (electric pulp test or cold test) to determine the condition of the tooth pulp. Initial tests following an injury frequently give negative results, but such results may only indicate a transient lack of pulpal response. Follow-up controls are needed to make a definitive pulpal diagnosis.

D. *Patient instructions*. Good healing following an injury to the teeth and oral tissues depends, in part, on good oral hygiene. Patients should be advised on how best to care for teeth that have received treatment after an injury. Brushing with a soft brush and rinsing with chlorhexidine 0.1% is beneficial to prevent accumulation of plaque and debris.

For further reading we recommend some review articles and original papers (6–20). All relevant new and old references can be found in the recent textbook and color atlas by Andreasen et al. (1).

Treatment guidelines for avulsed permanent teeth

1. Tooth with a closed apex.
a. The tooth has already been replanted.
b. The tooth has been kept in special storage media (Hank's Balanced Salt Solution), milk, saline, or saliva. The extra-oral dry time is less than 60 min.
c. Extra-oral dry time longer than 60 min.

2. Tooth with open apex.
a. The tooth has already been replanted.
b. The tooth has been kept in special storage media (Hank's Balanced Salt Solution), milk, saline, or saliva. The extra-oral dry time is less than 60 min.
c. Extra-oral dry time longer than 60 min.

Treatment guidelines for avulsed permanent teeth with closed apex

Clinical situation	Treatment
(1a) The tooth has been replanted prior to the patient arriving at the dental office or clinic	Clean the area with water spray, saline, or chlorhexidine. Do not extract the tooth. Suture gingival lacerations if present. Verify normal position of the replanted tooth both clinically and radiographically. Apply a flexible splint for up to 2 weeks. Administer systemic antibiotics. Tetracycline is the first choice (Doxycycline 2x per day for 7 days at appropriate dose for patient age and weight). The risk of discoloration of permanent teeth must be considered before systemic administration of tetracycline in young patients. (In many countries tetracycline is not recommended for patients under 12 years of age). In young patients Phenoxymethyl Penicillin (Pen V), in an appropriate dose for age and weight, can be given as alternative to tetracycline. If the avulsed tooth has contacted soil, and if tetanus coverage is uncertain, refer to physician for evaluation and need for a tetanus booster. Initiate root canal treatment 7–10 days after replantation and before splint removal. Place calcium hydroxide as an intra-canal medicament until filling of the root canal. *Patient instructions* Soft diet for up to 2 weeks. Brush teeth with a soft toothbrush after each meal. Use a chlorhexidine (0.1%) mouth rinse twice a day for 1 week. *Follow-up* See *Follow-up procedures for avulsed permanent teeth*.
(1b) The tooth has been kept in special storage media (Hank's Balanced Salt Solution), milk, saline, or saliva. The extra-oral dry time is less than 60 min	If contaminated, clean the root surface and apical foramen with a stream of saline and place the tooth in saline. Remove the coagulum from the socket with a stream of saline. Examine the alveolar socket. If there is a fracture of the socket wall, reposition it with a suitable instrument. Replant the tooth slowly with slight digital pressure. Suture gingival lacerations. Verify normal position of the replanted tooth both clinically and radiographically. Apply a flexible splint for up to 2 weeks. Administer systemic antibiotics. Tetracycline is the first choice (Doxycycline 2x per day for 7 days at appropriate dose for patient age and weight). The risk of discoloration of permanent teeth must be considered before systemic administration of tetracycline in young patients. (In many countries tetracycline is not recommended for patients under 12 years of age). In young patients Phenoxymethyl Penicillin (Pen V), at appropriate dose for age and weight, can be given as alternative to tetracycline. If the avulsed tooth has contacted soil, and if tetanus coverage is uncertain, refer the patient to a physician for evaluation and need for a tetanus booster. Initiate root canal treatment 7–10 days after replantation and before splint removal. Place calcium hydroxide as an intra-canal medicament until filling of the root canal. *Patient instructions* Soft diet for up to 2 weeks. Brush teeth with a soft toothbrush after each meal. Use a chlorhexidine (0.1%) mouth rinse twice a day for 1 week. *Follow-up* See *Follow-up procedures for avulsed permanent teeth*.
(1c) Extra-oral dry time longer than 60 min	Delayed replantation has a poor long-term prognosis. The periodontal ligament will be necrotic and not expected to heal. The goal in doing delayed replantation is to promote alveolar bone growth to encapsulate the replanted tooth. The expected eventual outcome is ankylosis and resorption of the root. In children below the age of 15, if ankylosis occurs, and when the infraposition of the tooth crown is more than 1 mm, it is recommended to perform decoronation to preserve the contour of the alveolar ridge. The technique for delayed replantation is: Remove attached necrotic soft tissue with gauze. Root canal treatment can be done on the tooth prior to replantation, or it can be done 7–10 days later as for other replantations.

Clinical situation	Treatment
	Remove the coagulum from the socket with a stream of saline. Examine the alveolar socket. If there is a fracture of the socket wall, reposition it with a suitable instrument. Immerse the tooth in a 2% sodium fluoride solution for 20 min Replant the tooth slowly with slight digital pressure. Suture gingival laceration. Verify normal position of the replanted tooth clinically and radiographically. Stabilize the tooth for 4 weeks using a flexible splint. Administration of systemic antibiotics, see (1a). Refer to physician for evaluation of need for a tetanus booster if the avulsed tooth has contacted soil or tetanus coverage is uncertain. *Patient instructions* Soft diet for up to 2 weeks. Brush teeth with a soft toothbrush after each meal. Use a chlorhexidine (0.1%) mouth rinse twice a day for 1 week. *Follow-up* See *Follow-up procedures for avulsed permanent teeth*.

Treatment guidelines for avulsed permanent teeth with open apex

(2a) The tooth has already been replanted prior to the patient arriving in the dental office or clinic.	Clean the area with water spray, saline or chlorhexidine. Do not extract the tooth. Suture gingival lacerations if present. Verify normal position of the replanted tooth both clinically and radiographically. Apply a flexible splint for up to 2 weeks. Administer systemic antibiotics. For children 12 years and younger: Penicillin V at an appropriate dose for patient age and weight. Refer the patient to a physician for evaluation of need for a tetanus booster if avulsed tooth has contacted soil or tetanus coverage is uncertain. The goal for replanting still-developing (immature) teeth in children is to allow for possible revascularization of the tooth pulp. If that does not occur, root canal treatment may be recommended – see *Follow-up procedures for avulsed permanent teeth*. *Patient instructions* Soft diet for up to 2 weeks. Brush teeth with a soft toothbrush after each meal. Use a chlorhexidine (0.1%) mouth rinse twice a day for 1 week. *Follow-up* See *Follow-up procedures for avulsed permanent teeth*.
(2b) The tooth has been kept in special storage media (Hank's Balanced Salt Solution), milk, saline, or saliva. The extra-oral dry time is less than 60 min	If contaminated, clean the root surface and apical foramen with a stream of saline. Remove the coagulum from the socket with a stream of saline and then replant the tooth. If available, cover the root surface with minocycline hydrochloride microspheres (Arestin™, OraPharma Inc, Warminster, PA, USA) before replanting the tooth. Examine the alveolar socket. If there is a fracture of the socket wall, reposition it with a suitable instrument. Replant the tooth slowly with slight digital pressure. Suture gingival lacerations, especially in the cervical area. Verify normal position of the replanted tooth clinically and radiographically. Apply a flexible splint for up to 2 weeks. Administer systemic antibiotics. For children 12 years and younger: Penicillin V at appropriate dose for patient age and weight. Refer to physician for evaluation of need for a tetanus booster if avulsed tooth has contacted soil or tetanus coverage is uncertain. The goal for replanting still-developing (immature) teeth in children is to allow for possible revascularization of the tooth pulp. If that does not occur, root canal treatment may be recommended – see *Follow-up procedures for avulsed permanent teeth*. *Patient instructions* Soft diet for up to 2 weeks. Brush teeth with a soft toothbrush after each meal. Use a chlorhexidine (0.1%) mouth rinse twice a day for 1 week. *Follow-up* See *Follow-up procedures for avulsed permanent teeth*.

(2c) Extra-oral dry time longer than 60 min	Delayed replantation has a poor long-term prognosis. The periodontal ligament will be necrotic and not expected to heal. The goal in doing delayed replantation of immature teeth in children is to maintain alveolar ridge contour. The eventual outcome is expected to be ankylosis and resorption of the root. It is important to recognize that if delayed replantation is done in a child, future treatment planning must be done to take into account the occurrence of tooth ankylosis and the effect of ankylosis on the alveolar ridge development. If ankylosis occurs, and when the infraposition of the tooth crown is more than 1 mm, it is recommended to perform decoronation to preserve the contour of the alveolar ridge. The technique for delayed replantation is: Remove attached necrotic soft tissue with gauze. Root canal treatment can be done on the tooth prior to replantation through the open apex. Remove the coagulum from the socket with a stream of saline. Examine the alveolar socket. If there is a fracture of the socket wall, reposition it with a suitable instrument. Immerse the tooth in a 2% sodium fluoride solution for 20 min Replant the tooth slowly with slight digital pressure. Suture gingival laceration. Verify normal position of the replanted tooth clinically and radiographically. Stabilize the tooth for 4 weeks using a flexible splint. Administration of systemic antibiotics, see (2a). Refer the patient to a physician for evaluation of need for a tetanus booster if the avulsed tooth has contacted soil or tetanus coverage is uncertain. *Patient instructions* Soft diet for up to 2 weeks. Brush teeth with a soft toothbrush after each meal. Use a chlorhexidine (0.1%) mouth rinse twice a day for 1 week. *Follow-up* See *Follow-up procedures for avulsed permanent teeth*.

Follow-up procedures for avulsed permanent teeth

Root canal treatment

If root canal treatment is indicated (teeth with closed apex), the ideal time to begin treatment is 7–10 days postreplantation. Calcium hydroxide is recommended for intra-canal medication for up to 1 month followed by root canal filling with an acceptable material. An exception is a tooth that has been dry for more than 60 min before replantation – in such cases the root canal treatment may be done prior to replantation.

In teeth with open apexes, that have been replanted immediately or kept in appropriate storage media, pulp revascularization is possible. Root canal treatment should be avoided unless there is clinical and radiographic evidence of pulp necrosis.

Clinical control

Replanted teeth should be monitored by frequent controls during the first year (once a week during the months 1, 3, 6, and 12) and then yearly thereafter. Clinical and radiographic examination will provide information to determine outcome. Evaluation may include the findings described as follows.

Favorable outcome

(1) *Closed apex*. Asymptomatic, normal mobility, normal percussion sound. No radiographic evidence of resorption or periradicular osteitis; the lamina dura should appear normal.

(2) *Open apex*. Asymptomatic, normal mobility, normal percussion sound. Radiographic evidence of arrested or continued root formation and eruption. Pulp canal obliteration is the rule.

Unfavorable outcome

(1) *Closed apex*. Symptomatic, excessive mobility or no mobility (ankylosis) with high-pitched percussion sound. Radiographic evidence of resorption (inflammatory, infection-related resorption, or ankylosis-related replacement resorption).

(2) *Open apex*. Symptomatic, excessive mobility or no mobility (ankylosis) with high-pitched percussion sound. In the case of ankylosis, the crown of the tooth will appear to be in an infra-occlusal position. Radiographic evidence of resorption (inflammatory, infection-related resorption, or ankylosis-related replacement resorption).

Splinting guidelines for avulsed teeth

Replanted permanent teeth should be splinted up to 2 weeks. Wire-composite splint has been widely used to stabilize avulsed teeth because it allows good oral hygiene and are well tolerated by the patients (Fig 2). For a detailed description of new splints and splinting times, see recent textbooks and articles (1, 5, 16–20).

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