



Management of avulsed permanent incisors: A decision analysis based on changing concepts

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The reported incidence of tooth avulsions ranges from 1%-16% of all traumatic injuries of the permanent dentition. Maxillary central incisors are the most frequently avulsed teeth. Although avulsions may occur at any age, the most common age for the permanent dentition is 8-12 years of age, a time when the loosely structured periodontal ligament surrounding erupting teeth provides only minimal resistance to an extrusive force. The primary etiologic factors for avulsions are fights and sports injuries.¹

Treatment of avulsions is directed at avoiding or minimizing the effects of the two main complications of the avulsed teeth, namely attachment damage and pulpal infection. When a tooth is avulsed the apical blood supply is severed and the periodontal ligament is damaged severely. While it is not possible for the original blood supply to be re-established after avulsion, under special circumstances it is possible for the replanted tooth to become revascularized. If the tooth is immature with an open apex, efforts should be made to promote revascularization of the pulp. In the tooth with a closed or open apex in which revascularization is unsuccessful, treatment efforts should be aimed at elimination of potential bacterial toxins from the root canal space.

Attachment damage as a direct result of avulsion cannot be avoided; however, considerable additional damage can occur to the periodontal membrane during the time the tooth is out of the oral cavity. Treatment is directed at minimizing this damage so that the fewest number of complications result. When severe additional damage has occurred and replacement resorption (ankylosis) is considered certain, steps should be taken to slow this irreversible resorptive process to maintain the tooth in the mouth for as long as possible.

Most clinicians in the United States follow the guidelines promulgated by the American Association of Endodontics. These guidelines, drafted by the AAE's Ad Hoc Committee on the Management of the Avulsed Tooth, were published first in 1983² and updated in 1995³ and can be found at <http://www.aae.org>.⁴ The decision trees presented here rely upon the AAE Guidelines as a point of departure and incorporate newer paradigms and changing concepts.

Clinical management—first steps first

When faced with an avulsion injury in the dental office, the clinician should obtain a thorough history, including exact

information on the time interval between injury and replantation as well as the conditions under which the tooth has been stored. When the decision has been made to replant, the avulsed tooth should be examined for obvious contamination. If visibly contaminated, the tooth surface should be rinsed gently with a stream of saline from a syringe until visible contaminants have been washed away. The debris on the root surface should never be scraped off because then viable periodontal ligament cells could be scraped off as well. It is better to replant the tooth with minor debris on it than risk removing or destroying periodontal ligament cells. No effort should be made to sterilize the tooth surface because this may damage or destroy vital periodontal tissue and cementum.

The alveolar socket should be examined. If needed, the socket can also be rinsed with a flow of saline to remove the contaminated coagulum. If there is evidence of socket collapse or fracture, the fractured bone should be repositioned using a blunt instrument such as a mirror handle to remodel the bony socket.

The replanted tooth requires temporary stabilization by splinting. Recent studies have shown that long-term rigid splinting of replanted mature and autotransplanted immature teeth increases the risk of replacement root resorption (ankylosis).¹ Accordingly, replanted teeth should only be splinted for a minimal amount of time (7-10 days) with a flexible wire or monofilament.

Replantation success

Replantation of teeth has been considered a temporary measure because many replanted teeth ultimately succumb to root resorption. However, many cases have been reported wherein teeth have survived successfully for 20-40 years with a normal periodontium. Such reports demonstrate that under certain conditions, replanted teeth can maintain their integrity and function. The success rate of replanted teeth had been reported to be as low as 4% and as high as 50%.⁵ The predominant and widely accepted treatment regimen is to replant immediately regardless of circumstance. This approach ignores recent evidence that success of replantation is dependent upon many factors, some of which the clinician can manipulate favorably in the dental office. The decision trees in Figures 1 and 2 offer the clinician the most up-to-date information in an easy-to-use flow chart format.

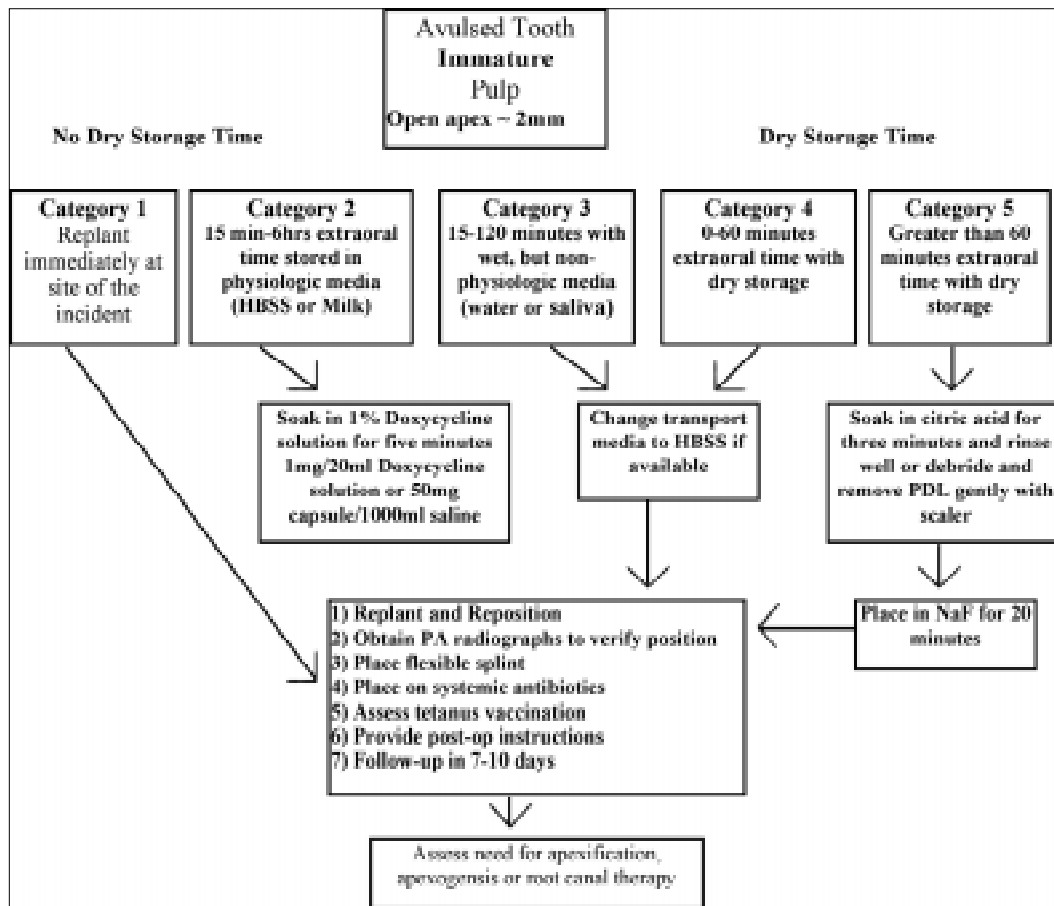


Fig 1. Decision tree for the management of an avulsed tooth with an immature pulp (open apex)

New treatment regimens and rationale

Enhancing revascularization -the use of topical antibiotics for immature teeth

The decision analysis and protocol for management differs for immature versus mature teeth. Because patient age is a poor prediction of tooth maturation, the clinician should rely upon apical closure as an indication of tooth maturation. An immature tooth (open apex) can establish revascularization while a mature tooth (closed apex) has no chance of revascularization.

Cvek and colleagues⁶ demonstrated that immature teeth soaked in Doxycycline solution have a greater rate of pulpal revascularization. It appears that antibiotic treatment reduces the chances of micro-abscesses in the pulpal lumen and this enhancement aids revascularization. These findings have recently been corroborated by Yanpiset and Trope.⁷ While these were animal studies, based on these findings it is recommended that immature teeth should be soaked in a 1% Doxycycline solution for five minutes.^{8,9} A 1% Doxycycline solution can be prepared as follows: 1 mg/20 ml Doxycycline solution or 50 mg/Doxycycline capsule/1000 ml saline.

Preserving the periodontal ligament attachment apparatus

Immediate replantation after avulsion is the best option for the preservation of the attachment apparatus because this prevents dessication of the periodontal ligament cells leading to their death. Because immediate replantation is often not practical,

tooth transport is often undertaken. There is good evidence that Hank's Balanced Salt Solution (HBSS) is the most suitable transport medium.^{3,4,8} Hank's Balanced Salt Solution (HBSS) is a pH-preserving fluid and trauma-reducing suspension apparatus. Save-A-Tooth (Biologic Rescue Products, Conshohocken, PA) is one HBSS-type product marketed for the transport of avulsed teeth. Cvek and colleagues¹⁰ and Matsson and colleagues¹¹ found pH-balanced cell-reconstituting media to be effective in reducing replacement root resorption by maintenance of a normal periodontal ligament.

It is advisable to have HBSS readily available in the hospital emergency room, in athletic coach trainer kits, at schools, and at the private office. If the avulsed tooth is in a non-physiologic medium, it should be placed in HBSS immediately upon arrival of the child to the emergency room or dental office and the tooth can be soaking while the child is receiving medical attention and clearance, needed radiographs and exam.^{4,8,9}

If HBSS is not available at the injury site, it is important to remember that milk has been shown to be the best alternative, because its osmolarity and pH is within acceptable biological range. Studies have shown that milk will preserve periodontal ligament cells up to six hours. Tap water is a very poor alternative because it will cause periodontal cell death within a few minutes.¹²

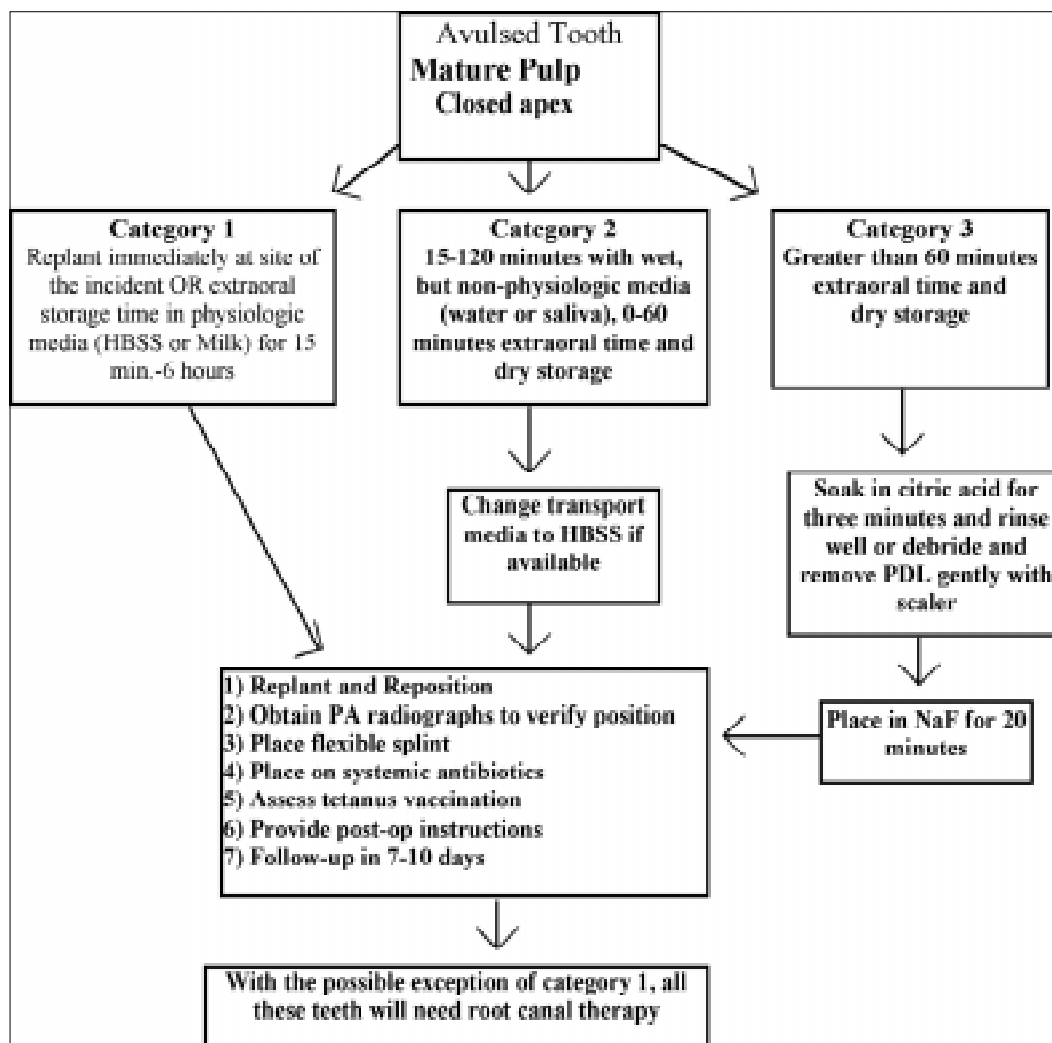


Fig 2: Decision tree for the management of an avulsed tooth with a mature pulp (closed apex)

The condemned periodontal ligament

While revascularization is not essential for the long-term success of the replanted avulsed tooth, maintenance of the periodontal ligament is essential for long-term success and the clinician must pay careful attention to this detail. This decision analysis focuses on extraoral time and storage conditions, both of which have been shown to be critical for the success of replantation.

When a tooth has been out of the oral cavity for greater than 60 minutes with dry storage, the periodontal ligament has no chance of survival. When such a tooth is replanted it will undergo replacement resorption and over time it will become ankylosed. The ankylosed tooth will be lost ultimately because osseous tissue will replace cementum and the root structure will be replaced by bone.

Although ankylosis is an unfortunate outcome for a replanted avulsed tooth, an ankylosed tooth is often a desirable outcome as a transitional circumstance for a child or adolescent. Therefore, for the tooth that has been out of the oral cavity for greater than 60 minutes with dry storage, the goal is to delay ankylosis for as long as possible. To slow the ankylosis process, the remaining periodontal ligament should be removed because it acts as a stimulus for inflammation.^{3,8,9} The remaining liga-

ment is removed by scaling and root planing or by soaking the tooth in citric acid for three minutes to debride the remaining ligament.

Following periodontal ligament debridement, the tooth should be soaked in fluoride (APF or NaF) for 20 minutes.^{3,4,8,9} Coccia¹³ found when teeth were soaked in fluoride before replantation the rate of resorption was significantly reduced after five years of follow-up.

The use of adjunctive systemic antibiotics

Hammarstrom and colleagues¹⁴ found that systemic antibiotics (Pen V K) given at time of replantation were effective in preventing bacterial invasion of necrotic pulp, thus reducing inflammatory root resorption and is the current American Association of Endodontics recommendation.^{3,4} Sae-Lim and colleagues found tetracycline likewise to be effective.¹⁵ Doxycycline has been found to be even more effective in reducing inflammatory root resorption.¹⁶ Thus, this decision analysis recommends: 1) For patients not susceptible to tetracycline staining. RX: Doxycycline 4.4 mg/kg/day q 12h on day one, then 2.2-4.4 mg/kg/day for seven days, and 2) For patients susceptible to tetracycline. RX: Pen VK 500 mg QID or child equivalent dose for seven days.

Conclusion

The decision trees in Figures 1 and 2 offer the busy clinician a contemporary, logical, and easy-to-follow approach to management of avulsed permanent incisors.

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ABSTRACT OF THE SCIENTIFIC LITERATURE



Maxillofacial injuries in the pediatric patient

This paper reviews the epidemiology and management of maxillofacial trauma. The authors emphasize that the management of the pediatric patient with maxillofacial trauma should emphasize the differences in anatomy and physiology between the adult and child patient, the presence of concomitant injury, the particular stage in growth and development of the child and the battered or abused child. It outlines state of the art management of traumatic injuries to each facial bone, including injuries to the dentoalveolar structures.

Comments: There is an excellent review of traumatic facial injuries in children that serves to emphasize our responsibility in not only the management but the prevention of traumatic injuries to children. CH

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