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Avulsion: An Alarm in Dental Traumatology

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Abstract

This paper presents the clinical protocol for the management of aulsed teeth; primary as well as permanent, in its various stages of development. It includes the guidelines from international association of dental traumatology, text books, systemic review articles and case reports. It also reviews the prognosis of avulsed teeth after various interventions. It aims at providing the comprehensive review regarding the management of avulsed teeth to aid the dental clinicians in the better treatment of such teeth.

Keywords: Dental trauma, replantation, tooth avulsion

Introduction

Facial esthetics play an important role in self-identification, self-image, self-presentation and interpersonal confidence. An attractive dentition and smile is an essential feature, both for the children and the adults. Children with a relatively normal dental appearance are judged to be better looking, more desirable as friends, more intelligent, and less likely to behave aggressively. Any deviation from norm, 'such as Dentofacial disfigurement, will stigmatize a person and make him less acceptable socially'. One of the major causes that can lead to Dentofacial disfigurement is traumatic dental injuries.[1] Trauma to the oral region occurs frequently and comprises 5% of all injuries for which people seek treatment. In preschool children the figure is as high as 18% of all injuries. Amongst all facial injuries, dental injuries are the most common of which crown fractures and luxations occur most frequently.[2] Avulsion of permanent teeth occurs most often in children 7 to 9 years old and the maxillary central incisors are the teeth most commonly affected. It accounts for 0.5 to 16% of all traumas to the permanent teeth.[3]

Definition of Avulsion: Complete displacement of tooth out of socket. The periodontal ligament is severed and fracture of the alveolus may occur

Diagnosis: Clinical and radiographic findings reveal that the tooth is not present in the socket or the tooth already has been replanted by patient himself or by primary care giver and is confirmed by radiographic evauation.[4]

The basic requirements for **optimal healing** are that the tooth is out of its socket for as short a period as possible, extra-alveolar storage is in a physiologic medium and contamination of the tooth is eliminated, reduced or controlled by antibiotics. Dry time of less than 5 min is considered ideal while 15–20min is considered acceptable where periodontal healing would be expected.[1]

Treatment objectives

Primary teeth: to prevent further injury to the developing successor.

Avulsed primary teeth should not be replanted because of the potential for subsequent damage to developing permanent tooth germs.

Permanent teeth: to replant as soon as possible and then to stabilize the replanted tooth in its anatomically correct location to optimize healing of the periodontal ligament and neurovascular supply while maintaining esthetic and functional integrity except when replanting is contraindicated by:

1. The child‘s stage of dental development (risk for ankylosis where considerable alveolar growth has to take place)
2. Compromised medical condition
3. Compromised integrity of the avulsed tooth or supporting tissues.[4]

Treatment

An avulsed primary tooth: Avulsed primary tooth must not be replanted, because it may cause damage to the developing tooth germ.[4] The literature mentions some clinical case reports on replantation of avulsed primary teeth, but most of them were extracted 2-24 months later due to complications such as abscess, mobility and advanced root resorption.[5] In cases where the tooth was kept dry during the extra-oral time, ankylosis may be anticipated due to necrosis of the periodontal fibers following late replantation. If there is no evidence to support replantation of primary teeth, the clinician must consider that there are many risks for the child: a danger of aspiration, retention problem, or inflammatory resorption and abscess formation.[6] In long-term studies, it has been observed that when incisors erupted, they were affected by hypoplasia and by white or yellow brown opacity of the enamel, crown dilacerations, malformation resembling an odontoma, duplication, angulations and dilacerations of the root, arrest of root development, germ sequestration, ectopic eruption, to non-irruption of the permanent tooth. This is the basis for the recommendation that primary teeth are not replanted.[7] A removable appliance may be indicated if the primary molars have erupted and there is a risk to develop phonation disorders or tongue interposition.

Instructions to parents/ patients: Parents must receive clear instructions about good oral hygiene of the affected area in order to promote healing.

1. Give the child a soft diet for 15 days. 2. Brush teeth after each meal with a soft brush. 3. Topical use of chlorhexidine twice a day for one week. 4. Inform about possible complications so that treatment can be sought: appearance of a vestibular fistula, color change of the crown associated with fistula.[8]
2. **Clinical Management of an avulsed permanent tooth at the accident Site**

   Replant if possible or place in an appropriate storage medium such as HBSS, milk, saliva

The damage that occured to the attachment apparatus during the initial injury is unavoidable but usually minimal. However, all efforts are made to minimize necrosis of the remaining periodontal ligament while the tooth is out of the oral cavity. Pulpal sequelae are not a concern initially and are dealt with at a later stage of the treatment. Of utmost importance is the prevention of drying, which causes loss of normal physiologic metabolism and morphology of the periodontal ligament cells. Every effort should be made to replant the tooth within the first 15–20min. This usually requires emergency personnel at the site of the injury with some knowledge of treatment protocol. The dentist should communicate clearly with the person at the site of the accident. Ideally, information on how to deal with such a situation should have already been given to the person who is likely to be on-site in an environment where such an accident is likely to occur, such as at school or on the playing field.

Management in the Dental office

Recognizing that the dental injury might be secondary to a more serious injury, If on examination, a serious injury is suspected, immediate referral to the appropriate expert is the first priority. After ruling out any emergency situation which requires immediate attention medical and accident history is taken and a clinical examination carried out. Clinical examination should include extra oral examination followed by intra oral extra examination.

The primary aim is to replant the tooth with a minimum of irreversibly damaged cells, as this will cause inflammation, and the maximal number of periodontal ligament cells that have the potential to regenerate and repair the damaged root surface.

If the tooth was replanted at the site of injury, a complete history is taken to assess the likelihood of a favorable outcome. In addition, the position of the replanted tooth is assessed and adjusted if necessary. If the patient‘s tooth is already out of the oral cavity, the storage medium should be evaluated and, if necessary, the tooth should be placed in a more appropriate medium.

Preparation of the root: Preparation of the root is dependent on the maturity of the tooth (open vs. closed apex) and on the dry time of the tooth before it was placed in a storage medium.[9]

A tooth that remains out of the oral cavity in a dry condition for less than 60 min, or stored in one of the recommended mediums within the advised time frame, proper conditioning is to coat the root surface with tetracycline and reimplant.

In the event that 60 min have passed in dry conditions, or the tooth remained in a recommended medium longer than the advised time period, then the tooth should be soaked in a fluoride solution before reimplantation.[10]

Extra – oral dry time < 60min

Closed Apex: If the tooth has a closed apex, revascularization is not possible[61] but, when the tooth is dry for less than 60min (replanted or placed in appropriate medium), the chance for periodontal healing exists. Most importantly, the chance of a severe inflammatory response at the time of replantation is lessened.[1]

A continuing challenge is the treatment of the tooth that has been dry for more than 20min (periodontal cell survival is assured) but less than 60min (periodontal survival unlikely). In these cases, logic suggests that the root surface consist of some cells with the potential to regenerate and some that will act as inflammatory stimulators. Exciting new strategies are currently under investigation that may be extremely valuable in these cases. [9]

Recent studies have evaluated the effectiveness of the placement of tetracycline/corticosteroids or corticosteroid

alone inside the root canal (acting as a reservoir) in order to block the surrounding inflammation.[11]

It is important to stress that the corticosteroids need to be placed as soon as possible after the initial injury while the initial destructive inflammation is taking place. Practically this means that in the emergency visit the root canal would have to be cleaned and the intracanal corticosteroid placed with a lentulo-spiral filler. This protocol would require that the dentist open into the pulp space in the first visit, a change in strategy where root canal tissues were previously left for the second visit.[12]

Apparently the use of the medicament was able to shut down the inflammatory response after replantation to allow for more favorable healing in comparison to those teeth that did not possess the medicament. [13]

Open Apex: Soak in doxycycline for 5min, gently rinse off debris, replant.

In an open apex tooth, revascularization of the pulp as well as continued root development is possible. Cvek et al found in monkeys that soaking the tooth in doxycycline (1mg in approximately 20mL. of physiologic saline) for 5min before replantation significantly enhanced revascularization (41% vs 18% in the control group). Furthermore, this treatment lowered the frequency of inflammatory root resorption to 30% vs 66% in the control group and the frequency of ankylosis to 48% vs 68% in the control group.[11] Ritter et al studied the effect of the antibiotic minocycline. Coating the root surface of teeth with open apices in dogs and reimplanting after 5 min outside the mouth, led to revascularization in 90% of the cases vs 73% with doxycycline, and only 33% with saline.[14]

Exra-oral dry time > 60min

Closed Apex: When the root has been dry for 60min or more, the periodontal ligament cells are not expected to survive. In these cases, the root should be prepared to be as resistant to resorption as possible (attempting to slow the osseous replacement process). These teeth should be soaked in citric acid for 5min to remove all remaining periodontal ligament and thus remove the tissue that will initiate the inflammatory response on replantation. The tooth should then be soaked in 2% stannous fluoride for 5min and replanted. Aledronate was found to have similar resorption slowing effects as fluoride when used topically but further studies need to be carried out to evaluate whether its effectiveness is superior to fluoride and whether this justifies its added cost.[14] Studies have found that enamel matrix protein may be extremely beneficial in teeth with extended extra oral dry times, not only to make the root more resistant to resorption but possibly to stimulate the formation of new periodontal ligament from the socket.[9]

If the tooth has been dry for more than 60min and no consideration has been given to preserving the periodontal ligament, the endodontics may be performed extraorally. In the case of a tooth with a closed apex, no advantage exists to this additional step at the emergency visit.[15]

Open apex: In a tooth with an open apex the endodontic treatment, if performed after replantation, involves a long-term apexification procedure. In these cases, completing the root canal treatment extraorally, where a seal in the blunderbuss apex is easier to achieve, may be advantageous. When endodontic treatment is performed extraorally, it must be performed aseptically with the utmost care to achieve a root canal system that is free of bacteria.

Since these teeth are in young patients whose facial development is usually incomplete, many pediatric dentists consider the prognosis to be so poor and the potential complications of an ankylosed tooth so severe that they recommend that these teeth are not replanted. In fact, not to replant these teeth is the recommendation of

the International Association of Dental Trauma.[16] However, considerable debate exists as to whether it would be beneficial to replant the root even though it will inevitably be lost due to resorption. If the patients are followed carefully and the root submerged at the appropriate time, the height and, more importantly, the width of the alveolar bone will be maintained, allowing for easier permanent restoration at the appropriate time when the facial development of the child is complete. Studies are ongoing to evaluate whether the present recommendations should be changed. Presently the recommendation is that if maintenance of a submerged root will be beneficial until the patient‘s facial growth is complete replantation of the tooth should be strongly considered.[70]

Preparation of the socket: The socket should be left undisturbed before replantation. Emphasis is placed on the removal of obstacles within the socket to facilitate the replacement of the tooth into the socket. It should be lightly aspirated if a blood clot is present. If the alveolar bone has collapsed, a factor which may prevent replantation or cause it to be traumatic, a blunt instrument should be inserted carefully into the socket in an attempt to reposition the wall.[9]

Splinting

A splinting technique that allows physiologic movement of the tooth during healing and that is in place for a minimal time period results in a decreased incidence of ankylosis.

Semi-rigid (physiologic) fixation for 7–10days is recommended. The only exception to this is when avulsion occurs in conjunction with alveolar fractures, in which case it is suggested that the tooth should be splinted for a suggested period of 4–8 weeks. The splint should allow movement of the tooth, should have no memory (so the tooth is not moved during healing), and should not impinge on the gingiva and/ or prevent maintenance of oral hygiene in the area.

After the splint is in place, a radiograph should be taken to verify the positioning of the tooth and as a preoperative reference for further treatment and follow-up. When the tooth is in the best possible position, it is important to adjust the bite to ensure that it has not been splinted in a position that will cause traumatic occlusion. [9]

Management of the soft tissues: Soft tissue lacerations of the socket gingiva should be tightly sutured. Lacerations of the lip are fairly common with these types of injuries. The dentist should approach lip lacerations with some caution and it might be prudent to consult with a plastic surgeon at this stage. If these lacerations are sutured, care must be taken to clean the wound thoroughly beforehand as dirt, or even minute tooth fragments, left in the wound affect healing and the esthetic result.

Adjunctive therapy: Systemic antibiotics given at the time of replantation and prior to endodontic treatment are effective in preventing bacterial invasion of the necrotic pulp and, therefore, subsequent inflammatory resorption.[17] The need for analgesics should be assessed on an individual case basis.[13]

The antibiotic regimen of choice in case of tooth replantation is the administration of tetracycline for 7 days or amoxicillin for 7 days, as a second option. In addition to stressing the need for adequate oral hygiene to the patient, the use of chlorhexidine rinses for 7–10days may also be useful.[18]

Follow-Up Care

Clinical and radiographic evaluations should take place at 2-3 weeks, 3-4 weeks, 6-8 weeks, 6 months and yearly for at least 5years. If osseous replacement is identified, timely revision of the long term treatment plan is indicated. In the case of inflammatory root resorption, a new attempt at disinfection of the root canal space by standard

retreatment can reverse the process. Teeth adjacent to and surrounding the avulsed tooth or teeth may show pathologic changes long after the initial accident. Therefore, these teeth should be tested at recall and the results compared to those collected soon after the accident.[13]

Prognosis of replanted avulsed permanent incisor

Author	Year of publication	Study design	Sample	Age group	Intervention	Outcome
Wang	2010	Case report	Immature avulsed 21 with uncomplicate crown fracture, E/0 dry time of 50mins, stored in tap water	7 years	Tooth was replanted immediately using semi rigid fixation, pt was kept on antibiotic prophylaxis. 9 days post trauma, splint was removed. Tooth was restored and occlusal adjustments were done	3 weeks post op, tooth was asymptomatic both clinically & radiographically. 2 months post RCT was done and CaoH dresssing was placed as the restoration was fractured and sinus formation was evident. At 5 month follow up, tooth showed hard tissue barrier formation both clinically and radiographically with continued root development
Werder et al	2011	Case report	37 individuals with 42 avulsed permanent central incisors , E/o dry time upto 60 mins	14-18 years	teeth were reimplanted & fixed with non-rigid splint, root canal treatment was performed 2 days post trauma	Survival rate was 83.3% (35/42 teeth), median follow-up period of 2.8 years (range 1 year to 5 years) after replantation. Periodontal healing observed in 20 teeth; more often in teeth with a closed apex (17/33 teeth) than in teeth with an open apex (3/9 teeth)
Tezel	2013	Case Report	avulsed mature11, stored	13 years	The patient was immediately	At 15 months follow up period, the tooth remained

			in saline with E/o dry time of 0 mins		anaesthetized, the alveolar socket was washed and the avulsed 11 was replanted with the help of finger pressure. The tooth was splinted to the adjacent teeth with composite resin. 10 days post op splinting was removed & CaoH dressing was given, Endodontic treatment of 11, 21, 22 was completed after 6 months	in a stable functional position and did not reveal clinical ankylosis or replacement resorption. The replanted incisor developed mild infraocclusion (of about 1 mm) and replacement root resorption 21 months after the replantation. 27 months after the replantation, the tooth still remained in a stable functional position. Infraocclusion was about 0.5mm
Kahtani et al	2013	Case Report	2 avulsed permanent incisors with E/o dry time of 45 mins	10 years	teeth were reimplanted & repositioned & stabilized using orthodontic wire and composite splint, MTA apexification was done after 1 month	the outcome of the teeth was clinically and radiographically favourable
SelcukSavas	2015	Case report	Avulsed 21, placed in dry paper, E/O dry time 27hrs	8 year	The root of the tooth was cleaned to remove necrotic and dried remnants of PDL. Extra-oral endodontic treatment was	No clinical or radiological pathological changes were detected after 2 weeks of review. In the third month follow-up change in the percussion sound due to ankylosis was noted.

					carried out on the tooth, the root canals were filled with (MTA) and the tooth was replanted slowly, with slight digital pressure. The tooth was stabilized using a flexible splint	During an 18month follow-up period, the replanted tooth remained in a stable, functional position but showed initial replacement resorption, ankylosis, and approximately 0.5mm infraocclusion
SelcukSavas	2015	Case report	Avulsed 11, no storage media used, E/O time 7 hrs	10 year	Same treatment protocol followed (as mentioned above)	At 4 weeks of follow up splinting wire was removed. At a recall visit of three months later, ankylosis of the replanted tooth was observed with a percussion test.
Munavalli	2017	Case Report	avulsed mature11, placed in its own socket	12 year	The half of the tooth was placed in the socket. The tooth was removed out of its socket and cleaned under running water and placed into HBSS solution. Fresh bleeding was prompted in the alveolar socket and the tooth was reimplanted. Splinting was done with the composite splint.	At the end of 3rd week, splint was removed and radiograph showed normal periapical tissues and vitality testing also showed the normal results. At the interval of 6 months, 1 year, and 2 years, the tooth gave normal vitality results and radiographs also showed the normal periapical findings
Korkut E	2016	Case report	Avulsed	9 year	Before the	After 3 years of follow-up,

			maxillary central teeth in a patient, E/O time dry environment for more than 1 hr		replantation; the socket and teeth were rinsed with saline & soaked in 5% tetracycline. splinting with semi-rigid fiber splint system was done for for 2 weeks. Following the splint removal, endodontic treatment was administered, and the patient was called for follow-ups	beginning of teeth root resorption was identified in the radiography. The clinical examination, left maxillary central incisor was found to have infraocclusion due to ankylosis
Kolli, et al	2017	Case report	After 22 hours of extraoral dry time, the tooth was placed in saline; total extraoral time was approximately 114 hours with approximately 92 hours of wet storage time).	8-year	Necrotic and dried remnants of the periodontal ligament tissue were carefully removed from the root surface with pumice prophylaxis. Tooth was soaked in 2% sodium fluoride for approximately 20 min. Extraoral endodontic treatment was carried out followed by root canal filling with Portland cement and restoration of the	After 2 weeks, there were no observable pathological changes, both clinically and radiographically. Splinting was removed and the fractured crowns were restored permanently with resin composite. Periodic evaluation at 12 months and 18 months showed that replanted tooth remained in a stable functional position but with initial replacement resorption and ankylosis

					access cavity with GIC. The tooth was replanted and stabilized	
Satabdi Saha	2018	Case report	Avulsed immature 11, stored in dry newspaper for 31 hours	9 year	Root was cleaned by soaking it in 5.25% sodium hypochlorite for 5 minutes, then treated with 2.4% acidulated sodium fluoride solution for 20 minutes. RCT was performed before replantation. The open apex was closed with MTA cement followed by obturation with gutta percha. Semi rigid splinting was done to stabilize the tooth in position.	Splint was removed after 3 weeks. Patient was kept on periodic follow up at 1, 3, 6 and 12 months. Regular follow up radiographs showed in Clinical evaluation revealed healthy, functioning tooth in normal occlusion.

Conclusion

The sucess in treating an avulsed tooth is the immediate replantation for both pulpal and periodontal healing. The correct knowledge about the prevention and first aid treatment of traumatic dental injuries spread among the masses by means viz; media, school, social workers, medical doctors, primary and secondary health care centres etc can be very beneficial to the human kind.

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