Dental Traumatology 2008; **24**: 120–123; doi: 10.1111/j.1600-9657.2006.00503.x

Replantation of an avulsed permanent maxillary incisor with an immature apex: report of a case

CASE REPORT

Andrew Paul Goldbeck[1], Kevin Lee Haney[2]

Departments of [1]Endodontics and [2]Pediatric Dentistry, College of Dentistry, University of Oklahoma, Oklahoma City, OK, USA

Correspondence to: Andrew Goldbeck, Department of Endodontics, College of Dentistry, University of Oklahoma, PO Box 26901, Oklahoma City, OK 73190, USA
Tel.: +1 405 271 5550
Fax: +1 405 271 3423
e-mail: andrew-goldbeck@ouhsc.edu

Accepted 22 February, 2006

Abstract – A case is reported of the replantation of a maxillary incisor with an immature apex following a traumatic avulsion. A 14-month follow-up clinical examination revealed the patient to be asymptomatic, the tooth to be still functional, and a recall radiograph showed no evidence of renewed periradicular breakdown. The indications for, and limitations of, replantation of an avulsed permanent incisor with an immature apex are discussed.

Avulsion or exarticulation refers to a traumatic injury that forces a tooth completely out of its socket. Tooth avulsion following a traumatic injury is comparatively rare, comprising 1–16% of traumatic injuries to the permanent dentition (1). Avulsion in the permanent dentition most commonly involves a single maxillary incisor and occurs most frequently during the age of 7–10 years, while these teeth are still in the eruption process (2). When avulsion of a tooth with a mature apex occurs, pulp necrosis should be anticipated and root canal therapy should be planned following the replantation of the tooth. In contrast, when an avulsed tooth with an immature apex is replanted within 3 h, a chance for pulpal revascularization exists and root canal therapy can be delayed (1). Long-term retention of an avulsed tooth is related to the condition of the periodontal ligament (PDL) at the time of replantation, with key factors being the amount of time out of the socket and how the tooth was stored during this time period (3). The following is a case report describing the avulsion and replantation of a maxillary central incisor with an immature apex and its 1-year follow-up.

Case report

A 7-year-old Caucasian female presented to the faculty clinic after hours on April 3, 2004. Her permanent left maxillary incisor and primary left lateral incisor had been avulsed as a result of a bicycle accident. Dirt on the teeth had been delicately removed with an alcohol gauze sponge prior to placing the teeth in a plastic bag with cold milk for transportation to the clinic. The teeth had been out of the mouth approximately 2½ h at the time of the patient's arrival. The primary lateral incisor was placed aside and not considered for replantation. The permanent central incisor had a visibly immature apex and was placed in a sterile isotonic saline solution while a health history and personal information were obtained. The child's health history was non-contributory; she was not taking any medications and had no known drug allergies or systemic illness. The status of her tetanus immunization was current.

Extra-oral examination showed abrasions on the nose, chin, forehead, neck and chest as well as a swollen upper lip. The right permanent maxillary central incisor was loose with the crown displaced slightly to the lingual. As the permanent incisors had not fully erupted, it was difficult to determine whether this tooth had been intruded. Radiographs of the area showed no remaining tooth particles in the sockets of the avulsed teeth, and immature root development on the maxillary right central incisor. Replantation was carried out under local anesthesia. The coagulum was gently rinsed from the socket of the left central incisor and that tooth was replanted slowly, so as not to force the tooth into place. A semi-rigid splint was constructed from 0.028 round orthodontic wire and extended from primary maxillary first molar to primary maxillary first molar to hold the tooth in place and still allow stimulation of the PDL (Fig. 1). The patient was placed on 250 mg of penicillin to be taken every 6 h for 1 week. The patient had a mixed dentition open bite and was placed on a soft diet and told to avoid biting directly with her two front teeth. Oral hygiene instructions were given and the patient was

Fig. 1. Replanted maxillary incisor with flexible splint.

given an appointment for follow-up. The patient was seen 2 days later for follow-up on April 5, 2004. She was sore and tender in the areas of trauma. Intra-orally the buccal vestibule was not swollen; the upper lip was still swollen but less than before. The patient was not eating well and her oral hygiene was poor in the area of injury. The patient was encouraged to improve her eating habits and a toothette was given to help clean the traumatized area. She was seen again on April 9, 2004, 6 days after the accident. Extra-oral swelling was resolved and there were just a few minor abrasions on her nose. Intra-orally the buccal vestibule and facial gingiva opposite the maxillary central incisors looked healthy and though there was no vestibular swelling or tenderness, the central incisors were sore to chewing pressure (Fig. 2). The gingiva lingual to the avulsed incisor was somewhat inflamed but less so than the previous appointment. The patient was instructed to clean more thoroughly in this area. A periapical radiograph showed no apical osseous breakdown. The patient was appointed for splint removal in 1 week and on April 16, 2004, the patient returned to the clinic for continued follow-up. The central incisors were no longer tender to chewing and the gingiva around the traumatized teeth appeared healthy. There was no vestibular swelling or apical palpation tenderness. A radiograph showed no evidence of periapical breakdown. The central incisors were freed from the splint but the splint remained attached to the primary teeth in case it needed to be reapplied to the central incisors. There was no change in status at the next appointment on April 23, 2004.

On May 12, 2005 the patient presented for an additional follow-up. The traumatized teeth were not painful to chewing and the patient had no complaints. The gingiva surrounding the tooth which had been displaced was healthy in appearance, however a small amount of purulence was observed draining from a sinus tract located on the attached gingiva at the distal–facial line angle of the replanted central incisor. A periapical radiograph showed the root end undergoing inflammatory resorption leaving minimum root structure. The patient was appointed for an apexification procedure. On May 18, 2005 she returned to the clinic and an endodontic access was performed on the replanted tooth under local anesthesia and rubber dam isolation. The contents of the canal were debrided and a tentative working length of 15 mm was established. Sodium hypochlorite irrigation was performed before, during, and after the debridement procedure. The canal was then dried and packed with calcium hydroxide (TempCanal; Pulpdent Corporation, Watertown, MA, USA) (Fig. 3). A temporary restoration was placed in the access cavity, and the patient was appointed for follow-up in 2 weeks. The parents were informed that if no improvement was observed, the tooth would be considered for extraction and subsequent placement of a Hawley retainer to which a tooth had been added would be needed.

On June 1, 2004 the patient returned without symptoms for further evaluation. The replanted tooth was firm in the alveolus and the sinus tract had resolved. Both incisors were continuing to erupt, and there was no radiographic evidence of apical breakdown on the right central incisor that had sustained the luxation injury. On June 15, 2004 the splint was removed from the primary molars and the teeth were polished. Both traumatized teeth continued the eruption process and despite very little root structure, the replanted tooth remained stable. The patient was given a recall appointment for 3 months.

On September 7, 2004 the patient returned for continued observation. The traumatized teeth were asymptomatic, and the gingiva around the teeth was healthy in appearance and there was no swelling or sinus tract present. Mobility of the teeth was not greater than class I. A periapical radiograph showed apical healing around the replanted tooth and continued root development for the luxated incisor. Under rubber dam isolation the calcium hydroxide was removed and the canal space was packed with mineral trioxide aggregate (MTA, Pro Root;

Fig. 2. Soft tissue lesion healings 6 days postreplantation.

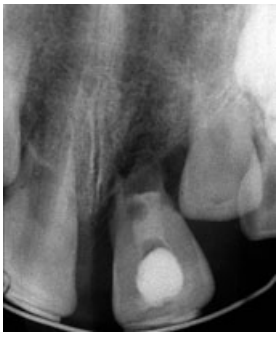

Fig. 3. Necrotic tissue removed; canal space package with calcium hydroxide.

Fig. 4. Fourteen-month recall appointment (tooth stable without symptoms).

Fig. 5. Fourteen-month recall appointment (periapical healing on replanted tooth).

Dentsply Tulsa Dental, Johnson City, TN, USA). A layer of polycarboxylate cement was placed over the MTA and the access opening was filled with a composite resin restoration. The patient was appointed for further recall.

On June 10, 2005 the patient returned for a 14-month follow-up appointment. Both traumatized teeth were without symptoms. There was no percussion palpation or chewing tenderness, and no swelling or sinus tact was present. The surround gingiva appeared healthy (Fig. 4). The teeth were not mobile and there were no probing depths >3 mm. A periapical radiograph showed complete apical healing on the replanted tooth and a mature apex on the luxated central incisor (Fig. 5). The canal space for the luxated tooth however had closed dramatically since the last appointment. A decision was made to perform root canal therapy on this tooth. On June 30, 2005 root canal therapy was performed on the maxillary right central incisor. At dismissal, the patient was given an appointment for follow-up in 6 months (Fig. 5).

Discussion

The decision to replant the avulsed permanent central incisor was based on the fact that the apex of the incisor had not matured, the extra-oral dry time was <20 min, and the total time out of the socket was <3 h. In a study of 400 avulsed permanent incisors, Andreasen et al. found that 34% of replanted teeth with immature apices achieved pulpal revascularization (4). Factors that decreased the chance of pulpal revascularization included wet storage of the tooth for >5 min prior to replantation and extended extraalveolar dry storage prior to replantation of the avulsed tooth. Although it was unavailable at the time of replantation of this tooth, Cvek et al. demonstrated that chances of pulpal revascularization can be enhanced by the topical application of doxycycline to the root surface prior to replantation. It is thought that doxycycline was effective in decreasing the microorganisms that may have contaminated the pulpal lumen and the root surface during the extraalveolar period (5).

Long-term retention of an avulsed tooth is related the healing of the PDL and the survival of PDL cells along the root surface of the avulsed tooth. Andreasen et al. studied PDL healing following replanted permanent incisors and concluded that the most significant factors in PDL healing were stage of root development, length of extraalveolar dry storage, immediate replantation, and length of wet storage, and recommended immediate replantation where possible (6). If immediate replantation is not possible, vitality of PDL cells on the root surface may be maintained for a period of time if the tooth is stored properly during the extraalveolar time. Extended dry storage is damaging to the PDL cells. When dry storage was 30 min or more, evidence of inflammatory resorption appeared following replantation. Where the extraalveolar dry time was 60 min or more, replacement resorption was prominent (7). Ideally, storage of the avulsed tooth in a tissue culture medium like Hank's balanced salt solution or ViaSpan, an organ transport medium, allows the best opportunity for PDL cell preservation (8). Limited availability of these media may prevent them from being used at some injury sites. Blomlof et al. found cold milk to be a suitable storage medium for a period of up to 3 h (9). Less effective storage media include physiologic saline, saliva, and tap water (10).

The replanted tooth should be held in place with a semi-rigid splint made with a passive orthodontic wire (size 0.015–0.030). Composite resin makes a good luting material. This type of splint allows for stimulation of the PDL during healing and reduces the incidence of ankylosis. A splinting time of 7–10 days is generally recommended (2). Current guidelines recommend a 1-week course of systemic antibiotics after replantation (11). Antibiotics are thought to minimize infection that may arise from a necrotic dental pulp, reducing the incidence of inflammatory resorption (12). A replanted tooth with an immature apex should be followed closely as evidence of pulp necrosis and root resorption can be seen as early as 2–3 weeks postinjury (13). At the first sign of apical pathosis, endodontic therapy should be initiated. The canal space should be debrided and treated with calcium hydroxide. Calcium hydroxide has been shown to reduce periapical inflammation and inflammatory resorption, and promote apical healing (14). In this particular case, calcium hydroxide was left in the canal for a period of 3 months. After that period of time there was definite clinical and radiographic evidence of apical healing. As the actual root length was only 4–6 mm, MTA was used to obturate the root canal space. MTA

has been shown to be an effective apical plug in apexification cases (15).

The goal in replanting the permanent incisor was to retain the tooth until the patient reached an age where a permanent replacement (an implant or fixed partial denture) can be made. Early loss of the permanent dentition can lead to space loss and deviation of the midline. To avoid this consequence, the space would have to be maintained by the used of various removable prosthetic and or orthodontic appliances over a period of 8–10 years. As a general rule, maxillary anterior implants are contraindicated in a growing child. Replanted permanent incisors should continue to be followed until facial and alveolar bone growth is complete. One of the complications that can arise from replanting a tooth in a young patient is that ankylosis can retain the tooth in the replanted position disturbing the normal growth pattern of the alveolar process. The resulting decrease in height of the alveolar process along with migration and malocclusion of the adjacent teeth can complicate future restorative procedures. The treatment of choice in these instances is to extract the tooth as soon as infraocclusion is diagnosed (1).

After 6 months, avulsed teeth should be followed every 6 months for 5 years and then annually for as long as possible. At the recall visit, teeth opposite and adjacent to the avulsed tooth should also be checked for vitality. These teeth may have a delayed response and not show signs of pathology until quite some time after the initial trauma (2). At the 14 month recall, there was significant closure of the canal space on the maxillary right permanent incisor when compared with the radiograph taken at the 5 month recall. This tooth had been extruded and displaced lingually at the time of the accident. By this time the apex had matured and the decision was to initiate root canal therapy before the canal became completely obliterated. In a study by Jacobsen and Kerekes, secondary pulpal necrosis in teeth that were undergoing canal obliteration following a traumatic injury was found only in cases of total canal obliteration and mostly in those teeth where the obliteration took place within the first 2 years postinjury (16). The authors acknowledge that people may disagree with the decision to initiate root canal therapy on a tooth undergoing rapid canal obliteration without evidence of pathologic periapical changes. Lundberg and Cvek studied pulp tissue taken from teeth treated because of reduce canal space following trauma. They failed to find histological changes in the pulp that would support the need for treatment (17). Cvek, Lundberg, and Graneth examined the ability to access teeth with periapical lesions that had under gone pulp canal obliteration. They were able to access 53 of 54 teeth studied even though there was either just a faint canal or no canal visible in the preoperative radiograph (18).

Conclusions

Traumatic injuries that result in inflammatory resorption of the permanent teeth in the growing child leave the practitioner with many considerations as to the most appropriate treatment plan. Even in severe cases of inflammatory resorption, the alternative of apexification may still be used effectively. In this case, the long-term alternative of removable prosthodontics until the patient is mature enough for a fixed prosthodontic procedure was not deemed as acceptable as the attempt to maintain the natural tooth for as long as possible. The key to the decision lies in careful consideration of the risks and benefits of the endodontic treatment as well as a thorough understanding of the indications for the appropriate use of conventional or implant retained fixed prosthodontics in the young child.

References

1. Andreasen JO. Traumatic injuries of the teeth, 2nd edn. Philadelphia, PA: WB Saunders; 1981. p. 151–383.
2. Trope M, Chivian N, Sigurdsson A, Vann W. Jr. Traumatic injures. In: Cohen S, Burns RC, editors. Pathways of the pulp, 8th edn. St Louis, MO: Mosby; 2002. p. 603–49.
3. Andreasen JO, Andreasen FM (editors). Avulsion injuries. In: Essentials of traumatic injuries to the teeth. Copenhagen: Munksgaard; 1990. p. 113–31.
4. Andreasen JO, Borum MK, Jacobsen HL, Andreasen FM. Replantation of 400 avulsed permanent incisors. 2. Factors related to pulpal healing. Endod Dent Traumatol 1995;11:59–68.
5. Cvek M, Cleaton-Jones P, Austin J, Lownie J, Kling M, Fattie P. Effect of topical application of doxycycline on pulp revascularization and periodontal healing in reimplanted monkey incisors. Endod Dent Traumatol 1990;6:170–6.
6. Andreasen JO, Borum MK, Jacobsen HL, Andreasen FM. Replantation of 400 avulsed permanent incisors. 4. Factors related to pulpal healing. Endod Dent Traumatol 1995;11:76–89.
7. 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;10:43–53.
8. Trope M, Friedman S. Periodontal healing of replanted dog teeth stored in Viaspan, milk, and Hank's balanced salt solution. Endod Dent Traumatol 1992;8:183–8.
9. Blomlof L, Otteskog P, Hammarstrom L. Effect of storage in media with different ion strengths and osmolalites on human periodontal ligament cells. Scand J Dent Res 1981;89:180–7.
10. Diangelis AJ, Bakland LK. Traumatic dental injuries: current concepts. J Am Dent Assoc 1998;129:1401–14.
11. Recommended guidelines of the American Association of Endodontists for the treatment of traumatic dental injuries. American Association of Endodontists; 2003.
12. Hammarstrom L, Blomlof L, Feiglin B, Andersson L, Lindskog S. Replantation of teeth and antibiotic treatment. Endod Dent Traumatol 1986;2:51–7.
13. Andreasen JO, Andreasen FM, editors. Avulsions. In: Textbook and color atlas of traumatic injuries to the teeth, 3rd edn. Copenhagen: Munksgaard; 1993. p. 383–426.
14. Hammarstrom L, Blomlof L, Feiglin B, Lindskog S. Effect of calcium hydroxide treatment on periodontal repair and root resorption. Endod Dent Traumatol 1986;2:84–9.
15. Kratchman SI. Perforation repair and one-step apexification procedures. Dent Clin North Am 2004;48:291–307.
16. Jacobsen I, Kerekes K. Long-term prognosis of traumatized permanent anterior teeth showing calcifying process in the pulp cavity. Scand J Dent Res 1977;85:588–98.
17. Lundberg M, Cvek M. A light microscopy study of pulps from traumatized permanent incisors with reduced lumens. Acta Odontol Scand 1980;38:89–94.
18. Cvek M, Granath L-E, Lundberg M. Failures and healing in non vital anterior teeth with post traumatically reduced pulpal lumen. Acta Odontol Scand 1982;40:223–8.