Dental Traumatology

Dental Traumatology 2010; 26: 182-185; doi: 10.1111/j.1600-9657.2010.00864.x

Continued root formation after replantation and root canal treatment in an avulsed immature permanent tooth: a case report

CASE REPORT

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Correspondence to: Yi-Shing Shieh, Triservice General Hospital, National Defense Medical Center, Taipei, Taiwan, No. 325, Cheng-Kung Road, Sec. 2, Neihu 114, Taipei, Taiwan, ROC Tel.: +886 2 87919276 Fax: +886 2 87919276 e-mail: ndmcyss@nhri.org.tw Accepted 23 November, 2009 Abstract – This case report describes the continued root formation following replantation and conventional root canal therapy of a traumatically avulsed open-apex tooth with suppurative apical periodontitis. A 7-year-old male patient had an avulsed upper left central incisor (tooth 21) replanted approximately 50 min after traumatic avulsion. A root canal procedure was initiated due to pulp necrosis and periapical abscess detected in the follow-up period. After endodontic treatment with calcium hydroxide $(Ca(OH)_2)$ dressing, a normal root length developed including an apical segment beyond the hard tissue barrier. Regeneration of the root occurred without pathology or ankylosis at 1-year of follow up.

Of all dental injuries, avulsion caused by trauma is the very serious condition. When a tooth is avulsed, damage to the pulp tissue and periodontal ligament (PDL) occurs (1, 2). The avulsed tooth is 'separated' from the boney socket mainly due to tearing of the PDL, which leaves viable PDL cells on most of the root surface. As a result of crushing of the tooth against the socket, smalllocalized cemental damage also occurs. Pulpal necrosis usually occurs after traumatic avulsion and the necrotic tissue is extremely susceptible to bacterial contamination. The complications of tooth avulsion, such as loss of pulp vitality and root resorption, usually can be observed at follow-up visits. Therefore, long-term follow up is needed subsequent to tooth avulsion. Trope (3) recommended 'ideal' follow up should include dental visits every 6 months for up to 5 years.

Tooth avulsion can result in hypoxia and eventual necrosis of the pulp. Replantation is an option following traumatic avulsion as pulp survival is possible. A tooth with open apex/apices has a greater potential for pulpal revascularization after replantation (1, 3). However, in many cases, tooth development is arrested and infection occurs. In the event of pulp necrosis with apical periodontitis, an endodontic procedure is usually required. In most cases, the canal is filled with calcium hydroxide (Ca(OH)₂) with subsequent hard tissue barrier formation in the apical portion of the root (4).

Recently, some studies have reported that immature permanent teeth with necrotic pulp and apical pathosis have achieved near normal root development after appropriate endodontic treatment (5–10). These reports provide evidence that appropriate management of infected canals can create a favorable environment for tissue regeneration since open-apex immature teeth may contain a rich blood supply and stem cells (11). The etiologies of the aforementioned cases were caries invasion or central cusp fractured. Here, we present a case of traumatic avulsion with uncomplicated crown fracture. Our case report describes the continued root formation following replantation and conventional root canal therapy of a traumatically avulsed open-apex tooth with suppurative apical periodontitis.

Case report

A 7-year-old male patient had traumatic avulsion of his upper left central incisor (tooth 21) because of falling down accident in October 2007. His parents kept the avulsed tooth with tap water and went to the nearest dental clinic. At the clinic, the dentist replanted the avulsed tooth into the socket with semi-rigid fixation using resin and wire. Then, an oral antibiotic (Amoxicillin 250 mg q8h for 3 days) was prescribed to prevent the possible infection.



Fig. 1. Radiograph from first follow-up visit before removing splinting. The tooth 21 was replanted into the socket with semi-rigid fixation using resin–wire.

Nine days after the accident, the patient and his mother presented to our section for further evaluation and treatment. Based on the patient's history, approximately 50 min extra-oral time for the avulsed tooth was estimated. No sinus tract or pathologic swelling was noted on intraoral examination. Uncomplicated crown fracture with dentin involvement of tooth 21 was also noted. Percussion, palpation tests were all within normal range. Pulp vitality tests were performed with refrigerant (Dichlorotetrafluoroethane, -41.5°C) and electric pulp test (EPT). No response was observed of tooth 21 while compared with tooth 11. A periapical radiograph (Fig. 1) showed a thin dentinal wall and immature open apex in the replanted incisor. After examinations, traumatic occlusion in this tooth was noted. Then the splinting wire was removed and the occlusion was adjusted after restoration of the fractured crown. Moreover, oral hygiene instruction and mouth rise with chlorhexidine was provided at this time.

Three weeks after replantation, the patient was seen on routine examination with no symptoms or signs. There were no obvious pathologic changes on the radiographic film (Fig. 2). Pulp vitality tests were carried out again on both central incisors. The reaction of tooth



Fig. 2. Periapical radiograph of teeth 11 and 21 at 3-weeks follow up.



Fig. 3. Two-month follow-up photograph. A sinus tract was found in the left upper gingiva corresponding to tooth 21.



Fig. 4. Two-month follow-up radiograph showed arrested root formation and apical radiolucency around tooth 21.

21 was also negative to the EPT and cold test seemed to have some response. After discussion, a conservative treatment approach was selected including observation and close follow up.

Two months after replantation, the boy came back to our section because of the composite restoration fractured. A sinus tract was then noted over the avulsed tooth (Fig. 3). All vitality tests showed negative responses. A periapical radiograph revealed a radiolucent image around the apical region with inflammatory resorption of the mesial root aspect. Compared with the neighboring tooth, arrested root formation was also noted (Fig. 4). Clinical and radiographic examinations indicated pulp necrosis with suppurative apical periodontitis. Endodontic treatment was strongly recommended, but the patient's mother was initially hesitant. After further consultation with the patient's parents, a root canal procedure was performed three days later. Liquification necrosis of pulp tissue was observed under access cavity preparation. The root canal was lightly instrumented, copiously irrigated with 2.5% NaOCl, and then filled with Ca(OH)₂ under rubber dam and dental floss isolation. Symptoms and signs were resolved in 1 week.

A hard tissue barrier was clinically noted inside the canal after $Ca(OH)_2$ dressing for 5 months. In addition,



Fig. 5. A hard tissue barrier was noted beneath the guttapercha cone of tooth 21. Radiographic evidence of continued root development was observed.



Fig. 6. The canal of tooth 21 was obturated with MTA and composite resin was used to restore the coronal access preparation.

the immature tooth showed radiographic evidence of continued root development (Fig. 5). Regression of the apical radiolucent lesion was also observed. The root canal was obturated with mineral trioxide aggregate (MTA) and the coronal part was filled with composite resin on June, 2008 (Fig. 6). At 1-year follow up, complete root length development and normal PDL were observed on the periapical film (Fig. 7). Tooth 21 showed normal response to palpation and percussion tests. The probing depth and mobility grade were within normal range. No metallic sound or infraocclusion was detected (Fig. 8).

Discussion

Management of a traumatically avulsed tooth in the dental clinic is always a challenge to the clinician. Avulsion of a permanent immature tooth is a very serious condition (1–3). Replantation of an avulsed tooth is a preferred treatment option if the extra-oral time is < 1 h (3). Cvek et al. (12) recommended that in the openapex tooth, avoiding contamination of root surface could promote revascularization of the pulp. Therefore,



Fig. 7. At 1-year follow up, complete root length development and normal periodontal ligament were observed on periapical radiograph.



Fig. 8. No discoloration or infraocclusion was detected at 1-year follow up.

soak the avulsed tooth in doxycycline for 5 min should be added in this emergency treatment. After replantation, tetanus prophylaxis and enough systemic antibiotics also should be provided to the patient (4).

The rate of revascularization in replanted teeth varies between 18% and 40% (13, 14). Moreover, cessation of root development and bacterial contamination of the pulpal space are common after traumatic avulsion (1, 3, 15). PDL damage leads to root resorption (2), and pulpal infection leads to cessation of normal root structure formation. Because of the uncertainty, post-traumatic follow up and management are very important following traumatic avulsion. If the pulp space does not revascularize after replantation, then an apexification procedure is usually required (4). In most cases, however, the prognosis is compromised due to weaker tooth structure and short root length (16).

In our case report, the tooth suffered from both avulsion and uncomplicated crown fracture. The deep proximal fractures with severe luxated injury significantly increased the risk of pulp necrosis. This tooth finally failed to revascularize and the endodontic procedure was provided. We originally attempted to perform the treatment of apexification. The endodontic procedure involved minimum instrumentation and copious irrigation because of the large canals space and thin dentinal wall. We used 2.5% NaOCl as irrigant because its antimicrobial and tissue-dissolving properties (17). $Ca(OH)_2$ paste was placed in the root canal space for disinfection and induction of dentinal bridge formation (18). Placement of $Ca(OH)_2$ dressing may also protect the underlying pulp tissue (8). Although a calcified barrier was observed in our case, we used MTA as final obturation material because its biocompatibility, antibacterial effect and resistance to leakage and fracture (19–21).

Despite the loss of pulp vitality with abscess formation, the apical root formation continued in our case. Some possible mechanisms may explain this phenomenon. First, it is possible that Hertwig's sheath survived and retaining its ability to continue its role of root organization when the inflammatory process was eliminated (22, 23). Second, the mesenchymal stem cells may reside in the apical papilla of permanent immature teeth (11). These stem cells appear to be the source of odontoblasts and can develop root dentin. According to the statement of Huang et al. (11), even if infection is present in the canal cavity and reaches the periradicular tissues, stem cells from the apical papilla may survive and contribute to tissue regeneration. Therefore, appropriate management of an infected canal may provide a favorable environment for tissue regeneration.

Recently, some reports have shown regeneration of an open apex in teeth with pulpal necrosis and infection (5-10). For example, Chueh & Huang (6) reported four cases of immature teeth that developed periradicular periodontitis or abscess and underwent conservative treatment. All cases developed mature apices within from 7 months to 5 years after initial treatment without complications. The etiologies of the aforementioned cases involve central cusp fracture or caries invasion. In this report, we presented a case of traumatic avulsion with uncomplicated crown fracture. In cases of involving disruption of PDL cells and pulpal infection, generation of normal root length and periradicular condition is surprising. To our knowledge, this situation is very uncommon. This case presents a successful outcome and may offer a treatment modality for a replanted tooth with immature open apex. Proper emergency and regular follow up are important in cases of traumatically avulsed teeth. If root canal treatment is initiated in an immature permanent tooth, our experience supports conservative instrumentation with copious irrigation. Further studies are needed to investigate the accurate development mechanism in cases that are like this kind of condition.

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