

CASE REPORT

Replantation of three avulsed permanent incisors with complicated crown fractures

C. Walter*, G. Krastl*, A. Izquierdo, H. Hecker & R. Weiger

Department of Periodontology, Endodontology and Cariology, School of Dentistry, University of Basel, Basel, Switzerland

Abstract

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Aim To report a rare case of multiple avulsions of permanent teeth associated with complicated crown fractures.

Summary The case describes a 3-year follow-up of the treatment of three avulsed maxillary incisors with complicated crown fractures. The teeth were replanted after an extra-oral time of 90 min (extra-oral dry time 6 min). After root canal treatment, the fractured maxillary incisors were restored with a layered hybrid composite material to re-establish aesthetics and function. Follow-up visits showed signs of replacement resorption affecting the maxillary central incisors but only minor signs of root resorption on the maxillary right lateral incisor. These findings were supported by digital volume tomography, which was performed 18 and 36 months post-trauma in order to assess extent, severity and progression of root resorption more accurately.

Key learning points

- Healing of avulsed teeth depends on the degree of periodontal ligament (PDL) damage.
- Digital volume tomography might improve diagnostics of root resorption.

Keywords: avulsion, crown fractures, digital volume tomography, root resorption.

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Introduction

Avulsions of permanent teeth following traumatic injuries are relatively infrequent ranging from 0.5% to 3% (Andreasen *et al.* 2007). An avulsion of a permanent tooth is rarely (5%)

Correspondence: Dr Clemens Walter/Dr Gabriel Krastl, Department of Periodontology, Endodontology and Cariology, University of Basel, Hebelstrasse 3, 4056 Basel, Switzerland (Tel.: +41 61 2672623; fax: +41 61 2672659; e-mails: clemens.walter@unibas.ch/gabriel. krastl@unibas.ch).

*Both authors contributed equally to this work.

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associated with an additional crown fracture (Andreasen 1970). Survival rates of replanted avulsed teeth are about 55% for mature teeth after 10 years (Andreasen et al. 1995). Pohl et al. (2005) estimated a mean survival time of 57 months for replanted avulsed permanent teeth. The prognosis of replanted teeth depends to a high degree on (i) the amount of physical damage to the root surface (cementum and PDL cells), (ii) the extraoral (dry) time (Trope & Friedman 1992, Trope 2002) and (iii) the type of storage medium (Trope & Friedman 1992, Andreasen et al. 1995, Schwartz et al. 2002). Favourable healing, characterized by complete regeneration of the periodontal ligament without clinical or radiographic signs of progressive root resorption (Andreasen et al. 2007) has been documented for 4-57.7% of all replanted avulsed teeth (Chappuis & von Arx 2005, Pohl et al. 2005, Andreasen et al. 2007). However, the high rate of functional healing (57.7%) reported recently (Chappuis & von Arx 2005) may be because of the limited observation period of 1 year. Because of timing of detection of resorption varied from about 3 months to 3 years, a minimum period of observation of 3 years has been suggested (Boyd et al. 2000, Chappuis & von Arx 2005). Whether or not the exposure of the pulp affects the incidence of root resorption and the long-term prognosis of avulsed teeth remains unclear because of lack of data.

As the present case comprising three avulsed permanent incisors with complicated crown fractures is quite unusual in several ways, the aim of this report was to present the features and management of three permanent incisor teeth which were avulsed and had concurrently sustained complicated crown fractures.

Case

An 18-year-old caucasian male attended for emergency treatment at the Department of Periodontology, Endodontology and Cariology, University of Basel, Switzerland. He arrived at the clinic in an ambulance together with his father and two medical assistants at midnight. His father reported that the young man had suffered an accident at work, collapsed, fell forward on his mouth and was unconscious for a short period of time (<10 s). Further medical investigation did not demonstrate any distinctive features such as vomiting, headache nor amnesia. The patient was physically and mentally healthy with the exception of the consequences arising out of the current accident. He had received an anti-tetanus booster approximately 1 year previously.

The clinical examination revealed a swollen upper lip, three alveolar sockets (teeth 12, 11, 21), filled with blood and several gingival lacerations in the maxillary anterior region (Fig. 1). The neighbouring teeth as well as the mandibular incisors showed no signs of



Figure 1 Initial intra-oral view of the patient.

trauma such as hard tissue defects, infractions, increased tooth mobility or alterations in tooth position. These teeth responded to CO_2 -pulp sensibility testing. The avulsed teeth were kept in saline for approximately 1.5 h after an extra-oral dry time of approximately 6 min. The crowns of the three avulsed teeth were fractured and approximately 2 mm² of the pulps was exposed. The fractured coronal fragments were not retained. The clinical diagnosis was avulsion of three maxillary incisors, associated with complicated crown fractures.

Treatment

Under local anaesthesia, the blood clots were carefully removed by rinsing the alveolar sockets with saline. Palpation of the buccal as well as of the palatal area and inspection of the sockets revealed neither fractures nor collapsed socket walls. The teeth were replanted gently and fixed by a flexible splint (Titanium Trauma Splint, TTS; Medartis, Basel, Switzerland), extended to two further teeth on each side (von Arx *et al.* 2001).

To avoid further infection of the root canal systems, approximately 2 mm of the exposed pulps was removed without enlarging the surface of the pulp exposures using a high-speed diamond bur (Cvek 1978). The pulp tissue was capped with pure calcium hydroxide powder and sealed temporarily with composite resin (Tetric; Vivadent, Schaan, Liechtenstein). Finally, the gingival lacerations were sutured using a monofilament polypropylene material 5.0. Doxycyline (100 mg day⁻¹) was administered for 10 days. The positions of the replanted teeth were verified radiographically (Fig. 2). Healing during the first days after trauma was uneventful. The sutures and the splint were removed on day 9 post-trauma. The tooth mobility (Miller index, degree 0-3) at that time was '0' (tooth 12), '1' (tooth 11) and '2' (tooth 21), and root canal treatment was initiated. After injection of local anaesthetic and placement of rubber dam, the root canals were instrumented using NiTi rotary files (ProTaper™; Dentsply Maillefer, Ballaigues, Switzerland) and NiTi hand files (Nitiflex™; Dentsply Maillefer) up to size 60 apically. Working length determination was carried out using a combination of apex locator (Raypex4; VDW, Munich, Germany) and radiography. Calcium hydroxide slurry was packed into the root canals and the access cavities were sealed with Cavit™ (3M ESPE, Seefeld, Germany).

Twenty-four days post-trauma, the root canals were filled with the Thermafil[™] System (Dentsply Maillefer) and a sealer (Apexit[™]; Vivadent). The access cavities were restored with composite resin. The postoperative radiograph revealed a surplus of filling material on tooth 11 as well as a radiopaque structure in the apical area of tooth 21 (Fig. 3).



Figure 2 Periapical radiographs of the maxillary incisors after replantation and splinting.



Figure 3 Postoperative radiograph of the root fillings.



Figure 4 Intra-oral view of the case after 3 years.



Figure 5 Periapical radiograph 6 months post-trauma.

Restorative measures were started on a subsequent appointment to re-establish aesthetics and function. The final restorations of the fractured incisors were accomplished with a layered hybrid composite material (EsthetX; DeTrey Dentsply, Konstanz, Germany).

Healing was clinically uneventful within the observation period of 3 years (Fig. 4). Probing depth (2–3 mm), clinical attachment level (2–3 mm) as well as tooth mobility (0) were comparable with the nonaffected teeth of the dentition during periodic follow-ups. The percussion test revealed an ankylotic tone on the two central incisors.

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Radiographically, signs of replacement resorption on tooth 11 and 21 slightly increasing within the first 18 months post-trauma documented the presence of ankylosis (Fig. 5). However, radiographic evaluation at 3-year follow-up (Fig. 6) did not show any progression of the resorptive process affecting the maxillary central incisors. This observation was supported by digital volume tomography, which was also performed 18 (Fig. 7) and 36 months (Fig. 8) post-trauma, in order to assess extent, severity and progression of root resorption more accurately. Despite a normal periodontal ligament space on the mesial



Figure 6 Periapical radiograph 3 years post-trauma.



Figure 7 Digital volume tomograph of tooth 11 at 18 and 36 months post-trauma.



Figure 8 Digital volume tomograph of tooth 21 at 18 and 36 months post-trauma.

aspect and unaltered percussion sound of the maxillary right lateral incisor, slight signs of resorption were presumed in the distal area of the root after 3 years. Moreover, the radiographs revealed loss of interproximal bone in the affected region in the early phase after replantation. The situation remained constant during the further period of observation.

Discussion

The most undesirable phenomenon after tooth replantation is root resorption. According to well-established treatment guidelines for avulsed teeth (Flores *et al.* 2007), new treatment protocols have been described to avoid these adverse effects of replanted teeth. They refer to the application of specific medicaments on the root surface and in the root canal as well as to the time of initiation of endodontic treatment. Whether or not the use of regeneration-promoting enamel matrix proteins or anti-inflammatory medicaments such as glucocorticoids is beneficial for improving the outcome in specific cases is controversial (Sae-Lim *et al.* 1998a, Filippi *et al.* 2001, Araujo *et al.* 2003, Pohl *et al.* 2005, Schjott & Andreasen 2005). The root canal treatment was performed according to the quality guidelines of the European Society of Endodontology (2006).

Calcium hydroxide was used as an intracanal dressing because of its anti-bacterial capacity and tissue dissolving effect. However, there are shortcomings regarding its antiinflammatory effect (Lengheden *et al.* 1991). For this reason, Trope and his group recommended the use of a steroid–antibiotic combination (Ledermix[®]; Haupt Pharma GmbH, Wolfratshausen, Germany) at the time of replantation (Bryson *et al.* 2002). In animal experiments, it seems to decrease the activity of clastic cells compared with Ca(OH)₂ after an observation period of 4 months. However, clinical data are missing on the potential advantages of Ledermix[®] versus Ca(OH)₂ in cases of delayed root canal treatment. The Thermafil[®] system was chosen for filling the root canals. On tooth 21, sealer or gutta-percha was unintentionally extruded. As the cleaning and shaping procedures were done meticulously, it was hypothesized that this would have no impact on the long-term prognosis (Halse & Molven 1987).

A slowly progressing replacement resorption occurred on the two central incisors, 11 and 21. As in older, grown-up patients, progression of osseous replacement is slower compared with growing patients (Andersson *et al.* 1989), the replanted teeth are likely to be retained for several years.

By contrast, tooth 12 showed periodontal healing to a large extent. Presumably because of transient surface resorption, the original outline of the distal root surface appeared altered. As the three avulsed teeth have been treated according to the same protocol, the differences in healing may be because of a different degree of PDL damage (Andreasen & Kristerson 1981) or the biological variance, such as size of the root surface of the tooth types involved (Otis *et al.* 2004).

Physiological saline is not an ideal storage solution for avulsed teeth and the storage time of 1.5 h can be considered rather long (Lekic *et al.* 1998) whilst the extra-oral dry time (6 min) was short. As there is evidence for an improved prognosis of replanted teeth stored in an appropriate storage medium, it is advisable to keep avulsed teeth in special growth media such as Dentosafe[®] (Medice, Iserlohn, Germany) (Pohl *et al.* 1999) prior to replantation. Unfortunately, such a medium was not available in this case.

As the extra-oral dry time was believed to be short in the present case, the generally advocated procedure was followed. It included the administration of tetracycline because of its anti-resorptive properties in addition to the anti-bacterial effects (Sae-Lim *et al.* 1998b, Trope 2002).

As conventional radiographic images describe the area of interest only in a twodimensional way, it may be useful to analyse the bone as well as the teeth with a threedimensional diagnostic approach. Recently, several dental computer tomography (CT) devices have been introduced to dentistry (Cohenca *et al.* 2007a,b). In the present case, the high-resolution imaging system Accuitomo (J Morita, Osaka, Japan) was used in order to assess extent, severity and progression of root resorption more accurately. Using this approach, the teeth could be visualized in other cross-sections. The sagittal and horizontal images obtained 18 and 36 months post-trauma only confirmed the findings of conventional radiography. Because of the missing data and extra radiation for the patient, cone beam CT can rather not be recommended for routine use in all cases of dental trauma. Further clinical trials are needed to verify the benefits compared with conventional radiography.

The periapical area of tooth 21 was difficult to interpret on the final radiograph after root filling (Fig. 3). The three-dimensional examination (Fig. 7) revealed a radiopaque bony or enamel-like structure at the palatal side of tooth 21. This may be a part of the bony alveolar wall or a piece of enamel. Although the bony sockets of the avulsed teeth had been irrigated and inspected carefully, this structure may have been overseen in the alveolar socket. A radiograph of the empty alveolar sockets prior to replantation may have been useful to assure that foreign objects were present.

In the age of osseointegration and implant dentistry, it could be argued that the placement of dental implants would have been the better approach in this case (Schwartz-Arad & Levin 2004). Because of the unpredictable aesthetic outcome, immediate implant placement was not suggested – especially in the maxillary anterior region with multiple tooth loss (Buser *et al.* 2004). In such situations, a delayed approach is advised (Chen *et al.* 2004). In the present case, implant placement is still an option.

Conclusion

This case report demonstrates the successful rehabilitation of a severe dental trauma. Three maxillary incisors were replanted and aesthetics was re-established. Osseous replacement occurred to differing degrees on the teeth involved. This may be due to different degrees of PDL damage.

Disclaimer

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