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Tooth fragment reattachment in multiple complicated permanent incisor crown-root fractures – a report of two cases

CASE REPORT

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Abstract – Crown-root fractures account for only 5% of all traumatic injuries; however, they can present difficulties for successful management. This paper describes the treatment of two unrelated children who sustained crown-root fractures, extending subgingivally, in permanent upper central incisor teeth with immature apices.

Crown-root fractures account for up to 5% of all traumatic injuries and are usually caused by direct trauma to the anterior teeth (1–3). These dental injuries extend below the cemento-enamel junction and involve enamel, dentine and cementum, with or without pulpal involvement (1–3). In posterior teeth, crown-root fractures usually present as cuspal fractures extending to variable depths down the root (2).

Conventionally crown-root fractures have been treated in a variety of ways depending on the site and type of fracture. In superficial crown-root fractures, the fragment can simply be removed and replaced by a directly bonded tooth-coloured restoration. In cases of deep fractures, the root can be surgically exposed, surgically extruded or orthodontically extruded and restored with a tooth-coloured restoration (1, 3). Various reports have been published in which cases of crown-root fracture have been treated by tooth fragment reattachment with or without surgical exposure or extrusion of the root depending on the site of the fracture (2, 4–7).

In the case of complicated crown-root fractures, maintenance of pulpal vitality is highly desirable especially in cases with an open apex. The methods available for treating traumatic pulp exposures include pulp-capping, pulpotomies or root canal therapy. The choice of treatment is based on various determinants such as the maturity of the tooth, the time lapse between injury and treatment and the size of the pulp exposure (8).

This paper presents the management of two non-related children with complicated crown-root fractures, of permanent maxillary central incisors, extending subgingivally. Each case had a different time lapse between injury and treatment but both had immature apices.

Case 1

A fit and healthy 11-year-old boy was referred to Glasgow Dental Hospital by his General Dental Practitioner. He had sustained a complicated crown-root fracture of his upper right central incisor following a fall from his bicycle some 16 h prior to his attendance. The General Dental Practitioner carried out clinical and radiographic examination but no treatment before referring the child to the Dental Hospital.

On examination the patient was alert with no symptoms of head injury or signs of neurological damage. There were no other injuries elsewhere on the body. Clinical examination revealed no abnormal facial asymmetry or other facial injury. The patient's lower lip was swollen on the right hand side. Intraorally he had sustained a vertical complicated crown-root fracture of the upper right central incisor, 11, extending subgingivally. The mesial corner of the upper right central incisor, 11 had an associated uncomplicated crown fracture (Fig. 1). The missing tooth fragment had been left at the accident site. There was no sign of injury to any of the other erupted teeth. Radiographic examination confirmed the above findings and it was also noted that the apices of the central incisors were still open (Fig. 2). The incisor relationship was class 2 division 1.

Treatment was carried out under local anaesthesia. The loose tooth fragment site was opened manually with a flat plastic instrument to gain access to the exposed pulp. A cervical pulpotomy was carried out and the coronal pulp chamber was irrigated with sterile water from a Cavitron tip to completely remove blood products and pulpal remnants to prevent crown

Fig. 1. Clinical appearance of tooth 11 at presentation (case 1).

Fig. 2. Radiographic appearances of teeth 11 and 21 at presentation (case 1).

discolouration. The exposed non-bleeding pulp was covered with non-setting sterile calcium hydroxide powder mixed with sterile water into a thick paste followed by a layer of setting calcium hydroxide (Dycal, Dentsply, Milford, DE, USA). The crown fracture site was reduced manually to close the exposure site. Following acid etching for 30 s, Scotchbond Multi-Purpose^{TM} (3M, St. Paul, MN, USA) primer was applied and dried gently for 5 s. The adhesive was applied and light-cured for 10 s. A preformed celluloid crown form (DeTrey, Dentsply) matched to the size and shape of the adjacent upper central incisor, filled with composite (Z100, 3M) matched to the tooth shade, was placed over the fractured upper right central incisor to splint the fracture sites firmly together and restore aesthetics. The restoration was then light-cured for 60 s from both labial and palatal surfaces. In this way the missing mesial

Fig. 3. Clinical appearance of tooth 11 following restoration (case 1).

corner of the upper right central incisor, 11 was also restored (Fig. 3). Oral hygiene and dietary instructions were given to the patient.

Reviews were carried out at 1- and 6-weeks, 2-, 4- and 8-month intervals. On each occasion the upper anterior teeth were checked for signs and symptoms of infection including tenderness to pressure, mobility and crown discoloration. Sensibility testing with the electric pulp tester and ethyl chloride were negative on the traumatized tooth compared with the non-affected adjacent teeth. Radiographs were taken to exclude periapical pathology at the second, third, fifth and sixth review visit.

Approximately 17 months after attending with the initial trauma, the patient re-fractured the upper right central incisor, 11. The composite restoration had been lost and was replaced by his General Dental Practitioner. Clinical examination revealed that the tooth had a dark yellow discolouration but was not tender to percussion or mobile. Radiographs showed that there was an apical third fracture of the root, which was however well approximated, despite an area of periapical pathology. Root canal treatment of the upper right central incisor was instigated some 18 months following the original trauma. Root canal treatment was completed over 2 years during which time the canal was dressed with non-setting calcium hydroxide (Hypocal, Merz, Germany), which was monitored radiographically and changed as necessary until the periapical pathology had resolved. The upper right central incisor, 11, was then root filled in the conventional manner with gutta percha through the apical third root fracture site to the apex (Fig. 4).

Case 2

A fit and healthy 9-year old boy sustained a traumatic dental injury to his upper left central incisor during a fall and was referred to the Glasgow Dental Hospital 2 days later by his General Dental Practitioner who did not carry out any treatment prior to referring the patient.

Clinical and radiographic examination revealed a complicated vertical crown-root fracture of the upper left central incisors and open apices of the upper permanent central incisors (Fig. 5). The fragment was attached but mobile. There were no other injuries to the facial and oral tissues and no symptoms of head injury.

Fig. 4. Completed root canal treatment with no periradicular pathology.

Fig. 5. Radiographic appearance of teeth 11 and 21 at presentation (case 2).

The patient had a mild class 2 division 1 incisor relationship.

Local anaesthetic was administered; the fragments were separated to perform a cervical pulpotomy which was carried out using the same technique and the fragment was reattached as in case 1 (Fig. 6).

Fig. 6. Clinical appearance of tooth 21 following restoration (case 2).

Fig. 7. Radiographic evidence of continued root growth in tooth 21 following restoration (case 2).

Reviews were carried out at 1- and 2-weeks, 1- and 2-month intervals. At these visits the tooth was neither tender to percussion nor mobile and responded positively to sensibility testing with ethyl chloride and the electric pulp tester. Radiographically there was no sign of periapical pathology and there was evidence of continual root growth (Fig. 7).

Four months after the initial injury the patient once again presented with trauma to the upper left central incisor sustained when he was accidentally hit in the mouth by his brother. However, the tooth remained asymptomatic and clinically and radiographically no further abnormalities were detected. The patient was again reviewed at 2 weeks, 2 and 4-month intervals. The

tooth continued to respond to sensibility testing and was asymptomatic.

A further 19 months after the original trauma, the patient again returned to the Accident and Emergency unit having re-fractured the upper left central incisor following a football accident. On this occasion the tooth fragment was mobile and it was reattached with Scotchbond Multi-Purpose^{TM} (3M) and a composite crown (Z100, 3M) in the same manner as discussed above. He was reviewed after 5 days and again three weeks later when alginate impressions for construction of a sports mouth guard were taken as the patient was now more physically active. The upper left central incisor was still asymptomatic on clinical and radiographic examination on both occasions and responding positively to sensibility testing with the electric pulp tester & ethyl chloride.

Two months later, in a fourth accident, this time at school, the patient collided with another child in the playground. The tooth fragment was again dislodged and the tooth fractured more apically. On this occasion it was deemed that the upper left central incisor was no longer restorable and so was extracted and replaced with an acrylic partial upper denture.

Discussion

A number of treatment options have been proposed for crown-root fractures, each with their own advantages and disadvantages (1, 3, 9). The choice of treatment depends on the extent of the subgingival lesion, the morphology of the lesion, the length and the morphology of the root and the situation in the aesthetic sensitive region (3). When the tooth is completely unrestorable, extraction is the only option available, leading to loss of bone in the area compromising future treatment with implants (1, 3, 9). In order to counteract this problem, reports have suggested vital root submergence which involves removing the crown, root treating the remaining root and retaining the root until such time when the patient is old enough to have an implant (2, 3, 10). The disadvantage in this case is the need for provision of a temporary replacement.

Surgical exposure of the fracture margin can be achieved by gingivectomy with or without an osteotomy. This is relatively easy to perform and the tooth can be restored soon after injury. However, it is not indicated in aesthetically sensitive regions and is best left for posterior teeth or the palatal surfaces of anterior teeth (1, 3, 9).

Orthodontic extrusion of a root, to facilitate restoration, was first described by Heithersay in 1973. To avoid relapse a period of retention is necessary (3). Although this is an effective solution, it is rather time-consuming and requires commitment and motivation from the patient (1, 3, 9, 11, 12). Surgical extrusion is another way of exposing the fracture line before restoration. This is a simpler and less time-consuming procedure, requiring minimal commitment from the patient (1, 3, 13, 14). The prognosis of surgical extrusion is good. Approximately 80% of surgically extruded teeth are still functional after 5 years (14). An added advantage is that this procedure allows the clinician to look for other fractures or fissures in the root (3). The main disadvantage in this procedure is the possible risk of root resorption because of damage of the periodontal ligament (1, 3, 15). Treatment must be planned carefully to avoid accidents, such as root fracture and extensive damage to the periodontal ligament (15).

The most conservative treatment is fragment removal and subsequent restoration with a composite build-up or fragment reattachment. However, this type of treatment is only appropriate when the fracture extends superficially below the cemento-enamel junction (1, 3). The difficulty in this form of treatment is poor moisture control with repercussions for pulpal and restoration prognosis (3).

Various reports of crown-root fractures treated by fragment reattachment have been published (2–7). Several advantages have been cited over the conventional treatment modality of composite restoration and these include better aesthetics, wear rate similar to other teeth and decreased chair-time (2–4). Loss of fragment is predominantly caused by new trauma, non-physiological use of the bonded tooth and horizontal traction (16). In both cases reported here the patients suffered repeated traumatic dental injuries to the same tooth and in case 2 the entire tooth, rather than the fragment, was eventually lost.

In complicated crown-root fractures when a decision has been made to maintain pulpal vitality, especially in children in whom root apices are not completely formed, the type of pulpal treatment chosen will depend on several factors including the time elapsed and the size of the exposure. The treatment options available include pulp capping, pulpotomy and complete root canal therapy. Pulp capping, where the exposure is covered by calcium hydroxide or more recently by mineral trioxide aggregate (MTA), is indicated when there is a small exposure that can be treated within 24 h of the injury (8). Pulpotomy involves removal of the inflamed tissue to the level of healthy pulp and dressing the pulp with calcium hydroxide (8). A review of the literature published in 2002 by Andreasen et al (17) has stated that at present there appears to be no definite time relation between the treatment procedure and pulpal healing when traumatic pulpal exposures are treated by pulp capping or pulpotomy. In view of this they suggest that treatment of these injuries within or after more than the first 24 h seems to be appropriate (17). The prognosis for complicated crown fractures following pulpal treatment is good: pulp survival following pulp capping is between 63 and 88% while that for vital pulpotomy ranges from 94 to 100% (3). There does not appear to be similar information in the literature on the prognosis of these procedures in crown-root fractures.

Complete root canal treatment is performed in cases of mature teeth where conservative pulp therapy is not indicated (8). The two cases in this report both presented with complicated crown-root fractures which necessitated attention to the pulp. Pulpotomies were carried out in both cases. In case 2 with the most immature root, the tooth maintained vitality following treatment some 48 h post-trauma and there was continued root growth. On the other hand in case 1, with a more closed apex, periapical infection occurred within a year and conven-

tional root canal therapy was then necessary as a result of repeat trauma. In both cases the treatment was carried out by the same operator. One might postulate that as there is less vascular pulp when the apex is more closed this may contribute to earlier loss of vitality. A multicentre study published in 1995 by Andreasen et al (16) has found a higher frequency of pulpal necrosis occurring after bonding of fragments in crown-root fractures. It was suggested that treatment failure was because of difficulties in maintaining a dry operating field (16).

It has been shown in various studies that increased overjet with protrusion of upper incisors and insufficient lip closure are significant predisposing factors to traumatic dental injuries (1). The patients presented here both have a class 2 division 1 malocclusion. This paper also highlights, what various studies have shown before, patients who experience trauma to their teeth appear to be accident-prone and sustain repeated trauma to their teeth; frequencies have been reported to range from 4 to 30% (1). Although many accidents may be sports related, where mouthguards are beneficial, many are also accidental as seen in both cases presented in this paper.

Conclusion

This report describes treatment of crown-root fractures in permanent teeth with apices of differing maturity. Although the procedure was successful in both cases in that the teeth remained asymptomatic, vital, with continual root growth in case 2, the tooth was eventually lost because of repeated trauma almost 2 years after the initial treatment. On the other hand, in case 1 the tooth lost vitality within 18 months of the initial trauma following repeat trauma and required root canal therapy. Despite this, the authors would recommend this technique as an option for treatment of crown-root fractures extending subgingivally particularly with immature apices.

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