CASE REPORT

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Conservative treatment of a cervical horizontal root fracture and a complicated crown fracture: a case report

I Belobrov,* MV Weis,† P Parashos‡

*General practice, Caulfield and Melbourne, Victoria.
†Endodontic practice, Armadale, Victoria, and School of Dental Science, The University of Melbourne, Victoria.
‡School of Dental Science, The University of Melbourne, Victoria.

ABSTRACT

This case report describes successful long-term conservative management of a cervical root fracture and a complicated crown fracture of the maxillary central incisors in a 12-year-old patient. A mineral trioxide aggregate partial pulpotomy was performed on the maxillary right central incisor, while the maxillary left central incisor was splinted to the neighbouring lateral incisor using an acid-etch technique. Both teeth remained asymptomatic throughout the 3.5 years of a review period, with the cervical root fracture having mostly healed with the formation of a calcified tissue between the fragments. Two different treatment methods were used for two different injuries that resulted in pulp preservation in both cases. This in turn has provided for normal root development to occur while also allowing for preservation of bone.

Key words: Cervical root fracture, conservative root fracture treatment, complicated crown fracture, dental trauma, mineral trioxide aggregate.

Abbreviations and acronyms: MTA = mineral trioxide aggregate; PDL = periodontal ligament.

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INTRODUCTION

The incidence of horizontal root fractures in the permanent dentition has been reported to range between 3 and 7 per cent, while complicated crown fractures account for approximately 20 per cent of all injuries to the teeth.[1,2] As with most dental injuries, horizontal root fractures and crown fractures occur most frequently in the maxillary central incisors of male patients.[2] Most root fractures occur in the middle-third of the root followed by apical and coronal third fractures, and are also more likely to take place in fully erupted permanent teeth with closed apices in which the completely formed root is solidly supported in bone and periodontium.[3]

The wound in a root-fractured tooth is very specific in that it involves damage to the pulp, dentine, cementum and periodontal ligament (PDL). The PDL injury may, as with the pulp injury, range from probably none to stretching and rupture.[4]

Clinical management of a root fracture depends on its position and the extent of root involvement. Conservative treatment of root fractures below the alveolar crest may require reduction of the displaced fragment, immobilization and relief of the occlusion.[3,5,6] However, spontaneous healing of root fractures without treatment has been documented.[7,8]

The prognosis of root fractures in the cervical one-third is considered to be poor due to a short mobile coronal fragment, with less probability of healing with hard tissue, and possible bacterial contamination of the root canal from the gingival crevice.[9] Complications that cause loss of a tooth with a healed cervical fracture are significantly more frequent in teeth with transverse fractures rather than in those with oblique fractures. Maintenance of pulp vitality is critical for the long-term prognosis as it allows for periodontal repair to occur uneventfully and is significantly related to the occurrence, but not to the type, of healing.[9]

The treatment aim for teeth with complicated crown fractures is to preserve vital, non-inflammed pulp tissue. This is particularly important in teeth with incomplete root apex formation. The prognosis for teeth with complicated crown fractures is generally good, if treatment is initiated soon after the trauma. A number of procedures have been recommended for the treatment of complicated crown fractures. These include pulp capping, partial pulpotomy, pulpotomy and pulpectomy procedures.

The following case report is an example of a conservative treatment approach to a cervical root fracture and complicated crown fracture.

CASE REPORT

A 12-year-old boy was seen in a private endodontic practice three days after suffering a bike accident and following a referral from his general dentist. The extra-oral examination revealed a sore and bruised upper lip. The intra-oral examination revealed a complicated crown fracture of the upper right central incisor #11, and an oblique root fracture of the upper left central incisor #21. Clinical examination showed that all teeth in the anterior segment responded to CO_2 pulp testing at the time of presentation.

Tooth #21 was slightly mobile (Grade 1–2) and tooth #11 had substantial coronal tooth structure remaining for its rehabilitation with a direct bonded resin-composite restoration. Radiographs confirmed the clinical findings and showed the oblique root fracture to tooth #21 to be 3–4 mm below the cervical margin (Fig 1).

After administration of local anaesthetic tooth #21 was rigidly splinted to tooth #22 with a stainless steel wire. The wire was removed after one month and the teeth were then bonded together with composite resin using an acid-etch technique for a further three months.

Under rubber dam isolation, a partial pulpotomy was performed on tooth #11 using a high-speed size 2 round diamond bur under copious water-cooling. The coronal pulp stump was then soaked in 4% sodium hypochlorite for 2 minutes until haemostasis was achieved and a ProRoot MTA (Dentsply Tulsa Dental, Tulsa, OK, USA) pulp cap was placed followed by bond and a direct resin composite restoration using Filtek Z250 (3M ESPE, 3M Center, St. Paul, MN, USA).

The patient was seen for regular reviews for 3.5 years with both teeth #11 and #21 remaining asymptomatic and continuing to respond to CO_2 testing throughout the review period.

At the three-month review (Fig 2) there was evidence of partial coronal canal obliteration in tooth #21.

Fig 1. Periapical radiograph taken at the initial appointment.

Fig 2. Three-month review shows beginning of coronal pulp obliteration.

Fig 3. A 2-year review shows almost complete narrowing of the root canal in tooth 21 at the fracture site and reduction in size of the radicular pulp space.

Fig 4. A 3.5 year review demonstrates almost complete healing and calcific union of the more apical fracture site and further peripheral rounding of the fractured edges in tooth 21.

The two-year review radiograph (Fig 3) demonstrates formation of a hard-tissue bridge of the apical segment and limited peripheral rounding of the fracture edges on tooth #21.

The two-year review radiograph (Fig 3) showed that a dentine bridge had not formed apical to the MTA pulp cap in tooth #11 but there was continued root development with narrowing of the canal space and apical maturation.

A review radiograph taken 3.5 years (Fig 4) after the initial accident showed further healing of the fracture sites in tooth #21, with a hard tissue callus forming in the pulpal lumen adjacent to the fracture site of the coronal segment.

DISCUSSION

Several clinical reports have demonstrated successful treatment of root fractures.[3-5] Previously, a preferable treatment for the cervical root fracture has been thought to be the removal of the coronal fragment and subsequent orthodontic or surgical extrusion of the remaining apical fragment.[10]

Since then, studies have shown that fractures located at the cervical third have fair to good prognosis of healing and a conservative approach is justified.[11,12]

Healing events following a root fracture are initiated at the site of pulpal and periodontal ligament involvement and lead to two types of wound healing response.[13–16] These processes apparently occur independently of each other and are sometimes competitive in their endeavour to close the injury site with either pulpal or periodontally derived tissue. If the pulp is intact a calcific hard tissue union is formed between the fragments.[10] When the pulp is severed or severely stretched, a revascularization process is initiated and while revascularization is under way, periodontally derived cells unite the two fractured fragments by interposition of connective tissue.[15] Finally, if bacteria gain access to the pulp necrosis results, with formation of granulation tissue between the two root fragments.[15]

The final outcome after root fracture is classified according to Andreasen and Hjörting-Hansen:[16] (a) healing with calcified tissue; (b) healing with interposition of only PDL tissue; (c) healing with interposition of bone and PDL between the fragments; (d) no healing and interposition of granulation tissue.

The principles of treating permanent teeth are reduction of displaced coronal fragments and immobilization. There are a number of treatment factors that have a negative influence on healing: forceful application of splints[11] and rigid splints.[17] Age,[18] stage of root development,[11,17,18] dislocation of the coronal fragment[11,16,17] and diastasis between fragments[18] have the greatest influence upon healing.

In this case the root fracture was oblique and the two fracture sites may have healed differently. The more apical fracture site most likely healed with calcified tissue, while the coronal fracture site most likely healed with interposition of PDL tissue. Comparing the radiographs (Figs 1–4) taken over the 3.5 years shows the apical fracture site and lateral margins at the cervical region to have healed with calcified tissue. A hard tissue bridge has also formed between the fragments (Fig 4). These interpretations of the different healing patterns are based on the radiographic findings. Clearly, confirmation of these interpretations must rely on histological examination which was not possible here. Because the fracture was oblique, this may partly explain why the coronal segment had not been displaced at the time of impact and there was only a grade 1–2 mobility. This may have been due to part of the coronal segment still having PDL attachment to the alveolar process. Additionally, it is possible that the fracture was incomplete as is implied by the unusual radiographic appearance of the fracture lines, particularly apically.

Treatment options for tooth #21 were discussed in detail with the 12-year-old patient and his parents. They included extraction of the whole tooth, extraction of the coronal fragment and orthodontic extrusion of the apical root fragment. However, most emphasis was placed on retaining the tooth as it was, at least as a short-term solution, and allowing the tooth every possible chance to heal. This initial goal of maintaining the tooth, and associated alveolar tissue and bony support in the developing dentition will allow for normal alveolar development during skeletal growth.

With reference to tooth #11, mineral trioxide aggregate (MTA) rather than calcium hydroxide was used for pulp capping following the partial pulpotomy. The main advantage of MTA over $CaOH_2$ is that it provides a good protective barrier against bacterial penetration as assessed in a study of MTA as root end filling material,[19] while being highly biocompatible.[20] It has also been shown that the bioactive property of MTA is superior (when compared to $CaOH_2$ and other materials) in dentine bridge formation following pulp capping and pulpotomies.[21] The advantage of both pulp capping and partial pulpotomy procedures in young teeth, if they prove successful, is that a healthy pulp is maintained throughout the root canal system. Not only does this ensure apical development, but also promotes the deposition of lateral root dentine which improves the root strength.

Although radiographically a dentine bridge could not be seen in this case, the pulp has healed normally with narrowing of the radicular pulp space and further development of the root. This is due to the fact that dentine bridge formation is not important for pulp health, as many demonstrate tunnel defects which allow for passage between the pulp capping material and the pulp tissue. Consequently, the selection of materials with the ability to seal the exposed pulp and prevent bacterial leakage is perceived as the most important factor in avoiding and minimizing pulp inflammation.[22]

CONCLUSIONS

In this case report two different methods were used for two different injuries that resulted in pulp preservation. This in turn has allowed for normal root development to occur and potentially an improved prognosis. It is concluded that an attempt should be made to conservatively treat cervical root fractures especially in young patients, as they usually have at least a favourable medium-term prognosis. This allows for normal alveolar development and preservation of bone.

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Address for correspondence:
Dr I Belobrov
104 Wattletree Road
Armadale, 3143 Victoria
Email: ilyabelobrov@hotmail.com