



CASE REPORT

Treatment and orthodontic movement of a root-fractured maxillary central incisor with an immature apex: 10-year follow-up

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Abstract

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Aim To report a maxillary central incisor tooth with a horizontal root fracture and incomplete root development that healed and was then moved orthodontically some years after the traumatic injury.

Summary A 7-year-old girl attended following trauma to the maxillary anterior region. Radiologic examination revealed a horizontal root fracture in the middle third of the maxillary right central incisor tooth that had an immature apex. After early treatment, the fractured tooth healed and pulpal health was retained. Recall examination after 2 years revealed complete root development. Orthodontic treatment was performed to correct an angle type I malocclusion. Clinical and radiologic controls were performed over 10 years and confirmed both pulpal and periodontal health.

Key learning point

- Orthodontic movements of teeth with previously fractured roots might be possible without adverse pulpal effects.

Keywords: immature apex, orthodontics, prognosis, root fracture, tooth injuries.

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Introduction

Root fractures are defined as fractures affecting dentine, cementum and pulp and are characterized by a complex healing pattern owing to concomitant damage to the various tissues. Most root fractures occur as a result of a frontal impact – the nature and direction of the force determining the location of the fracture line (Andreasen 1979).

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The incidence of root fractures ranges between 0.5% and 7% (Magnusson & Holm 1969, Ravn 1974) of injuries affecting the permanent dentition. The injuries predominantly affect the maxillary incisor region with the central incisor tooth being the most commonly involved (Jacobsen 1967, Andreasen & Andreasen 1994a). Injuries are associated with malocclusion (Zachrisson & Jacobsen 1974), and subjects with an increased overjet are more liable to fractures (Dearing 1984).

According to Andreasen (1979), root fractures are infrequent in permanent incisors with incomplete root development owing to the elasticity of the bony socket. This would explain the fact that such teeth are more prone to suffer dislocation injuries rather than root fractures (Jacobsen 1967).

It is possible to orthodontically move teeth with fractured roots provided that sufficient care is taken (Zachrisson & Jacobsen 1974, Hovland *et al.* 1983, Erdemir *et al.* 2005). Kindelan *et al.* (2008) and Day *et al.* (2008) have published reviews on dental trauma and its influence on the management of orthodontic treatment and provide the best evidence currently available for the management of orthodontic treatment for a patient who has suffered dental trauma. Erdemir *et al.* (2005) recommended observing teeth with root fractures repaired with hard tissue for 2 years prior to commencing orthodontic treatment and then continuing to follow up the case during treatment. Likewise, Healey *et al.* (2006) reported several clinical cases that describe the orthodontic management of teeth with root fractures repaired with calcified tissue.

This report describes the successful management of a maxillary central incisor tooth with a root fracture that was moved orthodontically; the case was followed up for 10 years.

Case report

In 1999, a healthy 7-year-old girl was attended 8 h following a traumatic injury to the maxillary anterior region during a basketball game. After the case history, a complete clinical and radiologic examination was performed that revealed mobility and extrusion of the maxillary right central incisor tooth 11 as well as mild laceration of the palatal mucosa (Fig. 1). The tooth was tender to palpation and percussion. The adjacent central and lateral incisors did not have any signs. Electric and cold tests were performed with negative results in both maxillary central incisors but with positive results in all mandibular incisors. Periapical radiographs revealed a horizontal fracture in the middle third of the root of the tooth 11 (Fig. 2). Both maxillary central incisors had incomplete root development; the other teeth had no clinical or radiographic pathosis.



Figure 1 Initial clinical view.



Figure 2 Periapical radiograph revealing horizontal root fracture at the level of the middle third of the maxillary right central incisor and incomplete root development of both maxillary central incisors.

Under local anaesthesia, tooth 11 was repositioned using gentle finger pressure. After radiologic control to check the correct alignment of both fragments, the tooth was immobilized using a palatal wire-composite dental splint (Fig. 3). Radiographic examination and pulp sensibility tests to detect possible pulp necrosis and to observe the root development were carried out periodically over time. One month after splinting, electric and cold tests were positive in both maxillary central incisors. Two and three months after splinting, root development was evident in both incisors (Fig. 4). After 6 months, the splint



Figure 3 Palatal view of the wire-composite dental splint.

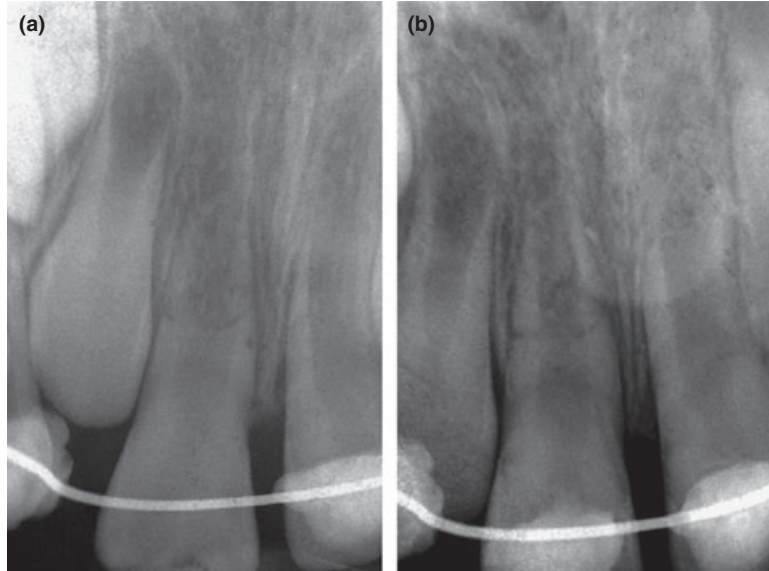


Figure 4 Periapical radiographs 2 (a) and 3 (b) months after splinting.

was removed. No clinical signs were observed, but partial obliteration of the pulp space and calcified nodules at the level of both coronal and apical segments were evident (Fig. 5).

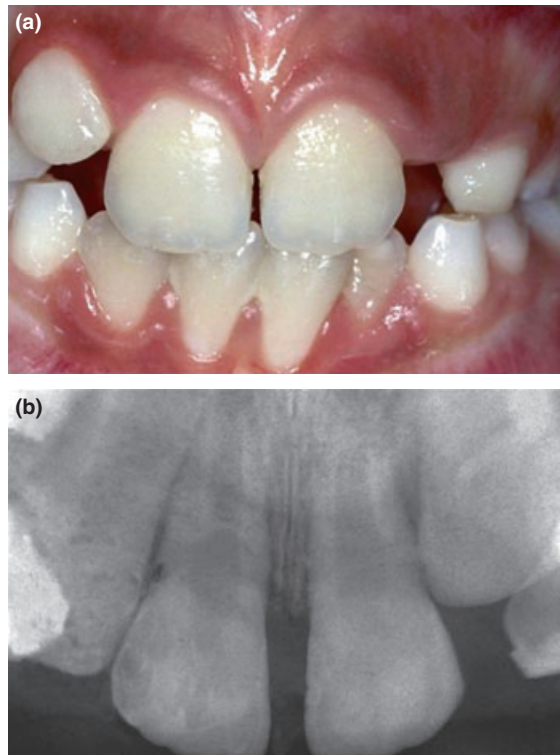


Figure 5 Clinical view (a) and periapical radiograph (b) 6 months after the tooth injury. Partial obliteration of the pulp space is evident in tooth 11.

From this moment onwards, the patient was clinically and radiographically recalled every 6 months, attending all appointments. Two years following the injury, both maxillary central incisors had complete root development. As the patient had an angle type I malocclusion with crowding and arch-length loss owing to the early loss of second primary molars and mesial drifting of first permanent molars (Fig. 6a), orthodontic treatment began with the aim of correcting the malocclusion. Orthodontic treatment involved fixed orthodontic appliances for both arches. The treatment was concluded successfully on both the injured central incisor (tooth 11) and tooth 21 (Fig. 6b). Ten years after the injury, the pulp responded to electrical and cold tests and no complications were present (Figs 7 and 8).

Discussion

Horizontal root fractures are more frequently observed in the maxillary anterior region and in 11- to 20- year-old male patients (Andreasen 1979). The time before the diagnosis of the pulp condition is significant. Many investigators have suggested that the reversal of vitality of pulp in teeth with root fractures varies between a few months and 2 years (Andreasen 1989, Caliskan & Pehlivan 1996, Erdemir *et al.* 2005).

Although healing of the horizontal root fractures with or without initial treatment is reported to occur in up to 80% of the cases (Andreasen & Hjorting-Hansen 1967, Birch & Rock 1986, Caliskan & Pehlivan 1996, Zabalegui-Andonegui & Taberero-Gallimó 2008), immediate splinting within an hour following the trauma gives the best results (Hargreaves 1972).

At the present time, stabilizing the fractured tooth with a flexible splint for 4 weeks is recommended (Flores *et al.* 2007). However, splinting for a longer period of time (up to

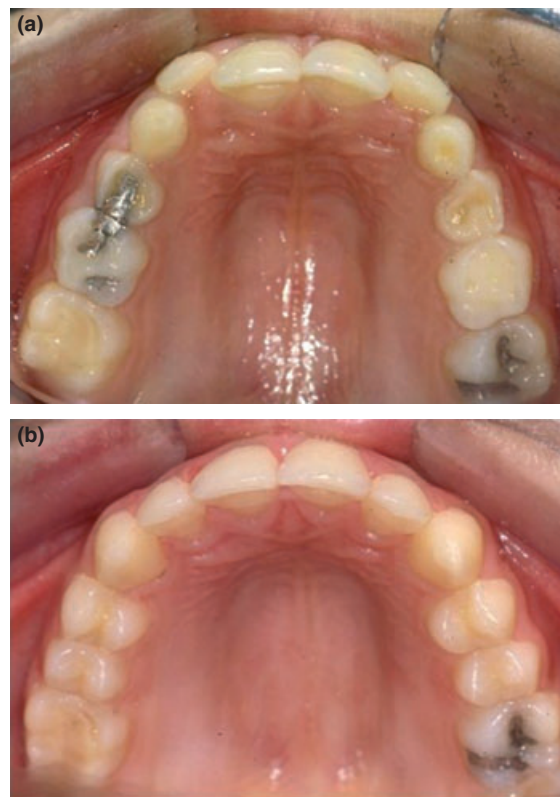


Figure 6 Pre-treatment (a) and post-treatment (b) views of the arches.

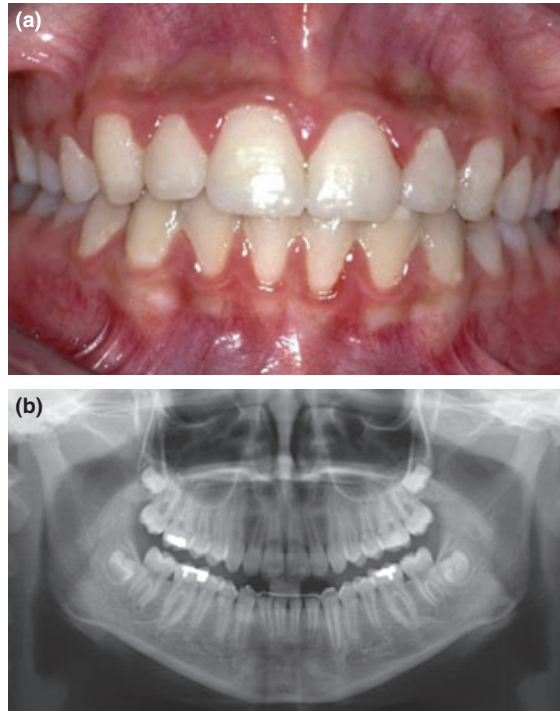


Figure 7 Clinical view (a) and orthopantomography (b) 10 years after the injury.

4 months) can be opportune when the root fracture is near the cervical area of the tooth (Erdemir *et al.* 2005, Flores *et al.* 2007, Kindelan *et al.* 2008). In the present case, the treatment was initiated in 1999, prior to those findings. At that time, splinting periods up to 2 years were proposed for such teeth (Clark & Eleazer 2000). Taking into account the localization of the root fracture, the incomplete root development and the tooth mobility, the splint was retained in place for longer.

Several authors have highlighted the unpredictable response of a tooth to pulp testing following trauma. This irregular response is caused by injury, inflammation, pressure or tension to apical nerve fibres (Dummer *et al.* 1980, Andreasen & Andreasen 1994b). It might take 8 weeks, or longer, before a normal pulpal response can be elicited (Andreasen & Andreasen 1994c). In the case reported here, electric test and cold test gave negative results immediately after the tooth injury but, only 1 month after splinting, the responses were positive in both maxillary central incisors. Actually, a more accurate assessment of pulp vitality is possible by determining the presence of a functioning blood supply, thus allowing the healing potential to be evaluated at an earlier stage (Gopikrishna *et al.* 2009).

Comparatively little has been written on the relationships between endodontics and orthodontics (Drysdale *et al.* 1996, Hamilton & Gutmann 1999, Llamas-Carreras *et al.* 2010). Moreover, whilst recommendations have been published regarding the orthodontic management of root filled teeth (Drysdale *et al.* 1996) and the effect of orthodontics on pulp vitality has been reviewed (Hamilton & Gutmann 1999), there is comparatively little literature to assist in the orthodontic management of teeth with root fractures. Thus, the need to reposition teeth with root fractures presents a clinical dilemma for orthodontist and endodontists (Healey *et al.* 2006). The practical guidelines proposed by Flores *et al.* (2007), Kindelan *et al.* (2008) and Day *et al.* (2008) allow the making of clinical decisions less personal or empirical.



Figure 8 Periapical radiograph 10 years after the injury. Partial obliteration of the pulp space is evident in tooth 11.

In this case report, radiographic examination revealed partial obliteration of the pulp space and calcified nodules at the level of both coronal and apical segments (Figs 5 and 8). Caliskan & Pehlivan (1996) reported that 62.5% of the healed cases of teeth with root fracture had partial or complete obliteration of the pulp space, without additional clinical problems. Moreover, approximately 75% exhibited calcified nodules that narrowed the pulp space. Hovland (1992) suggested that reparative dentine deposition and subsequent reduction in the pulp space had a close relationship with dental pulp revascularization or reinnervation. Taking into account that the tooth had open apex, over 1.5 mm in diameter, it can be assumed that revascularization and reinnervation did occur.

The present case, as well as other previous reports (Hovland *et al.* 1983, Erdemir *et al.* 2005, Healey *et al.* 2006), demonstrates that orthodontic movement of the teeth with repaired root fractures is possible and that orthodontic movement of traumatized teeth presents little risk of resorption if the pulp condition is normal. However, orthodontic movement might produce separation of the segments (Hamilton & Gutmann 1999), and the combination of trauma and orthodontic treatment can result in a high prevalence of loss of vitality and of pulp canal obliteration (Brin *et al.* 1991).

Conclusion

The case reported here, together with the results of previous reports, suggests that, when care is taken, significant orthodontic movement of teeth with fractured roots might be

possible without adverse pulpal effects. After an observation period in which apical closure can be checked, the tooth could be moved orthodontically. However, to recommend this approach, clinical trials must be conducted to provide a better evidence base for treatment.

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