Horizonal Root Fracture in Permanent Dentition

Double case report

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Abstract

Introduction: Horizontal root fracture is a term defined by a perpendicular or oblique fracture line to the long axis of the root. It is relatively infrequent, occurring in less than 3% of all dental injuries. The classification, diagnosis and prognosis of horizontal root fractures are directly related to root stage development, fracture line location (apical, middle, cervical third of the root), the degree of fragments dislocation and the number of fracture lines (simple or multiple). In terms of clinical possibility, horizontal root fracture may vary from an extruded or displaced crown to a clinically normal tooth.

Objective: The aim of present case report was to evaluate the clinical and radiographical findings on a 9-year-old boy after successful management of two horizontal (oblique) root fractures on both maxillary incisors using two different approaches based on fracture level height.

Methods: The right central incisor received an apical third fracture with almost no dislocation and it was splinted and monitored. The left incisor received an oblique fracture (middle vestibular to cervical palatal third), resulting in extrusive luxation of the coronal fragment, and was treated endodontically, two weeks after the reattachment and splinted for nine months.

Results: Both teeth have been followed for a period of three years on PA and CBCT and success was based on absence of pulpal and periapical inflammation, as well as functional and healthy periodontium along the fracture lines on both fragments despite the different approach.

Introduction

The frequency of root fractures in permanent dentition is around 1% to 7%, (Andreasen et al. 2007). Horizontal root fractures occur in less than 3% of all dental injuries of which the most commonest were fracture at the middle third of the root (57%), followed by apical third of the root (34%) and cervical third of the root (9%), Caliskan & Pehlivan 1996.

In a classic study, Andreasen and Hjorting-Hansen noted four types of healing after horizontal root fractures and only one was associated with pathology (1):

1. **Hard tissue healing**, most commonly found in root-fractured teeth in which the coronal fragment is not or slightly dislocated.
2. **Connective tissue healing**, with bone-like structure between the fragments.
3. **Connective tissue healing without bone**, often resulting after lateral dislocation, or extrusion of the coronal fragment.
4. **Granulation tissue interposition**, occurs as a result of infected or necrotic pulpal tissue, causing an inflammatory reaction in the fracture line (Schroeder 1997, Andreasen et al. 2007).
Case description:

The nine-year-old boy reported direct contact with teeth with another kid during a football match. They noticed that one tooth was loose while the other was missing. After approximately 20 minutes, they found the broken part and placed it back inside the socket. They visited this author’s office 60 minutes after the incident.

No soft tissue lacerations or signs of alveolar ridge fracture were evident at the intraoral exam.

The maxillary right incisor was bleeding from the sulcus and had an enamel infraction. No discoloration of the crown was noted. Pulp sensitivity testing was negative and it was tender to percussion.

False probing depth was evident due to swollen gingiva accompanied by Miller class 3 mobility: 2mm< depressibility in the socket.

Horizontal root fracture at the apical third of the root was visible on the PA radiograph. No preoperative CBCT was taken due to limitations of emergency.

The maxillary left incisor appeared elongated for a few mm and was excessively mobile. No structure loss was observed besides the small enamel infraction. On pulp sensitivity testing did not react. An oblique root fracture from middle vestibular to cervical palatal third of the root was obvious on the PA radiograph.

The lateral maxillary incisors were not affected from the trauma and were tested vital.
Root fracture diagnosis depends on careful clinical and radiographical examination. Due to the angulation of such fractures, two or three radiographs taken at various angles may be needed.

Root fracture location and dental pulp status determine the type of treatment. Most often the treatment is directed at repositioning and stabilizing the tooth (if necessary) in its correct position and monitoring the tooth for an extended period for pulp vitality. The left maxillary incisor was splinted and its pulpal status was weekly monitored. Initially, the pulp testing gave a negative result but slightly the sensation was getting better by the time.

Usually, most horizontally fractured teeth do not require endodontic treatment. In fact, one study found healing in 84% of the cases (2).

Dental pulp necrosis may be reported from 20 to 44% of the root fracture cases whereas in luxated teeth without fracture, necrosis occurs in at least 43.5% of cases (3).

During the attempt to perform a parallel radiograph, the extruded coronal part fell inside the oral cavity. Luckily it was repositioned back safely. Prior the repositioning, the alveolar socket was rinsed with 0.2% chlorhexidine.

The extrusive luxation has left the coronal fragment extra orally long enough to get contaminated. Extra orally the pulp was removed from the extruded fragment using tweezers only and repositioned back inside the socket. An endodontic treatment was postponed in two weeks, in order to reduce the extra oral period.
The presence of root resorption is related to the clinical variables, extra-alveolar period and storage media. It is a frequent complication after replantation of teeth and can be observed in three forms (3, 4):

- inflammatory resorption,
- surface resorption,
- replacement resorption (ankylosis).

The relationship between different resorption types and extra-alveolar period is not known at present. It is, however, known that dry storage over 30 minutes elicits a higher frequency of inflammatory resorption comparing to saliva storage, saline or tap storage (4). Inflammatory resorption is observed when a tooth with pulpal infection and partial loss of periodontal ligament is replanted or transplanted. The resorption usually starts in damaged periodontal ligament areas and damaged parts of the root surface (Andreasen JO 1981) and whether it develops as an inflammatory or just a surface resorption depends on the pulpal status and depth of the resorption cavity. Inflammatory resorption occurs if the resorption cavity penetrates the intermediate layer of cementum and contacts dentinal tubules that are in communication with infected necrotic pulp tissue. If the resorption cavity is too shallow and toxins cannot penetrate through the intermediate cementum layer then surface resorption usually occurs (5).

The frequency of inflammatory resorption increases with increased extra-alveolar periods. Storage in tap water gives a significant increase in replacement resorption compared to storage in saliva (P = 0.001) as well as to storage in saline (P = 0.02) while there is a significant decrease comparing to dry storage (4).
Fig. 4 Rigid splinting

Fig. 5 Flexible splint for 6 months
Replacement resorption occurs in case of extensive loss of vital periodontal ligament is transplanted or replanted. Replacement resorption is the phenomenon in which the root is resorbed and replaced by bone. It results in ankylosis, in which bone and root fuse together.

Flexible splinting for two to four weeks or no splinting is recommended if the coronal fragment is stable. Comparison between non-splinted and splinted for non-displaced teeth was found to reveal no benefit from splinting (6).

However, if the fracture line is close to CEJ, affecting the cervical third of the root and communication with the oral cavity is almost inevitable, than immobilization for two months or longer is recommended (3, 7). Flexible splinting is better than rigid splinting, except for extrusive luxation of the coronal fragment and cervical third root fracture (6). Following splinting, traumatized teeth should be evaluated clinically and radiographically during and after the splinting period. Slightly over time, gradual reduction of the root canal space may occur. However, if canal reduction is not associated with any periapical or marginal inflammation than it should not be a concern.

Both incisors received rigid splinting as initial emergency treatment, using kevlar- composite. Two weeks after the repositioning, endodontic treatment on the coronal fragment only was performed using 5.25% NaOCL, NaCL 0.9% and EDTA 17%. It is crucial to mention that during irrigation procedure, a negative pressure device was used to avoid any NaOCL extrusion through the fragment. Bioceramics was used as an obturation material up until the fracture line and it was sealed with composite. Two months following the trauma, the rigid splinting was removed and a more flexible splint was applied for another six months.

Since the introduction of cone-beam computed tomography, it is possible to examine root fractures three-dimensionally. The orofacial cut provides additional information, which may be important for assessing the prognosis of the injured tooth, therefore CBCT was taken 30 months after the trauma. Healing was evident on both incisors associated with pulp canal space reduction which was more significant on the apical fragments.

During the follow-up period, both maxillary central incisors appeared clinically and radiographically to be within normal limits. They remained stable and functional, having normal periodontal status. An orthodontic treatment is ongoing.

Fig. 6
Follow up 3 years CBCT:

Fig. 7 CBCT Right maxillary incisor (splinted for 9 months)

Fig. 8 CBCT Left maxillary incisor (coronal fragment endodontic treatment and splinted for 9 months)

Fig. 9
Discussion:

Andreasen et al. (2004) studied the influence of “pre-injury and injury factors” and they found that the patient’s age, the stage of root growth, mobility of the coronal fragment, dislocation of the coronal fragment and fragment diastasis had the greatest influence on healing at the fracture line and on the occurrence of pulpal necrosis (3, 6, 8).

Root fractures are uncommon in teeth with immature apices and in those in different eruption stages because of resilience of the alveolar bone. However, root-fractured teeth in children and adolescents or root-fractured teeth with a minimum dislocation of the coronal fragment – regardless of the patient’s age – should not be treated endodontically prophylactically. Rather, pulp healing should be carefully observed for a minimum of one year. Was it better to treat the extruded part prior or after the reattachment? Although, endodontic fragment treatment after reattachment can be extremely dangerous in terms of NaOCL extrusion, working length confirmation, as well as sealing material over fill, treating it extra orally prior repositioning might physically or chemically harm the crucial vital periodontal cells left on the fragment and trigger a root resorption. As long as the operator feels comfortable under the microscope and negative pressure irrigation system is applied than in author’s opinion it should not be a concern treating it after the repositioning. On the other hand it is more convenient and predictable to have it treated before prior repositioning, while it is still extraorally.
study of 400 intra alveolar fractures done by Andreasen JO1, Andreasen FM, Mejäre I, Cvek M. concluded that splinting for more than 4 weeks did not influence the healing pattern. Orhan et al. (9) reported that the time elapsed between trauma and treatment, stage of root development, signs and symptoms of mobility and pain may influence the type of healing. The prognosis is directly related to coronary fragment displacement, stage of root and pulp development, type of splinting and fracture localization. Preservation of vital periodontal ligament outside the mouth is essential for a successful outcome of extruded teeth. Orhan et al. have indicated that communication between the oral cavity and the fracture line can additionally influence the prognosis negatively. Although the outcome of a root fracture treatment is generally favourable (60–84% cases), complications such as pulp necrosis, radicular resorption and pulpal canal obliteration can arise (10).

**Conclusion:**

Although the prognosis of root fractures is generally good, as documented by several studies (Zachrisson & Jacobsen 1975, Andreasen & Hjörting-Hansen 1967, Andreasen et al. 1989), some studies describe complications during the healing process of the pulp and periodontium, which can unfavorably influence the long-term prognosis (Andreasen et al. 2007). Notably, HRFs in the cervical part of the root are considered to have the poorest prognosis and 70% of those teeth required extraction (10), optimal repositioning seems to favor the healing.

The right maxillary incisor in this report received an oblique fracture, resulting in an extruded broken fragment which was successfully repositioned while the apical fragment got calcified as it is obvious in the follow-ups. The left maxillary incisor received a horizontal apical third fracture and seems to involve hard tissue deposition in and around the fracture site and calcification in the pulp spaces on both apical and coronal fragments.

The role of pulpal tissue and the periodontal ligament in healing of fractured roots is not fully understood. Repair appears to depend on an intact periodontal ligament, from which the hard tissue-forming cells originate (1).

The survival rate of periodontal ligament cells has been studied under various conditions by many researchers and most of them agree that saline and saliva offer good protection against root resorption during the extra-alveolar period (4).

The purpose of this double case report was to demonstrate clinically and radiographically the importance of proper diagnosis and treatment planning. The observations showed that both teeth were functional and demonstrated healing after receiving horizontal root fracture.

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5. Andreasen JO. Relationship between surface and inflammatory resorption and changes in the pulp after replantation of permanent incisors in monkeys.


