

## Treatments of horizontal root fractures: Four case reports

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### ABSTRACT

Horizontal root fractures are rare in comparison to other types of injuries and the reported prevalence in the literature is between 0.5% and 7%. The treatment and prognosis of root fractures depend on many variables, the most important being the length of time between trauma and treatment, degree of dislocation and mobility, site of fracture, fixation period, stage of root development, age of patient, and quality of treatment. The ideal healing type is hard tissue healing. The aim of these case reports is to present four different patients who had horizontal root fractures of immature permanent teeth treated by repositioning and fixation with good healing. Patients were referred to our clinic with a complaint of mobility and tenderness in their upper central incisors as a result of an orofacial injury. As a result of radiographical examination, horizontal fractures were diagnosed on the roots. Teeth were repositioned and rigid fixation was applied. Splints were retained for about 12 weeks. After splints were removed, patients were scheduled for follow-up visits at 3 month intervals. After long-term clinical and radiographical follow-up, all teeth presented positive response to electrical pulp tests, suggesting a repair of root fractures. These immature teeth showed radiographic evidence of continued root development and normal color and mobility, and no pain was observed in horizontal and vertical percussion tests. Patients reported no discomfort with their teeth. Using splints without any further treatment was found to be successful in the presence of suitable conditions for the treatment of horizontal root fractures.

**Key words:** Horizontal Root Fracture, Immature Teeth, Treatment

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### INTRODUCTION

Root fractures are generally defined as fractures involving dentin, cement, pulp, and periodontal ligaments.<sup>[1]</sup> Compared to other dental traumas, root fractures are relatively rare. The frequency of root fractures is only 0.5-7% in permanent teeth and 2-4% in deciduous teeth.<sup>[2]</sup>

A systematic approach with clinical and radiographical examinations is essential in diagnosing injuries to the teeth.<sup>[3]</sup> The common clinical situation is a luxation injury of the coronal fragment and mobility increase. Radiographic examination confirms the diagnosis and reveals a horizontal or radiolucent line separating the displaced coronal fragment from the apical one.<sup>[3,4]</sup>

Clinical management of a root fracture depends on its localization and pulp vitality. When the coronal fragment

is displaced, conservative treatment is repositioning of the teeth, immobilization, and relief of the occlusion.<sup>[1-8]</sup> It has been reported that in up to 80% of cases, successful treatment results were obtained.<sup>[2-5]</sup> Immediate immobilization within 1 hour following the trauma gives the best results.<sup>[9]</sup> If the coronal fragment is nonvital or pathological symptoms develop during the follow-up period, endodontic treatment should be performed through the apical end of the coronal fragment.<sup>[10]</sup> Further dental treatment may involve intraradicular splinting and related restorative treatment.<sup>[11]</sup>

Root fracture healing is categorized into the following four types: (I) interposition of calcified tissue (callus formation); (II) interposition of connective tissue, which is characterized by peripheral rounding of the fracture's ends; (III) interposition of bone and connective tissue, which is radiologically characterized by the clear separation

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of the two fragments; and (IV) interposition of granulation tissue, caused by infected or necrotic pulp.<sup>[2,5-7]</sup>

The aim of these case reports was to present four different patients who had horizontal root fractures of permanent teeth treated by repositioning and fixation, and which healed as calcified tissue.

## CASE REPORTS

### Case 1

A 9-year-old boy was referred to Selcuk University's Faculty of Dentistry Department of Pediatric Dentistry clinic with a complaint of mobility and tenderness in his upper right incisor as a result of a dentoalveolar trauma approximately 10 days before. There were no extraoral symptoms. In the intraoral examination, there was no displacement of the coronal fragment, but the tooth had grade 3 mobility. Radiographic examination showed that the upper right incisor was immature, completed apical two-thirds of the root and had an open apex. A horizontal root fracture was determined in the middle third of the root [Figure 1a]. After horizontal root fracture was diagnosed, treatment was initiated by repositioning the coronal segment with finger pressure and using a fixed rigid splint (0.7 mm round wire and composite) under local anesthesia. Gentle tooth brushing, rinsing with an antiseptic solution, soft diet and avoidance of chewing on the upper incisor were recommended. The splint was retained for 12 weeks. Follow-up examinations were conducted at 1, 3, 6, 12, and 24 months after the trauma [Figure 1b to e]. During the follow-up period, no pathological symptoms were observed, including discoloration of coronal segment of the fractured tooth, mobility, or positive percussion response.



**Figure 1:** (a) The initial radiograph was showing the horizontal root fracture. (b) The periapical radiograph of the teeth was taken 3 months later. (c) Six month follow-up radiograph. (d) One-year follow-up radiograph. (e) Two-year follow-up radiograph

### Case 2

An 8-year-old female patient applied to our clinic on the day of trauma to her maxillary left central incisor. She experienced a trauma to the maxilla following a fall, which had occurred 1 hour previously. There were no extraoral symptoms, but the upper left central incisor showed grade 2 mobility and sensitivity in intraoral examinations. Completed root development with narrow apical foramen and a horizontal root fracture in the middle third of the root was observed [Figure 2a]. Under local anesthesia, the teeth were repositioned with finger pressure and fixed using a rigid splint (0.7 mm round stainless steel wire and composite) for 12 weeks' immobilization. Following the recommendations, the patient was checked with regular appointments. At the end of 12 months, there were no pathological symptoms [Figure 2b-d].

### Case 3

A 9-year-old boy was referred to our clinic after an injury to his maxillary left incisor about 1 hour previously. The tooth had grade 2 mobility and tenderness to percussion and palpation. In the periapical radiograph, the root end was almost complete but with an open apical foramen, and horizontal root fracture was observed [Figure 3a]. The fracture was localized in the apical third of the root. The initial treatment was applied under local anesthesia. In the sixth-month follow-up appointment, calcified tissue deposition was observed next to the fracture line of the root [Figure 3b,c].

### Case 4

An 8-year-old girl came to our clinic with a complaint of pain in the maxillary right anterior teeth associated with a history of trauma 2 hours previously. During intraoral examination, grade 2 mobility and gingival hemorrhage were observed. Radiographic examination showed a horizontal root fracture in the middle third of the root, completed in the apical two-thirds of the root, and an open apex [Figure 4a]. After splinting and repositioning the tooth for 12 weeks, the patient was checked clinically and radiographically for 24 months [Figure 4b-e].

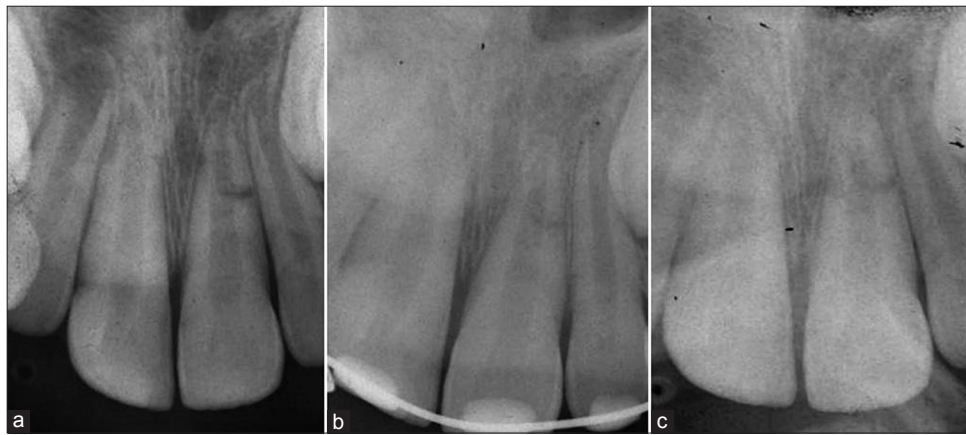
All teeth presented positive response to electrical and thermal pulp tests and showed normal color and mobility, and no pain was observed in horizontal and vertical percussion tests. In each case, clinical and radiographic healing was apparent. Follow-up of the patients is still proceeding.

## DISCUSSION

The first step in the treatment of horizontal root-fracture cases is accurate diagnosis.<sup>[12]</sup> Radiographic evaluation is needed for correct fracture detection in root fractures. More than one radiographic exposure is necessary to



**Figure 2:** (a) Initial periapical radiograph of the case. (b) Periapical radiograph of the teeth after 3 months. (c) After 6 months. (d) After 12 months



**Figure 3:** (a) Initial radiography was showing horizontal root fracture in the apical third of root on the left incisor. (b) Radiographic evaluation at 3 months. (c) Radiographic evaluation at 6 months

ensure detection of all root fractures, as they may be overlooked because of beam angulations. Andreasen *et al.* showed that if the central beam is directed within a maximum range of 15-20° of the fracture plane, the root fracture will be determined visibly. At the same time, fracture localization can affect the radiographic exposure. Apical or mid-root fracture follows a steep course facio-orally in an incisal direction. However, the cervical third tends to be more horizontal. Therefore, at least two additional periapical radiographs should be taken.<sup>[13]</sup>

The classification of horizontal root fractures is based on the location of the fracture line (apical third, middle third, or cervical third) radiographically and on the degree of dislocation of the coronal fragment.<sup>[12]</sup> Horizontal root fractures that localize in the middle or apical third of the root present better prognosis when compared with fractures in the cervical third of the root. In the cervical third, healing depends on proximity of the fracture to the gingival sulcus and possibility of contamination.<sup>[14-20]</sup> Three of our cases had horizontal fracture on the middle third of the root, and the other case had fracture on the apical third. During the follow-up periods, all cases showed favorable prognosis.

Splint type is an arguable factor in the treatment of root fractures. Andreasen *et al.* stated that the type of splints appeared to have no association with the healing outcome.<sup>[16]</sup> For the immobilization of traumatized teeth in the present cases, we preferred to use rigid splints, composed of 0.7 mm orthodontic wire and composite, to enable physiological mobility. Stabilizing the fractured tooth with a rigid splint for 3-4 weeks is recommended.<sup>[17]</sup> However, according to the localization of the root fracture, development of the root, and degree of root mobility, a splint may remain in place for a longer period of time.<sup>[17-19]</sup> A retrospective study on a sample of 208 teeth with intra-alveolar tooth fractures found a significant effect of the duration and types of splinting on fracture healing.<sup>[20]</sup> In our patients, there were mobility of all traumatized teeth at the end of the second month; therefore, a prolonged duration of the fixed appliance was considered safer and more viable for healing. After 10-12 weeks, no mobility, no pathological symptoms, and a positive vitality response were observed.

The success of treatment and type of healing related to age, stage of root development, diastasis of fragments especially degree of dislocation of coronal fragment



**Figure 4:** (a) Periapical radiograph was revealing horizontal root fracture at the level of the middle third of maxillary right incisor. (b) Periapical radiographs 3 months after trauma. (c) Periapical radiographs 6 months after. (d) Periapical radiographs 12 months after. (e) Periapical radiographs 24 months after

and pulp condition. Following initial treatment of the root fracture, the type of healing can be divided into five groups: (1) fracture healing, (2) pulp necrosis, (3) root canal calcification or obliteration, (4) resorption, and (5) fracture nonhealing.<sup>[8]</sup> The ideal outcome for horizontal root fractures is fracture healing with interposition of calcified tissue. For this type of healing, the pulp of the traumatized tooth must be intact and the coronal fragment should not be dislocated. Thus, the pulp remains vital and the mobility of the tooth is within certain physiological limits. In these cases, pulpal healing and hard tissue formation were also observed.

Pulp necrosis is relatively rare (20-44%) after apical third or middle third root fracture.<sup>[21]</sup> Additionally, a wide immature apical foramen in a traumatized tooth favors pulp survival.<sup>[22]</sup> There is a great deal of information about healing root fracture without endodontic treatment.<sup>[23,24]</sup> The clinical and radiographical examinations of our patients showed no obvious displacement and the root apices were immature; all of these conditions favored healing by hard tissue across the fracture segment. Actually, it has been suggested that to determine the vitality of a

fractured tooth, observation for longer than 1 year may be necessary.<sup>[25]</sup> We did not perform endodontic treatment after the initial treatment. In fact, root canal treatment was not found to be necessary in the follow-up periods. After long-term clinical and radiographical follow-up, all teeth presented positive response to the electrical pulp test, suggesting a repair of root fractures. Furthermore, these immature teeth showed radiographic evidence of continued root development, as well as normal color and mobility, and no pain were observed in horizontal and vertical percussion tests. Patients reported no discomfort with their teeth.

These cases show the favorable results of using this technique, exhibiting hard tissue healing, maintenance of pulp vitality, and continued root development. In other words, under the conditions described in these cases, a conservative approach should be attempted before endodontic treatment.

## CONCLUSION

It is concluded that fractured roots can spontaneously

heal if the vitality of the pulp is preserved. Using splints without any further treatment was found to be successful in the presence of suitable conditions for the treatment of horizontal root fractures. However, long-term follow-up of patients with trauma is important because pathological changes can occur several years following injury.

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