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MANAGEMENT OF A HORIZONTAL ROOT FRACTURE IN AN IMMATURE MAXILLARY CENTRAL INCISOR: A CASE REPORT

Menzile Seda Cosar, DDS
Specialist, Department of Pediatric Dentistry, Faculty of Dentistry, Hacettepe University, Ankara, Turkey
ORCID: 0000-0002-5400-1290

ABSTRACT

Root fractures constitute 0.5-7% of all dental traumas. It is important to understand the etiology, diagnosis, management and prognosis of root fractures. There are different treatment options ranging from conservative treatment methods involving observation and follow-ups to complex surgical procedures. It is possible to preserve tooth structure and have a long-term good prognosis for root fractures with immediate, appropriate treatment and follow-up procedures. In this case report, the management and favourable healing of a horizontal root fracture located in the middle third of an immature permanent maxillary central incisor is presented. Throughout the 36-month follow-up period, the tooth was successfully preserved both aesthetically and functionally.

Correspondence
Menzile Seda Cosar, DDS
Department of Pediatric Dentistry, Faculty of Dentistry, Hacettepe University, Ankara, Turkey
ORCID: 0000-0002-5400-1290
Phone: +90 312 305 22 80
Fax: +90 312 310 44 40
Email: menzilecosar@hacettepe.edu.tr

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INTRODUCTION

Root fractures involve the pulp, dentin, cementum and comprise 0.5-7% of all dental traumas.[1] This type of injury most commonly occurs during the permanent dentition between the ages of 11 and 20, and maxillary anterior teeth are the most affected teeth due to a frontal impact.[2,3,4] Root fractures may occur in any direction as vertical fractures, horizontal fractures (transverse) or oblique fractures (as apical toward the palatal surface or apical toward the labial surface). The shearing stress zones resulting from a frontal impact on the tooth usually determine the fracture line.[5] Horizontal root fractures are classified according to the location of the root fracture, the fracture may be located in the cervical, middle or apical third of the root.[6] The patient's age, level of root development, pulpal status, localization and direction of the fracture line, the degree of the mobility, displacement of the coronal fragment and timely intervention are factors affecting the prognosis.[4,6,7]According to the current guidelines of the International Association of Dental Traumatology (IADT), emergency management of horizontal root fractures depends on repositioning (if the coronal fragment is displaced) and stabilization of the mobile coronal segment with a passive and flexible splint for 4 weeks. If the fracture line is in the cervical third of the root, splinting may be necessary for up to 4 months. Regular clinical and radiological follow-ups are recommended for at least 5 years. When there are clinical and radiographical symptoms of pulp infection or necrosis, endodontic treatment of only the coronal fragment may be required, as in most cases the apical fragment maintains its vitality.[8] Root fractures with appropriate diagnosis and treatment protocols in the literature have been reported to have a success rate of up to 80% in children.[9]

In this case report, the management and 36-month follow-up period of an immature maxillary left central incisor with a horizontal fracture in the middle third of the root is presented.

CASE REPORT

A healthy, 8-year-old girl was referred to our Pediatric Dentistry Clinic with the complaint of her traumatized maxillary anterior teeth due to a traffic accident a week ago. No signs of injury were observed in the perioral tissues of the patient. The clinical examination revealed subluxation injury on the immature maxillary right central incisor and the maxillary left central incisor showed Grade 2 mobility without a displacement. The radiographic examination revealed a horizontal fracture in the middle third of the root in maxillary left central incisor (Figure 1). The treatment plan and possible outcomes were explained to the patient and her family, treatment was initiated after written informed consent was given by the patient's parents. The treatment chosen was in accordance with the current recommendations of the IADT guidelines.[8] The teeth were stabilized with a bonded passive and flexible splint (Figure 2), the traumatic anterior deep-bite was slightly eliminated by placing compomer restorative material on the mandibular primary molars, oral hygiene instructions were given, soft diet was recommended and the patient was scheduled for follow-up visits.

After 4 weeks, the splint was removed, since the maxillary left central incisor still had Grade 1 mobility, compomers placed to eliminate traumatic anterior deep-bite on the mandibular primary molars were not removed and it was decided to monitor the mobility. Fracture line, pulpal status, and root development were followed up with regular clinical and radiographic controls (Figure 3). At the 8th month follow-up, tooth 21 had only physiological mobility, so the compomers were removed. At 36 months, maxillary central incisors were asymptomatic. In the maxillary left central incisor, radiographically there were no pathological changes, thickening of the dentinal walls of the root, completed root development and a slight root canal obliteration were observed (Figure 4). The patient and the parents continue controls without any aesthetic and functional complaints. Figure 5 demonstrates the intraoral view of the central incisors at 36-months follow-up.

DISCUSSION

This report is based on three years of clinical and radiographic review with spontaneous healing of a traumatized permanent incisor tooth with horizontal root fracture. Appropriate treatment procedures applied at the right time can help to preserve the tooth structure, leading to the long-term survival of the tooth. At the 36-month follow-up, the tooth was clinically healthy, and radiographic examination showed a successful outcome.

In young permanent teeth having incomplete root development, root fractures are less common compared to luxation injuries due to the flexibility of the alveolar socket. However, a careful, comprehensive clinical and radiographic examination is crucial for determining the presence of root

Figure 1. **a)** Initial intraoral periapical radiograph **b)** Initial intraoral view

Figure 2. Intraoral view after splint placement

fractures.[5] If there is no displacement or mobility of the coronal fragment, the root fracture cannot be detected without a proper radiographic imaging.[10] Radiographs taken from different angles are important for diagnosing root fractures.[10] IADT guidelines recommend to take a parallel periapical radiograph, two additional periapical radiographs taken from different angles, and an occlusal radiograph to detect root fractures.[11] The use of Cone Beam Computed Tomography (CBCT) is recommended when radiographs do not provide sufficient information for treatment planning.[8] Though, some root fractures may occur without any signs or symptoms during the initial clinical and radiographic examinations and may become evident at subsequent follow-up period due to the inflammatory response that will be in the fracture line, so it is important to follow-up dental traumas with regular adequate radiographic examinations specially in the early post-trauma period.

Root fractures involve different tissues of teeth and supporting tissues including the pulp, dentin, cementum and periodontal ligament. Thus, in root fractures there are complex healing patterns of these different tissues. Healing of a root fracture depends on pulp vitality and the health of the periodontium.[11] The displacement of the coronal root fragment may lead to pulp necrosis of the coronal root fragment with the reduced or severed blood supply. As all the forces during trauma have been absorbed by the fracture site, the apical root fragment is commonly not affected by the injury and the pulp in apical part of the root remains healthy and have the best prognosis.[5,12] The healing potential of fractures that occur in the apical third of the root is higher. Cvek et al.[9] reported an 80% survival rate for 534 teeth with root fractures over a period of up to 10 years. When excluding cervical fractures with a poorer long-term prognosis, this rate increased to 88%.[9] Root fractures may be accompanied by other types of injuries such as subluxation, concussion, lateral luxation, extrusion or avulsion of the coronal fragment and crown fractures. When there is a root fracture, the periodontal ligament at the fracture line and surrounding the coronal fragment is damaged. But when there is a concurrent injury, the damage of the periodontal ligament is greater. Therefore, such concurrent injuries can significantly impact the treatment management and prognosis negatively.[10,13] In this case, the absence of displacement of the coronal root fragment and the absence of any other injuries accompanying the root fracture are considered to have a positive effect on the prognosis of the root fractured tooth.

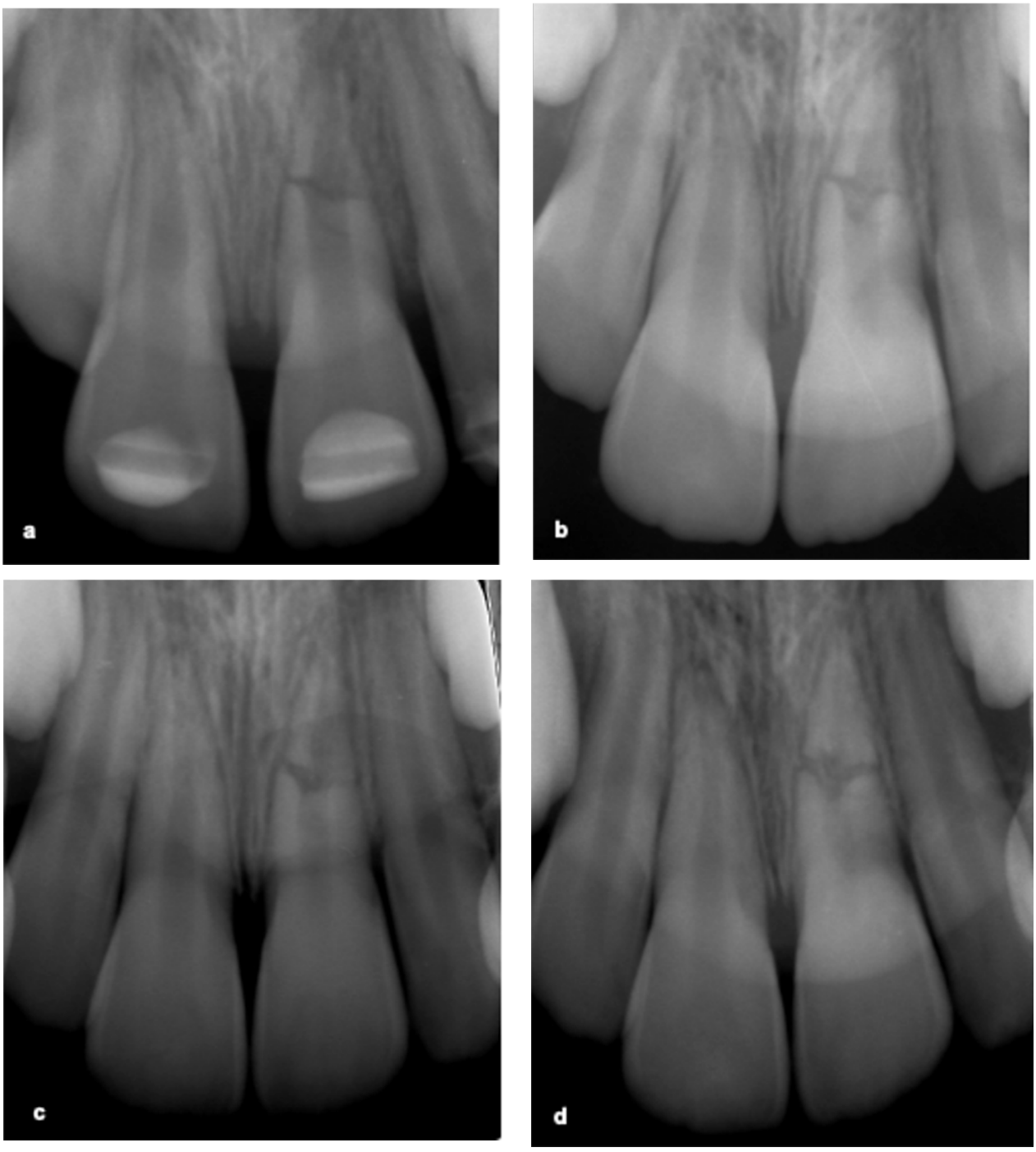

Figure 3. Radiographic follow-up at **a)** 4 weeks **b)** 3 months **c)** 6 months and **d)** 1 year

After traumatic injuries, regular follow-ups including detailed clinical and radiographic assessments as well as pulp sensitivity tests are recommended. However, the pulp's response to these tests is not reliable immediately after trauma. Deciding to start root canal treatment based only on a negative response to pulp tests after traumatic injury is not a proper approach.[8,14] Root canal treatment is indicated when there are objective signs of pulp necrosis and infection, such as pain, swelling, apical periodontitis, root resorption or periapical radiolucency on

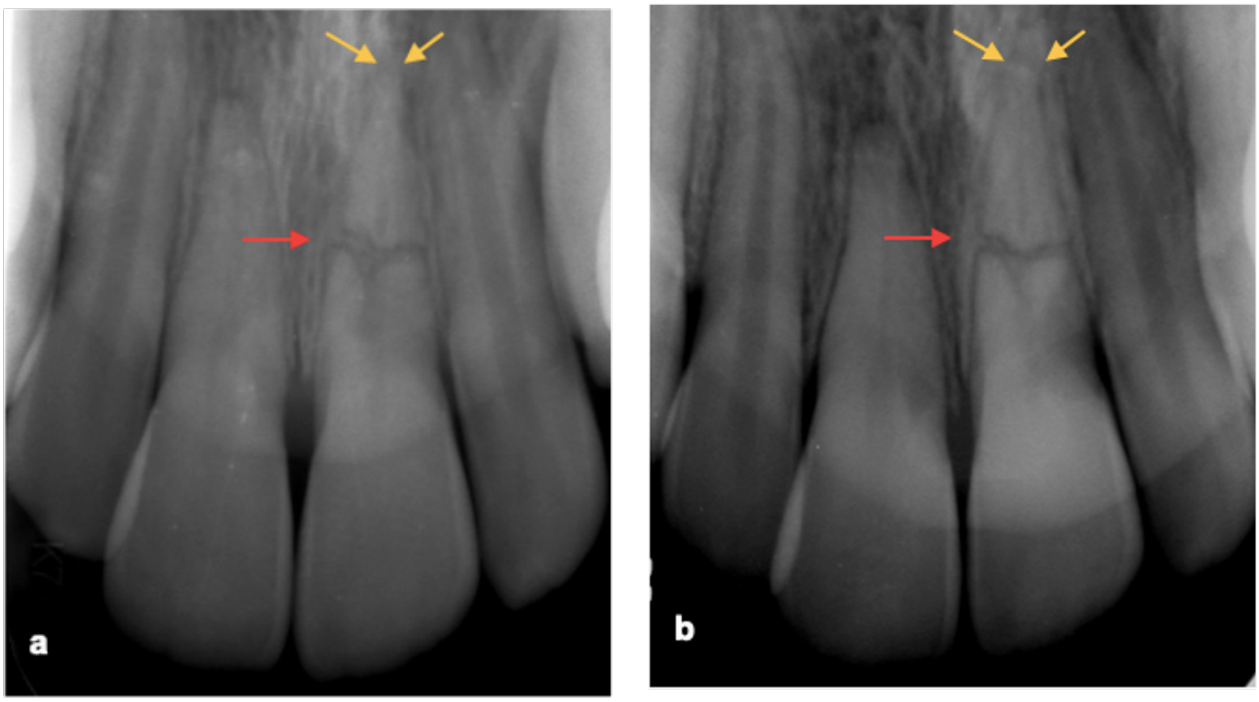

Figure 4. Radiographic follow-up at **a)** 2 years and **b)** 3 years (Yellow arrows indicate the apex closure and red arrows indicate the healing of the fracture line with calcified tissue and connective tissue.)

Figure 5. Intraoral view at 3-year follow-up

radiographs.[8,15,16] The infection of the pulp in the coronal fragment is typically caused by bacterial contamination at the time of the injury or immediately afterward and when the fracture line is supra-crestal located, dental plaque in the gingival sulcus may be the source of bacteria.[10] In most cases, only root canal treatment of the coronal fragment is sufficient because the pulp of the apical fragment is usually healthy. However, if pulpal pathologies develop in the apical fragment, root canal treatment of both the coronal and apical fragments up to the root apex or root canal treatment of the coronal part followed by apicectomy of the apical fragment is required. A 10-year survival rate of root fractures has been reported to be 87% with an appropriate treatment approach.[10] Andreasen et al[5] listed 15 studies which had a combined total of 1017 teeth, with only 274 (26.9%) teeth developing pulp necrosis.

Mobility, if present in the coronal fragment, needs to be evaluated. However, the presence of mobility in the coronal fragment alone does not indicate the presence of pulp pathology. The present case was treated in accordance with current IADT guidelines, with a flexible splint for 4 weeks. Continued mobility of the coronal fragment after splint removal is a potential situation and there is no additional recommendation other than follow-up for clinically and radiographically asymptomatic teeth with continued mobility in the guidelines.[8,9] In this case report, slight mobility persisted after the splint was removed. Considering that traumatic occlusion may adversely affect the healing process during the period of continued mobility, it was aimed to maintain stabilization by preventing traumatic occlusion during this period. The mobility of the fractured root tooth decreased over the time and the compomers placed on the deciduous molars was removed at the 8th month when physiological mobility was observed. Since no clinical or radiographic pathologic findings were observed during the 8-month period of continued mobility, the presence of pulp

pathology was not considered. Additionally, both teeth responded positively to an electric pulp test and a cold test. Different healing patterns have been described for root fractures and these responses, ranging from hard tissue healing to healing with granulation tissue, have been reported in many studies.[17,18,19] Andreasen et al.[12] reported that 30% of 400 teeth with root fractures healed with hard tissue interposition, 43% with connective tissue interposition, 5% with both hard tissue and connective tissue interposition, and 22% did not heal due to pulp necrosis and infection.The type of response will depend on several factors. Healing is dependent on the response of the pulp and the periodontal ligament, which compete to repair the injury. In this case, the fracture line healing with calcified and connective tissue interposition in the immature maxillary incisor was observed. This type of healing can be observed before the growth of the alveolar bone is completed in young patients, similar to the 8-year-old young girl in this case. In this type of healing, the coronal fragment erupts normally within the alveolar downgrowth process, but the apical fragment remains in the position as at the time of the injury.

Partial or complete pulp obliteration, coronal discoloration, and root resorption may develop after root fractures.[5,20] In this horizontal root fracture, a slight root canal obliteration was observed. Pulp canal calcification observed after root fractures ranges from 69% to 73%.[21,22,23] The presence of this calcification should not be considered as a poor prognosis because the pulp can produce dentin when only it is viable, healthy. So pulp canal calcification should be considered as a normal physiological response.

The time elapsed after trauma, the status of root development, mobility and displacement of the coronal fragment, the diastasis between fragments, location of the fracture are important factors affecting the healing and prognosis of root fractures.[4,9,12] In young permanent teeth, the potential regenerative properties of the pulp positively affect the healing of root fractures.[11,12,24] Providing the best conditions for healing, repositioning and stabilization of the fractured fragment is very important. In this case, with a non-invasive conservative approach that included splinting, prevention of traumatic occlusion during the early healing period and post-traumatic care with regular follow-ups, the immature tooth with a horizontal root fracture successfully maintained both aesthetically and functionally in the mouth.

CONFLICT OF INTEREST STATEMENT

The author declares no conflict of interest.

ETHICS STATEMENT

Written informed consent was obtained from the parents.

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