Apical Third Horizontal Root Fractures in Anterior Teeth: A Review

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Horizontal root fractures are a type of traumatic dental injury. Horizontal root fractures are classified as apical third, middle third, and cervical third of the root based on the fracture line and on the degree of dislocation of the coronal fragment. The prognosis of the tooth depends on the patient’s age, stage of root growth, mobility of the coronal fragment and diastasis of the fragments. Proper clinical and radiographic examination should be done to reveal apical root fractures. Hence, the treatment plan can be decided depending on the type of fracture and extent of fracture line. This review was conducted to evaluate the apical third horizontal root fractures in order to determine the appropriate therapy.

Keywords: Anterior teeth, Apical third, Horizontal fractures

INTRODUCTION

Root fractures are relatively uncommon compared to other dental traumas. The frequency of root fractures in permanent teeth is only 0.5-7%, and in deciduous teeth, just 2-4%. Root fractures occur mainly in the central and lateral maxillary incisors; in contrast, only 5% of root fractures are found in mandibular incisors.

Aim

The purpose of this article was to perform a review of the apical third root fractures to determine the treatment.

REVIEW

Root fractures are defined as fractures involving the dentine, cementum, and pulp. They occur most commonly in the middle-third and rarely in the apical- and coronal-third of the root.¹

Classification

Horizontal/transverse root fractures can be sub-classified on the basis of:
• Location of fracture line (cervical, middle and apical)
• Extent of fracture (partial and total)

• Number of fracture lines (simple, multiple and comminuted)
• Position of the coronal fragment (displaced and not displaced).

Depending on the position of the fracture line, transverse root fractures can also be classified into three zones² as follows:
Zone 1: Extends from the occlusal/incisal edge to the alveolar bone crest.
Zone 2: Extends from the alveolar bone crest to 5 mm below.
Zone 3: Extends from 5 mm below the alveolar bone crest to the apex of the root.

These zones are analogues to crown fracture, cervical-root fracture, and middle/apical root fracture, respectively.

The histological reactions at the fracture line are categorized into four types:³
1. Interposition of calcified tissue
2. Interposition of connective tissue
3. Interposition of bone and connective tissue
4. Interposition of granulation tissue.

Etiology

Maxillary central incisors are most vulnerable to injury, sustaining approximately 80% of all dental injuries, followed by the maxillary lateral and the mandibular incisors.⁴

Several studies have reported that the average age of patients with root fractures lies between 11 and 20 years.¹³
As fights and sporting activities are more common in the first and second decade of life, an increased prevalence of root fractures is observed in a similar age group (11-22 years).¹

Usually, horizontal root fractures are observed in anterior teeth with direct trauma. In posterior teeth, it usually occurs as a result of indirect trauma. In addition, root fractures may occasionally be caused by parafunctional habits, traumatic occlusion, extensive tooth decay and iatrogenic causes (Figure 1).

### History
The diagnosis begins by recording the demographics of the patient and taking a brief history of the traumatic event:
- Time and place of the event
- Reason for the injury
- Previous dental injuries
- Spontaneous pain or sensitivity
- Other associated symptoms following an injury (unconsciousness, drowsiness, vomiting or headache).

### Clinical examination
The diagnosis of apical root fractures is determined by clinical and radiographic examination.

Fractures in the apical-third of the root do not show signs of displacement or mobility.

### Pulpal status
A routine follow-up is required to monitor the pulpal status continuously.⁵

More recently, the use of a pulse-oximeter was recommended to evaluate the pulpal status of a recently traumatized tooth.

This has better sensitivity and specificity than electrical and thermal tests⁶ and gives a constant positive vitality reading with time in cases of recently traumatized teeth.⁷

### Radiographic examination
The fracture line is oriented obliquely in the apical-third and middle-third of the root and more horizontally oriented in the cervical-third. In addition to the conventional periapical radiograph, two additional periapical radiographs (one with a positive angulation of 15° to the fracture line and the second with a negative angulation of 15° to the fracture line) should be exposed.³

Other suggested protocols to visualize the fracture line accurately are:

- Processing three-angled radiographs at 45°, 90° and 110°.⁶ A steep occlusal exposure along with two conventional periapical bisecting-angle exposures.⁸

- In addition to the views listed above, occlusal radiographs may be required to disclose fractures in the apical-third of the root, although cervical-third root fractures are better visualized with periapical radiographs.⁸

Since the introduction of cone-beam computed tomography (CT), examination of root fractures in three-dimension is possible.

### Management of root fractures
Horizontal root fractures occur primarily in maxillary anterior teeth and occur most commonly in the middle-third of the root and rarely in the apical-third (Figure 2).⁹

Frontal forces effect compression zones labially and lingually/palatally and divide the root into coronal fragment and apical fragment. Root fractured teeth often possess a vital apical fragment, even when the coronal fragment is necrotic. For this reason, only the coronal fragment should be endodontically treated. In the study by Cvek et al. (2004), overfilled root canal

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**Figure 1:** Radiograph showing horizontal root fracture in maxillary anterior tooth

**Figure 2:** Radiograph showing middle third horizontal root fracture in anterior tooth
filling material between the fragments did not lead to healing or lead to interposition of granulation tissue (Figure 3).\textsuperscript{10}

In a retrospective study by Andrea Wolner-Hanssen and Thomas Von Arx, endodontically adequately treated teeth with root fractures have a good prognosis. Root resorptions were seldom observed, and the most frequent tissue reaction at the fracture line was interposition of connective tissue. Pulpal necroses and lack of healing at the fracture line were the most common complications.

Andreasen \textit{et al.} (2007) observed that 60\% of the teeth with root fractures exhibited external root resorption. Several experimental studies have shown that external root resorption after trauma occurs less frequently when ledermix paste is applied as the first filler in the canal (Thong \textit{et al.}, 2001, Bryson \textit{et al.}, 2002, Wong and Sae-lin 2002). The steroid component of ledermix (triamcinolone) suppresses the initial inflammatory reaction and the antibiotic component (dimethylchlortetracycline) inhibits the osteoclast-induced root resorption.

International Association of Dental Traumatology (Flores \textit{et al.}, 2007) guidelines recommend endodontic treatment only after pulpal necrosis, not as a prophylactic intervention. It has long been accepted that the treatment for horizontal root fractured teeth involves repositioning and rigid splinting. Additional dental treatment of root fractures may also include endodontic therapy and restorative treatment if necessary.\textsuperscript{11}

Root canal therapy is not recommended on the tooth with horizontal root fracture in the apical third, because research has demonstrated that the pulp will remain vital in most cases with high percentage of successful healing without receiving endodontic treatments.\textsuperscript{12} A minimum observation period of 1 year is recommended for damaged teeth with no apparent complications.\textsuperscript{13}

Repositioning the displaced tooth fragment enhances pulp and hard tissue healing. Type and duration of splinting had no significant difference in healing (Figure 4).\textsuperscript{14}

The study also found that cervical fractures showed a greater likelihood of healing than middle and apical fractures.\textsuperscript{15} Horizontal root fractures situated on the middle or apical third of the root present better prognosis in comparison with vertical fractures\textsuperscript{4} and teeth with vertical root fractures and poor prognosis are classified as a genuine indication for autogenous tooth transplantation.\textsuperscript{16}

CONCLUSION

Patients age at the time of injury is considered one of the most important factor in pulpal healing after root fracture.

In apical third root fractures, it is recommended to leave the apical fragment untreated unless pathological, in which case it may be surgically removed. Endodontic treatment of both fragments is not recommended. Further studies are required on apical root fractures. This review is conducted as there are few studies on apical root fractures to gain knowledge to determine the appropriate treatment plan.

REFERENCES

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How to cite this article: Vinutha YJ, Sandya P. Apical Third Horizontal Root Fractures in Anterior Teeth: A Review. IJSS Case Reports & Reviews 2015;1(9):61-64.

Source of Support: Nil, Conflict of Interest: None declared.