

TITLE PAGE

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ABSTRACT:

Fractures of crown and root are common emergencies encountered in the dental office. Root fractures are defined as fractures involving the dentin, cementum and pulp. These root fractures are broadly classified as horizontal/transverse and vertical root fractures. The correct diagnosis is essential to ensure proper treatment of root fractures. Various treatment strategies have been proposed, each has its own advantages and disadvantages. Hence this review article presents an overview of various types of root fracture, their diagnosis and clinical management.

KEYWORDS: Trauma, Injuries, Fracture line, Horizontal root fracture, Vertical root fracture.

MAIN TEXT

REVIEW

1. INTRODUCTION:

Traumatic tooth injuries can vary in severity from simple enamel infraction to complete tooth avulsion. Tooth fracture can be classified into three types, Crown root fracture, Crown

fracture, Root fracture^[1]. Among this, root fractures accounts for about 0.5 to 7% of injuries in permanent dentition. Root fractures can be defined as fractures involving dentin, cementum and pulp. This is most commonly seen in maxillary centrals and laterals. It occurs mainly in the age group of 3-4 years in primary dentition and 11-20 years in permanent dentition^[2]. Root fractures can be considered as a third most common cause for tooth loss. It can be broadly classified based on the direction in which they occur, horizontal/transverse and vertical root fracture.

AETIOLOGY:

Root fracture can be classified into two types:

1. Fractures occurring in non-endodontically treated teeth.
2. Fractures occurring in endodontically treated teeth.

Non endodontic tooth fractures are considered to be rare and can occur due to occlusal or accidental trauma. Endodontic tooth fractures are common and occur due to varying reasons such as condensation forces during root canal obturation, trauma due to post space preparations, occlusal trauma or accident^[3].

CLASSIFICATION OF ROOT FRACTURES:

HORIZONTAL OR TRANSVERSE ROOT FRACTURE: Horizontal root fractures mainly occur in the anterior region of maxillary : central and lateral incisors with complete root formation. The incidence of root fractures in the middle third (57%) and less likely in the coronal (9%) and apical third (34%) (Caliskan and Pehlivan 1996). Based on the position of the fracture line^[4], it can be classified into three zones:

ZONE 1. Extends from the incisal edge / occlusal edge to the alveolar crest.

ZONE 2. Extends from the alveolar crest to 5mm below.

ZONE 3. Extends from 5mm below the alveolar crest to the apex of the root.

Based on the occurrence, it can be further classified into:

1. Simple or multiple (number of fracture lines)
2. Cervical, middle or apical (location of fracture lines)
3. Displaced or not displaced (position of coronal segment)
4. Partial or total (extent of fracture)

CLINICAL EXAMINATION OF HORIZONTAL ROOT FRACTURE:

It depends on different factors such as age, coronal fragment mobility, root fracture location and stage of root formation. Treatment is mainly focused on stabilizing and repositioning its original position and monitoring the tooth for pulp vitality for an extended time period. However, analyzing the pulp vitality can be difficult in this situation, it may even take several months to determine the actual state of vitality as the nerve supply can be dysfunctional or damaged.

Clinical examination to determine the horizontal root fracture is based on the following steps:

1. Checking the clinical tooth mobility.
2. Presence of tenderness to percussion.
3. Bleeding in gingival sulcus.
4. Tenderness on the surface of the root during palpation^[5].
5. Patient may complaint of sensitivity on biting pressure for several days or weeks.

RADIOGRAPHIC EXAMINATION:

It is used for the confirmation of root fracture. For disclosing the apical third root fractures, occlusal radiographs are required, while periapical radiographs provide better visuals for cervical third root fractures.

MANAGEMENT OF HORIZONTAL ROOT FRACTURES:

It can be divided into three based on the fracture line:

1. Apical third
2. Middle third
3. Cervical third

APICAL THIRD FRACTURE:

In apical third fractures, tooth may be asymptomatic with no mobility. In most cases apical segment remains vital in the transversely fractured tooth. Treatment is not required but observation is necessary. In the apical fragment, if the pulp undergoes necrosis surgical removal of the apical fragment is indicated. When the root fracture occurs horizontally, apical fragment is not generally displaced as the apical pulpal circulation is not disrupted, pulpal necrosis in apical segment is very rare. Tooth has a positive response to the vitality test and there is no sign of periapical pathology in the radiograph.

MIDDLE THIRD FRACTURE:

The treatment begins with repositioning of the coronal fragment and immobilization by fixation to the neighboring teeth with semi rigid or rigid splint. The splint should be maintained for two to three months. The splinting methods include the use of stainless steel wire, resin-based composite splints, or titanium trauma splints (TTS). TTS splints are 0.2mm thick rhomboid meshes which are easily adapted and stabilized on teeth. During observation, after 45 days of repositioning the clinical findings remain unaltered and the rigid fixation is removed.

CERVIAL THIRD ROOT FRACTURE:

They have poor prognosis due to pulp exposure and constant tooth mobility. Treatment can be based on the position of the fracture line, presence and absence of coronal segment and length of the remaining tooth segment, usually healing with calcified tissue is poor in cervical root fractures^[6]. The treatment of cervical third root fractures can be classified based on fracture line:

1. Fracture line above the level of alveolar crest
 - a) Intact coronal segment
 - b) Lost coronal segment
2. Fracture line below the level of alveolar crest

FRACTURE LINE ABOVE THE ALVEOLAR CREST:

If the fracture line is above the coronal segment, the conventional reduction and stabilization is indicated. Pulp tissue becomes necrotic, endodontic treatment is required. Healing does not take place when there is bacterial contamination in the fracture line. Reattachment of the fracture segment can be done by fiber-reinforced post and resin-based composite material.

If the coronal segment is lost, crowns with sub gingival margin or false shoulders are indicated. If the apical root fragment has sufficient length and fracture level is above the alveolar crest and exposure of crown margin is required, then gingivoplasty or apical repositioning of flap is performed.

FRACTURE LINE BELOW THE ALVEOLAR CREST:

If the fracture line is below the alveolar crest and the remaining root structure is long enough to support the applied restoration, then only the fractured segment is removed and root canal treatment is performed. To convert the subgingival fracture to supragingival, gingivectomy, surgical or orthodontic extrusion of the apical fragment is necessary. Restoration of the fracture segment with the original fragment or with composite resin^[7].

OTHER TREATMENT OPTIONS:

1. Crown lengthening or periodontal surgery
2. Orthodontic extrusion
3. Intra alveolar transplantation of fractured tooth(surgical extraction).

CROWN LENGTHENING OR PERIODONTAL SURGERY:

Crown lengthening is typically carried out when the fracture line is 1-2mm below the alveolar crest bone. It involves the removal of 1-2mm of crestal bone adjoining the deepest part of fracture and restoring the normal sulcus depth of 2mm. Thus periodontal and osseous recontouring is done for exposure of the fracture margin and root surface to give a restorative finish line.

ORTHODONTIC EXTRUSION:

The orthodontic extrusion is done when the fracture line extends deeply in the labial surface or interproximal area (6mm below alveolar crest). The distance from the fracture line to apex should not be less than 12mm and the crown-root ratio must be 50:50 for a successful extrusion and post-treatment restoration. Extrusion involves the newly formed crestal bone, gingiva and the epithelial attachment along with the tooth, leading to a coronal shift of marginal gingiva. Thus there is no loss in the periodontal support and the bone. The disadvantages in the coronal shift of gingiva are the extruded fragment may relapse, partial coverage of root extrusion and discrepancy in the bone level between the adjacent tooth. Thus a conservative periodontal surgery is necessary to correct the discrepancy followed by

stabilization for 7-14 weeks before the removal of the orthodontic appliance. The orthodontic extrusion includes the use of fixed or removable orthodontic appliance^[8].

INTRA ALVEOLAR TRANSPLANTATION OF THE FRACTURED TOOTH (SURGICAL EXTRACTION):

This procedure is carried out on emergency basis where there is severe luxation of the fractured root. Marginal luxation is done to the required position and stabilization is done by interdental suturing and surgical dressing. A rotation of 180° is given before fixation if the fracture line is more apical on the labial side^[9].

HEALING OF HORIZONTAL ROOT FRACTURE:

According to Andreasen et al, the four types of responses^[10] are:

- Healing with hard dental tissue.
- Healing with connective tissue .
- Healing with bone and connective tissue.
- No healing because of the interference of inflammatory tissue in the fracture line.

THE FACTORS INFLUENCING PROGNOSIS AND HEALING ARE:

1. **Position and mobility of coronal segment after trauma:** when there is an increase in the rate of dislocation and mobility it results in poor prognosis. Healing with connective tissue is high in the case of luxation. For optimum consolidation and repair across the fracture line, immobilization procedure is performed. The use of passive flexible splint favours healing process.
2. **Status of the pulp:** Faster healing and hard tissue repair of the fracture are seen in vital pulp and positive pulp sensibility at the time of injury. In most of the cases the pulp in the apical root remains vital.
3. **Position of the fracture line:** The best prognosis is seen in middle third fractures. When the fracture line is close to the gingival crevice, healing with calcified tissue occurs and whereas the chance of healing in the cervical third is poor. According to Zachrisson and Jacobsen, the outcome is not influenced by the location of fracture line, except the fracture that occur close to the alveolar bone crest (where the tooth support is compromised).
4. **Communication with the oral environment:** When communication is developed between the gingival sulcus and the fracture site the prognosis is poor due to bacterial contamination.

OTHER FACTORS INCLUDE:

- Diastasis between fractured segments.
- Presence of marginal periodontitis.
- Presence of any restoration at the time of injury.

VERTICAL ROOT FRACTURE Vertical root fracture (VRF) can be described as “longitudinally oriented fractures of the root that originates from the apex and propagates to the coronal part”. They usually occur in endodontically treated tooth and sometimes in non-restored tooth. It involves the whole length of root or only a section of the root. It can also involve one or both sides of the root. The VRFs usually occurs in posterior teeth of older patients due to iatrogenic cause. The prevalence ranges from 2-5% of the crown-root fractures.

CLASSIFICATION: Vertical root fractures are classified based on

- 1) Separation of fragments
 - a) Complete
 - b) Incomplete
- 2) Position of the fragment to the alveolar crest
 - a) Supraosseous
 - b) intraosseous

CLINICAL EXAMINATION:

Clinical presentation of vertical root fracture may be extremely variable. The clinical signs of vertical root fracture are

1. Tenderness over the root and swelling of soft tissue.
2. Development of deep periodontal pocket
3. Dislodgement of post or post-crowns
4. Sharp cracking sound at the time of cementation and condensation.
5. Bleeding during condensation of obturation materials into the canal.

CLINICAL DIAGNOSIS : The tests used are bite test, transillumination test, periodontal probing test, pulp test, staining with disclosing dye i.e methylene blue, direct visualisation of fracture by removing the restoration, direct visualisation with good illumination via fiberoptics and exploratory surgery to view the root and confirm the presence of fracture. The bone resorption pattern is more rapid in VRF progressing apically and laterally to the intraproximal area.

RADIOGRAPHIC EXAMINATION: It varies from case to case. Initially the radiograph shows unilateral thickening of PDL on the fracture side. As the fracture advances a diffused radiolucency is uniformly seen surrounding the tooth root^[11].

Other radiographic features are:

1. Fracture line existence
2. Separation of root fragments
3. Space beside root canal obturation material.
4. At external root surface a double image is seen.
5. Vertical bone loss.

MANAGEMENT OF VERTICAL ROOT FRACTURE:

Treatment of the vertical root fracture is dependent on the tooth type, the extent of fracture, duration and location. The constant intervention of the bacteria at the fracture

site provides an open pathway from the oral cavity to the supporting tissue leads to the bone loss.

Various treatment approaches are:

1. Use of cyanoacrylates^[12].
2. Adhesive resin cement (4-META/MMA-TBB)^[13].
3. Repositioning
4. Fixation with wire^[14] and mineral trioxide aggregate
5. GIC with guided tissue regeneration therapy^[15].

In most cases, vertical root fracture extraction is the most appropriate option for anterior teeth because of the poor prognosis. For posterior teeth multiple treatment options were proposed by Luebke

TREATMENT PLAN 1:(In the case of incomplete supraosseous fracture with no radiographic changes and periodontal defects)

- a) Vital pulp – the tooth is restored with full coverage temporary crown and must be evaluated after three months. If the pulp is asymptomatic a permanent crown is fixed with glass ionomer cement or polycarboxylate.
- b) Non vital pulp – the tooth is restored with full coverage stainless steel crown and calcium hydroxide is initiated. After 9-12 months of calcium hydroxide therapy, if the level of bone remains unchanged, endodontic treatment is done and permanent crown is placed.

TREATMENT PLAN 2:(In the case of incomplete intraosseous fracture with non vital pulp and a periodontal pocket in the fracture line)

For the visualization of fracture line and osseous defect, exploratory surgery is indicated. When the fracture line is below the osseous defect, periodontal surgery is done to restore the defects. Depending on the status of the pulp, initiate treatment plan 1 a & b.

TREATMENT PLAN 3: (In case of complete intraosseous fracture with non vital pulp and presence of periodontal pocket and bone loss)

For a single rooted teeth, extraction is done. For a multi-rooted tooth when the fracture is confined to one root or passes through the furcation - root amputation, hemisection or extraction is done.

CONCLUSION: The successful treatment of root fracture is based on an evidence based clinical approach. The aesthetic and functional outcome of the treatment depends along with the combined restorative and endodontic therapy with regular follow up and maintenance.

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