

## Review Article

## Vertical Root Fracture: A Review

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**ABSTRACT:** Vertical root fractures associated with endodontically treated teeth present as one of the most difficult clinical problems to diagnose and treat. Prognosis most often is hopeless and differential diagnosis from other pathoses may be difficult at times. Nevertheless, proper diagnosis is critical to distinguish a fracture from clinical manifestations of periodontal and endodontic diseases. In as much as there are no specific symptoms, diagnosis can be as difficult. Clinical detection of this condition by endodontists is becoming more frequent, where as it is rather underestimated by the general practitioners. Early detection of a fractured root and extraction of the tooth maintain the integrity of alveolar bone for placement of a future implant with better prognosis. Since, vertical root fractures almost exclusively involve endodontically treated teeth; it often becomes difficult to differentiate a tooth with this condition from an endodontically failed one or one with simultaneous periodontal involvement. The diagnosis of vertical root fracture is difficult because of the delayed appearance of the signs and the appearance of pure endodontic or periodontal problems. Also, a tooth diagnosed for vertical root fracture is usually extracted, though attempts to reunite fractured root have been attempted in various studies with varying success rates.. Cone beam computed tomography has been shown to be very accurate in this regard. This article focuses on the diagnostic and treatment strategies, and discusses about predisposing factors which can be useful in the prevention of vertical root fractures.

**Key Words:** vertical root fractures, root canals, prognosis, treatment , etiology

## INTRODUCTION

The location, extent and direction of a crack or fracture have a profound effect on the choice of treatment, so clarity on this aspect is very important. The five types of longitudinal tooth fractures known are as follows:<sup>(1)</sup>

- Craze Lines • Split Tooth
- Fractured Cusp • Vertical Root Fracture
- Cracked Tooth

## Vertical root fracture

(VRF) is defined as a complete or incomplete, longitudinally oriented fracture of the root, which is usually directed in the buccolingual plane. This fracture usually initiates in the tooth root and may extend coronally.<sup>(1,2,4)</sup> VRFs occur mainly in endodontically treated teeth with or without posts, and or restored teeth. The incidence of VRFs however is seen to be more in the mesial roots of mandibular molars followed by the maxillary premolars<sup>(2,9,10)</sup>. According to the American Association of Endodontists, "A vertical root fracture is a longitudinally oriented fracture of the root that originates from the apex and propagates to the coronal part." Vertical root fractures present with multiple problems both for the dentist as well as the patient as its definitive diagnosis is made only after years of its initiation<sup>(10,11,12)</sup>. VRF is an unfortunate complication to root canal treatment which often calls for extraction of the involved tooth. It may be initiated during obturation or because of stress induced on the tooth due to masticatory forces.<sup>(3,4,5)</sup> Depending on the nature of the stress factors, VRF usually originate from the apical end of the root and travel coronally or can originate from the cervical portion of the root with extension in an apical direction.

Endodontically treated teeth may need to be extracted if they cannot be restored or present with severe bone loss. The purpose of this updated review is to further discuss the diagnostic and treatment challenges related to tooth cracks and fractures that occur primarily in the long axis of the root.

**Clinical evidence of VRF's**

VRF's are more than often misdiagnosed because of the late appearance of its radiographic changes.<sup>(10)</sup> However clinically mild pain is the symptom, followed by dull aching pain on mastication. Diagnosing VRF's can be challenging for the clinician as the radiographic and clinical symptoms mimic those of failed endodontic treatment and periodontal disease. Clinically the patient may present with dull pain on mastication, mobility of the tooth, pain on percussion, pain on palpation. Most often there is a draining sinus seen in relation to the tooth, If not, a swelling is seen on the buccal surface. An abscess forms when the situation becomes chronic and it very much mimics a periodontal abscess. A gutta percha point can be used to trace the path of the sinus opening.<sup>(10)</sup> Presence of a deep narrow periodontal pocket is one of the classic symptoms of VRF's. Pockets are narrower with normal depth of sulcus on either side. Periodontal type abscesses are also one of the clinical findings in cases of vertical root fracture, which result from chronic inflammation at the fracture line. Early diagnosis of VRF's need to be made because of the direct correlation between bone resorption around the involved root.<sup>(9,10)</sup> The longer this inflammatory process continues, the more bone loss occurs, affecting the prognosis of the involved root and consequently the involved tooth. The affected root or tooth/teeth has a poor prognosis and extraction is usually the

only treatment option.<sup>(13,14)</sup> Therefore, each of these clinical findings should be carefully observed and correlated with the radiographic findings, to get definitive evidence for vertical root fracture.

### Radiographic features

Radiographic features of vertical root fractures vary widely. These may be observed on radiographs as diffuse widening of periodontal ligament, dislodgement of retro-filling material, vertical bone loss separation of root fragments or displacement of apical portions of root. Presence of 'radiographic halo' or a "J" shaped radiolucency has been shown as a major finding in cases of vertical root fractures.<sup>(9,10,11)</sup> A typical hair line fracture line has been documented by authors. In addition, in mandibular molars, furcation radiolucency is also seen. Also on instances, "hair like" radiolucency can be detected in periapical radiographs suggestive of vertical root fractures. The appearance of radiolucency associated with VRF's is based on the direction and location of the fracture and the extent of bone destruction.

### Incidence and distribution of VRF's in teeth;

It has been seen that mandibular molars are at the highest risk of vertical root fractures followed by maxillary premolars, mandibular premolars. Root depressions in the mesial roots of mandibular molars and buccal roots of bifurcated maxillary premolars are the anatomical entities that can predispose the roots to fracture. The root canal shape combined with the dentin thickness, affects the tensile stress distribution during intracanal procedures. Canal shape is the most important factor of the two since the area of reduced curvature radius is strongly influenced by stress concentration. Teeth having roots with a thinner mesio distal width as compared to buccolingually, are more prone to fracture buccolingually and not mesiodistally, although tooth structure is removed from mesial and distal aspects at the stage of canal instrumentation.

### Predisposing factors for vertical root fractures

The root anatomy

As previously discussed, roots narrower in mesiodistal dimensions, are more prone to vertical fractures than the other counter parts<sup>(2,5,10)</sup>. Ratio of canal width to the width of total root also increases the risk of root fracture.

Dentin removal during canal instrumentation:

Excessive removal of dentin during canal preparation plays important role as a predisposing factor to increase the chances of VRF's.<sup>(1,2,9,10)</sup> Round canal preparation in an oval canal increases the amount of dentin removed during instrumentation.

Obturation technique used

Studies have shown that using a lateral compaction technique for root canal obturation, increases the concentration of stresses.<sup>(2,9,13)</sup> The wedging action created by the use of spreaders during obturation may predispose the tooth to VRF<sup>(18)</sup>. It has been suggested to have an increased canal taper to avoid concentration of stresses.

Post placement and vertical root fracture

Tapered end posts produce wedging effect near the apex, severe for posts of smaller diameter with shallower embedment<sup>(2,13)</sup>. Parallel sided posts produce uniform stress distribution, whereas larger diameter and greater depth

produce best stress distribution<sup>(8)</sup>. Zirconia posts are rigid, and cause vertical root fracture.

### DISCUSSION

Vertical root fracture associated with root canal treated teeth is one of the most difficult problems to diagnose and treat. Early detection has two fold advantages — it prevents unnecessary frustration and inappropriate endodontic treatment, and prevents extensive damage to the supporting tissues. Diagnosis is usually confirmed through the clinical signs and radiographic features. But not all the typical signs of a fractured root may be present in each case. So, the combination of clinical signs, symptoms and radiographic features may provide a clue for the diagnosis of vertical root fracture<sup>(2,9)</sup>. Also, presently CBCT has been shown to be promising in the early detection of vertical root fractures<sup>(15)</sup>. Another study was done that aimed to report a possible effect of the presence of an adjacent implant on the development of a vertical root fracture (VRF) in endodontically treated teeth<sup>(16)</sup>. The case series analysis revealed that the time from implant placement to the diagnosis of VRF was between 5 and 28 months (average = 11 months). Also it was concluded that majority of cases occurred in female patients who received 2 or more implants. Six of the seven patients were older than 40 years, with an average age of 54 years<sup>(16)</sup>. The majority of teeth with VRF were premolar or mandibular molar teeth. Clinical evidence concerning the application of radiographs for the early determination of VRF is inadequate. Both conventional digital radiography and advanced imaging techniques such as cone-beam computed tomographic imaging have been suggested to present limitations in the detection of VRFs<sup>(15,16)</sup>. In later stages, with the progression of VRFs, root separation may transpire, which, in turn, would facilitate the determination of VRFs. Studies have suggested, a "halo" type of radiolucency to be found as a significant indicator<sup>(1,2,9,11,12)</sup>.

### CONCLUSION:

The constant ingress of bacteria from the oral cavity into the VRF's provides an open pathway to the supporting alveolar tissues<sup>(1,2,9,10)</sup>. Multiple treatment modalities have been suggested for the treatment of VRF's, but in vain. Unfortunately, by the time the diagnosis is made, severe bone loss has already occurred making the prognosis of the tooth poor, indicating a need for extraction.<sup>(9,10,11)</sup> However, the practitioner should be vigilant at all times and VRF's should be ruled out. Also, in posterior teeth, the affected root can be extracted and the other roots can be retained with a coronal restoration. Prevention of VRF's is of utmost importance. Prevention, knowledge and appreciation of the multifactorial etiology of fractures are the best solutions which should be mastered by the clinician. However, the clinical presentation of vertical root fracture is variable.<sup>(1,6)</sup> The clinical picture depends on the position of the fracture, tooth type, time elapsed after fracture, the periodontal condition, and architecture of bone adjacent to the fracture<sup>(2)</sup>. When a diagnosis of vertical root fracture is made, a quick decision to extract the tooth or root is necessary since, inflammation in the supporting tissues can lead to periodontal break down, which is then followed by development of an osseous defect and resorption of the bone. Replantation of root filled teeth with vertical root fracture reconstructed with resin bonding has emerged as a new promising method in recent years.

Finally, it should always be remembered that poor quality root canal fillings complicate the diagnosis of vertical root fracture,

which in turn extend the time for accurate diagnosis and medico legal risk. Premolar and mandibular molar teeth are more prone to medico legal claims related to vertical root fracture following root canal treatment<sup>(2,7,9,10)</sup>. Judicious use of posts should be practiced and post should be placed only when essential for additional core support .

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