Vertical Root Fractures: Diagnosis and Management - A Review

Abstract

Vertical root fractures (VRF) have been described as longitudinally oriented fractures of the root, extending from the root canal to the periodontium. Diagnosis and management of vertical root fracture is a challenging task for the clinician. Vertical root fracture commonly affects endodontically treated teeth. Prognosis most often is hopeless and differential diagnosis from other pathologies may be difficult at times. This review emphasizes about the etiology, diagnosis, and management of vertical root fractures.

Key Words: Root Fracture; Vertical Root Fracture; Fracture

According to American Association of Endodontists, vertical root fracture (VRF) is defined as “A longitudinally oriented fracture of the root that originates from the apex and propagates to the coronal part”. 
(1) They usually occur in endodontically treated teeth, although occurrence in non-restored teeth has been described. (2) The vertical fracture may involve the whole length of the root or only a section of it. It may involve only one or both sides of the root. (2) In this review, the diagnosis and treatment of vertical root fractures is discussed in detail.

VRF represent between 2 and 5% of crown/root fractures, with the greatest incidence occurring in endodontically treated teeth and in patients older than 40 years of age. The maxillary and mandibular premolars and the mesial roots of mandibular molars are most susceptible to VRF. In molar teeth, the fracture occurs most commonly in buccolingual direction in individual roots. Mesiodistal fractures are less common. In anterior teeth, the fractures are most commonly seen in buccolingual direction. (3)

Vertical root fractures are classified into two types. a) Based on position of the fracture in relation to alveolar crest, Class 1: Incomplete supra osseous fracture as one terminating coronal to the alveolar crest not creating a periodontal defect, Class 2: Incomplete supra osseous fracture as one terminating at or slightly apical to the alveolar crest creating a shallow osseous lesion and Class 3: Complete or incomplete intraosseous fracture resulting in loss of periodontal attachment. b) Based on separation of the fragments, 1. Where total separation is visible or fragments can be moved independently. This is defined as complete fracture and 2. An incomplete fracture is said to occur in the absence of visible separation. (4)

The predisposing factors for vertical root fractures are either anatomical predisposing factors or operative or iatrogenic factors. Anatomical Predisposing factors for VRF are a) Root anatomy: The most susceptible roots to fracture are those in which the mesiodistal diameter is narrow compared to the buccolingual dimension such as in maxillary and mandibular premolars, mesial roots of mandibular molars and mandibular incisors. (5), b) Amount of tooth structure missing: Due to caries or trauma, and also with reduced amount of radicular dentin which results due to various intracanal procedures like initial root canal therapy, retreatment and post space preparation could lead to a fracture, c) Moisture loss in endodontically treated teeth, compared with teeth with vital pulps, is not a major etiological factor but rather a predisposing one for the fracture. (6) d) Specific biochemical properties of dentin: Kishen et al found that the dentin adaptation to functional stress-strain distribution results in greater mineralization in the buccolingual areas. This may increase the likelihood for a fracture to propagate in this direction, compared with the less mineralization and more collagen in the mesiodistal areas. (7)

Operative or iatrogenic predisposing factors for VRF are as follows. a) Excessive canal shaping during endodontic treatment, especially in teeth with curved roots that are narrow in the mesiodistal plane like maxillary second premolars, mesiobuccal roots of maxillary molars, mesial roots of mandibular molars and mandibular premolars are most prone to VRFs, b) Excessive hand pressure during lateral or vertical compaction of gutta-percha can result in development of a VRF, c) Excessive restorative procedures during a canal preparation weakening the walls by making them too thin, d)
Choosing an inappropriate tooth for a bridge abutment may contribute to the development of a VRF.(5)

Clinical presentation of a vertical root fracture is extremely variable. The clinical signs and symptoms vary according to the position of the fracture, tooth type, time after fracture, and the periodontal condition of the tooth and the architecture of the bone adjacent to the fracture.(8)

There are various signs for vertical root fractures. a) Swelling of the soft tissue and tenderness over the root, b) presence of a sinus tract close to attached gingiva, rather than in the apical region, c) development of deep, narrow, isolated periodontal pockets, d) a repeated dislodgement of a post or post crown, e) sharp cracking sound at the time of condensation of gutta percha or cementation of a post and f) bleeding during condensation of a root filling material and an apparent lack of resistance within the canal during condensation leading to an almost unlimited ability to condense gutta-percha in to the canal.

Different clinical diagnostic tests are used for vertical root fractures. a) Bite test i.e., biting on rubber wheels, cotton tip applicators, moist cotton rolls and commercial biting applicators, b) Trans-illumination test, c) Periodontal probing test, d) Pulp testing, e) Staining, use of disclosing dye (methylene blue) to visualize a suspected crack and f) Direct visualization of the fracture by removal of all restoration and direct visualization, with good illumination (via fiber optics) and magnification (> X 3.5) and Exploratory surgery to view the root and confirm the presence of fracture. The bone resorption pattern in vertical root fracture is more oblong with resorption rapidly progressing apically and laterally to the interproximal areas.(2, 3, 5)

Radiographic findings can vary considerably from case to case and are a) Separation of root fragments, b) fracture lines along the root or root fillings, c) space beside a root filling or a post, d) double images, e) radiopaque signs, f) widening of the periodontal ligament space around the whole length of the root and g) Pattern of bone loss(Radiolucent halos, Isolated horizontal bone loss in posterior teeth, unexplained bifurcation bone loss, step like bone, V- shaped diffuse bone loss on roots of posterior teeth, resorption along the fracture line), h) dislodgement of retrograde filling material & i) Endodontic failure in the form of persistent radiolucency after healing has occurred without symptoms.”.(3)

There are many variables in the evaluation and prognosis of vertical fractures, a) direction and depth of the fracture plane, b) separation or movement in the fracture line, c) evidence of pulpal involvement and the occlusal dimension or length of the fracture.(6)

Treatment of vertically fractured teeth is difficult and dependent on the tooth type as well as on the extent, duration and location of the fracture. The constant ingress of bacteria in to VRF’s provides an open pathway from the oral cavity to the supporting periodontal tissues leading to bone loss. The aim of treatment is therefore to eliminate the fracture or the leakage of bacteria along the fracture plane.(5, 8) In treating posterior teeth for endodontic therapy, a careful look at the dentin floor for the evidence of a subtle fracture before removal of the roof of the chamber will minimize the chances of failure. Once the treatment decided, the occlusal surface should be reduced radically at the time of the pulpectomy. These will, for a short time, limit occlusal forces that would tend to fracture the tooth further before a full crown can be placed. If the fracture does not intersect the pulp space and does not terminate beneath the epithelial attachment (i.e., a common fracture of the lingual cusp of a maxillary premolar) and no esthetic problem results, no treatment is necessarily indicated.(6) Multi-rooted teeth can often be successfully treated by resecting the fractured root either by root amputation or hemisection. Prognosis for posterior teeth is good, provided the fracture can be removed in its entirety. Studies of root resected teeth have reported five year retention rates of 94 percent and ten year retention rates of 68 percent. Extraction is indicated when tooth is not suitable for restoration (for ex: fracture line extending below the alveolar crest).(9, 10)

Usually anterior teeth show poor prognosis and extraction is often the treatment of choice. In some case reports clinicians have either removed the fractured segment or attempted to bond the root using a biocompatible material like cyanoacrylates, silver glass ionomer cements, calcium hydroxide and mineral trioxide aggregate.(11)

If the incomplete vertical root fracture involves only the facial wall, and does not involve the gingival sulcus, the fracture may be eliminated with the preparation of a long amalgam restoration. The advantage of this procedure is that the original root length is maintained. In the field of lasers, an in vitro study proved CO₂ and Nd:YAG laser to be an
ineffective to fuse fractured tooth roots. Various treatment modalities have been suggested to save vertically fractured roots, but all of them have proved to be ineffective in the long run. (12-15) No statistical data are available concerning the success in treatment of fracture cases. (16)

In conclusion vertical root fractures pose a difficult diagnostic challenge. As there is no single pathognomonic sign to verify VRF, exploratory surgery may be an option to confirm the diagnosis. In case of anterior teeth with VRF, extraction is the treatment of choice, where as in a multi-rooted teeth hemisection or root amputation of the involved root can be considered as an alternative treatment. All case reports published so far which describe a treatment rationale; do not include enough teeth to ascertain the efficacy of any procedure. There is room for further clinical research, so that an evidence based practice could be applied to treat teeth with vertical root fractures.

Authors Affiliations: 1. Dr. Sushama R. Galagali, M.D.S, Professor and Head, Department of Periodontics, V.S. Dental College and Hospital, 2. Dr. Santosh Kumar B.B, M.D.S, Senior Lecturer, Department of Periodontics, M.R. Ambedkar Dental College and Hospital, Bangalore, Karnataka, 3. Dr. Navaneetha H, M.D.S, Senior Lecturer, Department of Periodontics, New Horizon Dental College and Research Institute, Bilaspur, Chhattisgarh, 4. Dr. Srikanth Choudary B.S, M.D.S, Reader, Department of Conservative Dentistry, HKDET’s Dental College and Hospital, Humnabad, Bidar, Karnataka, India.

References

Address for Correspondence
Dr. Santosh Kumar B.B, M.D.S, Senior Lecturer, Department of Periodontics, M.R. Ambedkar Dental College, Bangalore, Karnataka, India. Ph: +91-9896806639 Email: drbbsantosh03@gmail.com

Source of Support: Nil, Conflict of Interest: None Declared