

Vertical root fracture

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ABSTRACT

Prompt diagnosis of vertical fracture in teeth could cause difficulties to practitioner but with various specific clinical and radiographic signs that are present during diagnosis could alert clinicians to the existence of such fractures. Hence, this review describes diagnosis of a vertical root fractures with its clinical and radiographic signs and presents treatment strategies for the same.

KEY WORDS: Pain, Pocket, Root amputation, Vertical root fracture

INTRODUCTION

Vertical root fractures (VRF) have been described as longitudinally traversing fractures of the root, involving the root canal and extending to the periodontium. Clinicians can be challenged in providing proper diagnosis and management protocols for VRF situations. The etiological factors for VRF may be, weakening of the tooth structure during endodontic treatment or restoration, placement of endodontic posts and pins, parafunctional habits, heavy masticatory stress, and occlusal overload.^[1] The maxillary and mandibular premolars are most susceptible to VRF. Besides that, studies have showed the mesial roots of mandibular molars also have high chances 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.^[2] As the prognosis of root fracture worsens with time and to avoid rapid bone loss and periodontal destruction, an early accurate diagnosis is essential to determine the most appropriate treatment technique. VRF detection on the conventional periapical radiograph is often challenging even if it is recorded from different angles.^[3]

ETIOLOGY

The predisposing factors for VRF could be anatomical, iatrogenic, or operative factors. Anatomical predisposing factors for VRF are:

- Root anatomy: The roots having a mesiodistal diameter much narrower than the buccolingual dimension tend to be the most common roots to fracture which are the maxillary and mandibular premolars. Besides that, the mesial roots of mandibular molars and the mandibular incisors are also the most susceptible roots of fracture.^[4]
- 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 such as initial root canal therapy, retreatment, and post space preparation could lead to a fracture
- 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.^[5]
- Biochemical properties of dentin: The elastic behavior of the dentinal tubules to functional stress-strain distribution results in greater mineralization in certain areas and lesser in some, thus making those areas vulnerable for fractures.

Iatrogenic factors predisposing to VRF are as follows:

- Excessive canal shaping during endodontic treatment, especially in teeth with curved roots that

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are narrow in the mesiodistal plane like maxillary second premolars, mesiobuccal roots of maxillary molars. The mesial roots of mandibular molars and premolars are the most vulnerable to VRFs.

- Excessive pressure used while doing vertical or lateral compaction of GP can lead to the development of a VRF.
- Excessive restorative procedures during a canal preparation are weakening the walls by making them too thin.
- Choosing an inappropriate tooth as an abutment for fixed partial dentures may contribute to the development of a VRF.^[4]

SIGNS AND SYMPTOMS

The clinical signs and symptoms vary according to the position of the fracture, tooth involved, and duration after fracture, architecture of the bone and the periodontal status of the tooth adjacent to the fracture. Teeth are sustaining VRF often associated with a long history of variable discomfort and are usually accompanied with localized chronic infection. The concurrent pain can vary from mild to moderate in intensity.^[6] Sometimes severe swelling of soft tissue may be present. Moreover, swelling would appear as broad-based and situated at mid-root in positional aspect. Palpation will often reveal swelling and tenderness over the root itself, but less conspicuous swelling in the periapical region.

Moreover, in condition of sinus tract presence, it could be situated in or else close to attached gingiva rather than in the apical region. Double or multiple sinus tracts are common. Furthermore, multiple sinus tracts are present one or more of these tracts may be located some distance from the involved tooth. The insertion of a gutta-percha point into each sinus tract can assist with diagnosis.^[7] A common feature of teeth with VRF is the presence and development of deep, narrow, and isolated periodontal pockets. Pocket formation is usually situated adjacent to the fracture site. Besides that, in cases of a fracture extending right through the root, the probing patterns could be bilateral. The probing pattern for a tooth with a VRF is very different from that seen in teeth with periodontal ailment, where the pocket formation is consistent in depth surrounding a major portion of the tooth. Deep probing in one position around the circumference of the tooth with pain during chewing in the presence of otherwise normal attachment usually indicative of tooth fracture.^[8]

RADIOGRAPHIC SIGNS

The clinical presentation of vertical fracture could have vary radiographic signs at times and might be specific as well. These signs can vary considerably, depending on the angle of the radiographic beam in relation to the plane of fracture, the time interval after fracture and

the amount of separation of the fragments.^[9] Vertical fractures allow the ingress of bacteria and associated irritants that cause localized periodontal destruction and bone loss adjacent to the fracture site. The magnitude of bone loss is dependent on the nature of the fracture and the time the fracture has been present.

Radiographically, there are certain patterns of bone loss that are specifically found to be associated with vertically fractured teeth. The radiographic presentation of the osseous loss is dependent on the area and extent of destruction, plane of the fracture and the bone architecture adjacent to the fracture. Thus, the appearance of osseous destruction noted during the fracture plane in buccolingual position will be different from that seen when the plane of the fracture is mesiodistal direction. Bone destruction associated with anterior teeth will be easier to visualize than that associated with lower molars, where changes are obscured by a thick buccal plate of bone.^[10]

Besides that, various more advanced clinical diagnostic tests would aid in determining VRF:

- Bite test, i.e., biting on rubber wheels, cotton tip applicators, moist cotton rolls, and commercial biting applicators.
- Trans-illumination test.
- Periodontal probing test.
- Pulp testing.
- Staining, use of disclosing dye (methylene blue) to visualize a suspected crack.
- Direct visualization of the fracture by removal of all restoration and direct visualization, with good illumination (*via* fiber optics) and magnification ($> \times 3.5$) and exploratory surgery to view the root and confirm the presence of a fracture. The osseous resorption pattern in VRF is oblong in shape with resorption rapidly extending epically and laterally to the interproximal spaces.^[4]

MANAGEMENT

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 into 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.^[11] The dentin floor for the evidence of a subtle fracture should be carefully examined before removal of the roof of the chamber will minimize the chances of failure while endodontically treating posterior teeth. 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.

In condition where the absence of intersection between the pulp space and fracture and also does not terminate beyond the epithelial attachment as in a common fracture of the lingual cusp of maxillary bicuspid and when no esthetic problem results, no treatment is mandatorily indicated.^[15]

Multi-rooted teeth can often be successfully treated by resecting the fractured root either by root amputation or by hemisection. Besides that, studies show that posterior tooth has good prognosis compared tooth but only if the condition that the fracture can be removed in its entirety. Studies of root-resected teeth have reported 5-year retention rates of 94% and 10 years retention rates of 68%. Extraction is indicated when a tooth is not suitable for restoration (for example, fracture line extending below the alveolar crest).^[12,13]

Usually, anterior teeth show poor prognosis and extraction is often the treatment of choice. Moreover, several case reports had proved that clinicians could neither remove the fractured segment nor attempt to bond the root using a biocompatible material such as cyanoacrylates, silver glass ionomer cement, calcium hydroxide, and mineral trioxide aggregate.^[14]

A number of other reports discussing treatment alternatives are listed in the literature. Takatsu *et al.*^[15] used orthodontic elastics to join the buccal and palatal segments of a vertically fractured maxillary second molar that were then sealed with a photo-cured resin liner to allow the tooth to be endodontically treated and restored with a cast crown. The reduction in pocket depth allowed the tooth to remain in function for more than three and a half years. Sinai and Katz^[16] demonstrated regeneration of bone and healing when the detached root segment, root canal filling, and soft tissue were surgically removed.

Besides that, in long-term aspect follow-up was an unfavorable condition as it had deep pocket and mobility as well. An *in vitro* study^[17] proved CO₂ and Nd: YAG laser to be an ineffective way to fuse fractured tooth roots. Scanning electron microscopy revealed heat-induced fissures and cracks, areas of cementum break down and separation of cementum from underlying dentine. Energy densities required inducing melting were considered excessive and damaging to pulp tissue. Now, there does not seem to be any justification for the use of a laser to fuse fractured portions of tooth together.

CONCLUSION

VRF 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. Anterior teeth with VRF can be treated with endodontics, whereas in posterior multi-rooted teeth, hemisection or root amputation of the involved root can be considered as an alternative mode of treatment. All citations published presently have stated the treatment rationale but do not include sufficient volume and number to ascertain the effectiveness of any procedure. There is scope for further clinical research so that an evidence-based practice could be applied to treat teeth with VRF.

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