

Vertical Root fracture and its Management – A Review

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Abstract- Vertical root fracture is one of the most common procedural error occurs during endodontic treatment. Due to widening the root canal, increased food habits, overshaping of the canal, excessive force applied during lateral condensation, improper instrumentation the vertical root fracture occurs. Patients may experience soft tissue swelling over the root portion, multiple sinus tract near attached gingiva rather than apical portion, deep, narrow pocket development, repeated post and crown dislodgment, bleeding during condensation, etc. So the diagnosis can be made by trans-illumination test, periodontal probing method, pulp vitality, staining and direct visualisation. Radiographically, it can be investigated with both IOPA & CBCT imaging. On IOPA, Haloradiolucencies are seen over the periapical portion of the root surface and fracture may be seen. Where CBCT can be easily/ accurately able to define the fracture and it can be able to detect both buccolingual and mesiodistal aspects. It can be managed by fragments amputation, and restoring with retrograde filling material like MTA. It can also be managed with reattachment of the fractured fragments. This article will explain in detail about the basic knowledge of vertical root fracture and about its management.

Keywords: Vertical root fracture, Root amputation, Soft tissue swelling, Improper Instrumentation, Haloradiolucencies

INTRODUCTION:

Vertical root fractures (VRF) associated with endodontic therapy are among the clinical concerns that are difficult to diagnose and treat. On the other hand, early detection in conjunction with a thorough treatment strategy may help avoid consequences. A vertical root fracture (VRF) is a tooth fracture that starts at the apex and travels along a long axis to the coronal region. The condition could appear before, during, or after endodontic therapy. VRF can be characterized based on the placements and separations of the fragments. Whether a fracture is complete or incomplete will depend on its size. The etiological causes, clinical symptoms, case evaluation, clinical investigations, and therapy may all be explained in this article.(1)

Etiology

Vertical root fracture has a complex etiology.

1. Following placement:

Widening the root canal area excessively in order to accommodate a post causes VRF. Posts with threading and tapering provide a wedging effect close to the apex, which raises stress levels. VRF is caused by rigid zirconia posts. The formation of VRF is additionally predisposed by the corrosion products found in pins and posts.(2)

2. Parafunctional behaviors: The likelihood and danger of developing VRF are increased by behaviors such as chewing ice and eating abrasive foods. (2)

3. Moisture loss: Following endodontic therapy, moisture loss in pulpless teeth results in brittleness and VRF. The wedging action of pulpless teeth is more prone to plastic deformation. (2)

4. Overshaping of the root canal: VRF is frequently observed in cases when the root canal is overly shaped after endodontic treatment. (2)

5. Obturation techniques: VRF is caused by an excessive amount of force during lateral condensation. (2)

6. Spreader use: The spreader's wedging action during lateral condensation raises the likelihood of VRF.(2,3)

7. Instrumentation length: Rotating files might be used to minimize crack formation. The incidence of VRF can be decreased by using rotary files 1 mm short of the apical foramen and stopping all instrumentation at the Cemento-dental junction (CDJ), which corresponds to the minor diameter. (3)

Predisposing factors:

1. Endodontically treated tooth: The adaptation of dentin to functional stress during endodontic treatment results in biomechanical alterations in the root dentin, which mineralizes the buccolingual areas. Due to their higher collagen

content and lower mineralization, mesiodistal zones will not experience fracture propagation; instead, it will occur buccolingually. (4)

2. Reduced amount of healthy tooth structure: Teeth are more vulnerable to VRF when there is a significant loss of tooth structure from conditions like dental caries. (4)

3. Root canal anatomy: Developmental depressions in roots that are more prone to fracture and roots with a limited mesiodistal diameter and curvature are more likely to have VRF. (5)

4. Residual Dentin Thickness: VRF is frequently observed in situations when too much dentin is removed, particularly during post-space preparation. (5)

5. Prior to the cracks: Tiny fissures and virtually undetectable dental transgressions are susceptible to the development of VRF. (6)

Clinical Features:

Clinical signs of VRF are not always clear-cut.

A severe, deep, traumatic pain that is typically characterized by patient as a shooting or throbbing type of sensation frequently occurs during mastication can be a sign which indicates Vertical root fracture. Multiple sinus tracts along the gingival margin are the most common clinical finding. When the obturation material is well condensed, but a persistent peri-radicular lesion persists, indicating that the endodontic treatment was unsuccessful, this may be considered as an example of VRF. Soft tissue edema is seen in the mid-root region. In contrast to the apical portion, patient may feel discomfort when the swelling got palpated clinically. The formation of a deep, narrow pocket without any periodontal attachment loss is a common characteristic of VRF. If there is a whole fracture, there may be bilateral pockets. (6)

Vertical root fractures can present with a variety of symptoms. A few symptoms include:

- a) soft tissue swelling and tenderness over the root
- b) a sinus tract near the attached gingiva rather than in the apical region
- c) the development of deep, narrow, isolated periodontal pockets
- d) bleeding during root filling material condensation
- e) an apparent lack of resistance within the canal during condensation, which appears to allow guttapercha to condense into the canal almost infinitely.
- f) a sharp cracking sound during gutta percha condensation or post cementation
- g) Repeated post or post crown dislodgement leads to periapical vertical root fracture (7)

Clinical Diagnostic methods:

Vertical root fractures are diagnosed with various clinical diagnostic techniques. A few methods for testing fractures include:

- a) biting on rubber wheels, cotton tip applicators, moist cotton rolls, and commercial biting applicators; b) trans-illumination test (6)
- c) periodontal probing test
- d) pulp testing
- e) staining; using a disclosing dye (methylene blue) to visualize a suspected crack (8)
- f) direct visualization of the fracture by removing all restoration and using good illumination (via fiber optics) and magnification (>X 3.5) and exploratory surgery to view the root and confirm the presence of fracture. In vertical root fracture, the pattern of bone resorption is more oblong, with resorption quickly moving laterally and apically to the interproximal regions.(4)

Radiographic Investigations

On periapical radiographs (PRs), the radiographic appearance of VRFs can vary greatly and may show no evident pathology, mild periradicular bone loss, vertical crestal bone abnormalities, or frank separation of the root fragments. The "classic" J-shaped radiographic lesion of a long-standing VRF and/or a "halo" radiolucency, which frequently involves the furcation region, are examples of vertical bone defects. In certain cases, mesially and/or distally visible crestal bone loss may occur when the fracture starts at the CEJ and proceeds in an axial plane. Moreover, radiolucencies on the lateral root surface of cast-restored root-filled teeth, usually at the post's base, can be observed; these are signs of a VRF.(10)

Numerous studies have been conducted in the literature that show CBCT is more accurate than PRs in detecting VRFs in teeth with root fillings. When compared to PRs, CBCT offered significantly greater diagnostic accuracy for the diagnosis of VRFs, according to a meta-analysis of data evaluating the radiography detection of root fractures (Salineiro et al., 2017). The findings of this study should be interpreted cautiously, though, as there was a great deal of variation in the study designs among the included ex vivo studies. Notably, several of these studies had widely displaced fractured segments (0.2–0.4 mm), which would be readily identifiable clinically and eliminate the need for CBCT imaging to

confirm the diagnosis. Currently, there isn't enough evidence to support using a CBCT to find VRFs inside a tooth's root. But according to Chavda et al. (2014), Dias et al. (2020), G et al. (2021), Zhang et al. (2019), and other studies, there is strong evidence that CBCT can identify the subtle radiographic symptoms of periradicular bone loss indicative of a VRF. In a recent clinical investigation, the precision of CBCT in identifying root-related fibroids (VRFs) was evaluated in relation to its accuracy in identifying secondary alterations in the periradicular bone that may indicate a root fracture. The scientists came to the conclusion that while CBCT was far more sensitive and accurate in identifying periradicular bone loss patterns suggestive of a VRF, it was not able to precisely assess VRFs within a tooth's root. (11)

Management

According to a study by Remya et al. (2015), it is imperative to decide whether to extract the tooth or root as soon as VRF is diagnosed. Taking prompt action could be crucial as it could aid in preventing more infections. Replantation using VRF that has been rebuilt using resin bonding could be a useful treatment for the problem [9]. To effectively manage the condition, this management strategy necessitates follow-up. Remya et al. (2015) state that atraumatic fragment extraction, disinfection, and the methodical administration of tetracycline are necessary for the successful prognosis replantation therapy. The degree of adherence to sanitary precautions will also affect the procedure's recovery. (12)

Treatment for VRF should begin as soon as possible after a diagnosis since supporting tissue inflammation can cause the periodontal structures to break down, which can then result in the formation of a profound osseous defect and bone resorption.

1. Amputation and extraction of roots :A portion of the root in a multi-rooted tooth with VRF will keep the tooth intact. The preferred course of treatment for a single rooted tooth with VRF is extraction because the prognosis is poor. A surgical method supported by Farrar et al. called for excising the root and replacing the empty space with retro-filling material, such as mineral trioxide aggregate. Root stripping is the procedure that Matusow et al. recommended. (13)

2. Re-plantation: Lately, a vertically broken root is removed, extra-oral endodontic therapy is finished, the fractured portions are filled up using resin bonding, and the root is replanted into the socket. An 18-month follow-up research by Hayashi et al. was published in 2004 to ascertain the prognosis of resin bonding and replanted teeth. The following are the elements that affected the prognosis:

- It is necessary to remove the broken pieces in an atraumatic manner.
- According to Pohl et al., extra oral time shouldn't last longer than fifteen minutes.
- An intra-canal dressing containing calcium hydroxide for disinfection.
- It is necessary to administer tetracycline systemically. This disinfects, lowers collagenase activity, and decreases osteoclast mobility. (13)

Materials used for reattachment of fractured fragments:

- i. Glass ionomer cement
- ii. Cyanoacrylate
- iii. 4- methacryloxy ethyl trimellitate anhydride (META)
- iv. Dual cure resin cements
- v. Mineral trioxide aggregate (14)

Conclusion:

This review comes out with the following demands in case of vertical root fracture:

1. Vertical root fracture is one of the most common procedural error occurs during endodontic treatment. Due to widening the root canal , increased food habits ,over shaping of the canal, excessive force applied during lateral condensation, improper instrumentation the vertical root fracture occurs.
2. Clinically, Patient may experience Soft tissue swelling, multiple sinus opening tracts, pain over the tooth region and associated with narrow periodontal pockets etc.
3. It can be investigated with bite test, trans-illumination, probing, pulp testing, staining and radiographic Investigations.
4. Radiographically, CBCT will be the best diagnostic tool for identifying the vertical root fracture while comparing with periapical radiograph.
5. Management can be done with Amputation of the root fragment, Endodontic Management, Retrograde filling

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