

Vertical root fracture

Factors related to identification

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A vertical root fracture (VRF) is a common and often devastating event. When identified, the treatment plan is straightforward: extraction of a single-rooted tooth, or at least root amputation or hemisection of a molar. As a result of a VRF, processes begin near the root. In a histologic study, Walton and colleagues¹ showed that the fracture spaces contained a combination of irritants: bacteria, necrotic debris, sealer, and degraded inflammatory cells. Root surfaces consistently demonstrated an inflammatory lesion adjacent to the fracture.

By definition, according to the American Association of Endodontists' *Glossary of Endodontic Terms*, the VRF is an incomplete fracture in the root that may occur buccolingually or mesiodistally; it may cause periodontal defect(s) or sinus tracts, and may be radiographically evident.² It is also described as being confined to the root and complete or incomplete.³ The VRF is invariably associated with endodontic therapy and often with apical surgery.⁴ Frequently a post is present,^{5,6} which can generate significant wedging forces.⁷ The lateral wedging forces of gutta-percha compaction during obturation^{8,9} and post placement¹⁰ are the initiators of stresses and strains that could result in fracture. The VRF is more prevalent in roots with a cross-section that is narrower mesiodistally, that is, in deep oval, flattened, or hour-glass-shaped roots.¹¹

Obviously, accurate identification of a VRF is critical¹²; treatment is tooth extraction or root

ABSTRACT

Background. Vertical root fracture (VRF) requires root removal. Diagnostics for proper identification are critical. The author conducted a study to relate subjective, objective, and radiographic findings for VRF identification. They noted visual changes of root and overlying bone patterns after flap reflection.

Methods. The author examined a case series of roots with suspected VRF after flap reflection and root or root-end removal; 42 roots were identified with a fracture. Before reflection, the author obtained diagnostic and periapical radiographic data that included symptoms, soft-tissue changes, percussion, mobility, probing patterns, and radiographic findings. After flap reflection, the author evaluated bony changes and root surfaces. VRF was visually confirmed after tooth or root removal.

Results. Signs and symptoms diagnostic of VRF were inconsistent. All patients had endodontic therapy, many with posts, and for all patients, the pain was none to mild. In addition, the author found a history or presence of swelling (77%) or sinus tract (31%), that probing patterns differed (narrow-rectangular 66%), and that there was no defect in some patients (21%). Radiographic patterns varied from no change to extensive bone loss, and mobility ranged from none (55%) to slight or moderate (45%). Flap reflection revealed a "punched-out" bony lesion with granulomatous tissue (100%), and patterns were fenestration (21%) or dehiscence (79%). A fracture was visible on roots or resected root ends.

Conclusions. The author found no consistent signs, symptoms, or radiographic changes of VRF. Flap reflection was found to be predictably useful; fractured roots had bony defects filled with granulomatous tissue.

Practical Implications. VRF may be suspected from clinical findings; however, flap reflection is usually required for identification. Characteristic bony pattern and root visualization reveals the fracture, although root-end resection and examination is occasionally required.

Key Words. Diagnosis; tooth; fracture; endodontics.

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removal. Clinical findings suggest 1 of 3 entities: VRF, periodontal lesion, or failed endodontic therapy. How to diagnose, differentiate, and treatment plan depends on identification.¹³ Lacking is sound evidence-based research on how to predictably identify these fractures. A systematic review¹⁴ concluded that there was not substantive evidence in the literature that tested the accuracy of clinical and radiographic findings as to diagnosis and identification. The available information is incomplete and at lower levels of evidence (that is, case reports and case series).^{3,4,15-17}

With a suspected VRF, these diagnostic approaches have been proposed¹⁸:

- signs and symptoms: possibly, VRF fractures result in pain with occlusal or lateral forces;
- periodontal probing patterns: it has been suggested¹⁹ that the longitudinal fracture commonly results in narrow, deep probing defects on the facial or lingual aspect;
- radiographic findings: the VRF is longitudinal and, therefore, tends to generate certain patterns of resorption (Commonly, the resorptive bony defect shows an apical-to-lateral pattern, the so-called “J-shaped” lesion; the resorption extends around the apex and extends along the lateral surface of the root. Other resorptive patterns have been reported,^{20,21} but it is unknown if these patterns are consistent and thus aid diagnosis);
- treatment history: this includes whether a tooth has had endodontic treatment and the subsequent restoration (post or no post)²²;
- surgical exploration: flap reflection to expose the area of inflammation and visualization of the fracture line on the root surface.^{23,24}

To date, there have been no complete or comprehensive studies or reports on these diagnostic modalities used for VRF. Unknown is whether any combination of these findings will consistently and predictably identify the presence of a VRF. Important questions include: Are there any definitive indicators from noninvasive diagnostic findings that will predictably identify the VRF?, and How may the clinician confidently decide to remove the tooth or root? The aim of this study was to determine the relative incidences and frequency of diagnostic findings in teeth in which a VRF was identified (visualized after extraction or root-end resection).

METHODS

The study was approved by the institutional review board of the Medical College of Georgia School of Dentistry, Augusta, GA. I assured the board and the patients that no unnecessary procedure would be performed when gathering the data. All patients gave consent to participate, and I guaranteed that their identities would be confidential. They further gave consent that the teeth could be used in a companion histologic evaluation.¹

The process of selection was as follows. I subjected all patients in whom a VRF was suspected because of a

combination of clinical findings^{15,18} to further comprehensive diagnostic evaluation using these criteria:

- signs and symptoms, including presence, levels, and initiators (percussion and palpation) of pain;
- periodontal probing to determine depths, patterns, and shape of probing defects;
- mobility, whether none, slight, or moderate;
- soft-tissue changes, such as swelling or sinus tract;
- periapical radiographic findings including presence and patterns of radiolucencies;
- history of treatment to the tooth.

In each patient (except when there was a clear separation of fractured root segments radiographically), I reflected a flap to expose the overlying bone and root surface. I identified bony defects, if present, and attempted to see the presence of a fracture line on the root surface (the criterion standard of diagnosis). I removed overlying inflammatory tissue from the defect and root surfaces, without magnification. If I saw a fracture, the diagnosis was definitive. If I did not see a definitive fracture, I applied dyes or resected a root end and examined the surfaces under a dissecting microscope for a fracture.

I included 42 multi- and single-rooted teeth, all from different patients, in my sample. In these teeth, I analyzed the diagnostic data relative to incidence. I further determined whether any 1 or any combination of noninvasive findings or tests could definitively identify a VRF, before flap reflection. I extracted those roots in which VRF was identified visually. I further verified the fracture by examining the root under a dissecting microscope. I recorded the data and reported it descriptively as percentages of each pattern of findings and test results.

RESULTS

All VRFs had received endodontic therapy; many also contained a post. Overall, the only definitive mode of identifying a VRF required flap reflection and visualization of bone and root. All fractured roots had an overlying, facial, “punched-out” bony lesion, filled with granulomatous, inflammatory tissue (Figures 1-3). I was not as readily able to see all the fracture lines on root surfaces; the balance of fracture lines were seen after root-end resection.

My findings from other tests were either negative or variable and inconsistent:

- pain: none to mild (100%);
- swelling: none (23%), present or history (77%);
- sinus tract: none (69%), present or history (31%);
- probing patterns: no defects (21%), narrow-rectangular (66%), other (13%);

ABBREVIATION KEY. CBCT: Cone-beam computed tomography. VRF: Vertical root fracture.

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