

1.7

Vertical Root Fracture

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Objective

At the end of this case, the reader should be familiar with the diagnosis of vertical root fracture (VRF). The reader should also know the aetiology and treatment options available for VRF.

Introduction

A 62-year-old man presented to his general dental practitioner with intermittent dull ache associated with his previously root-treated lower right first molar (LR6). He was then referred to an endodontic specialist for further management of the LR6.

Chief Complaint

The patient complained of occasional episodes of dull pain on the LR6 for the last few weeks. The patient had the LR6 root canal treated and restored with a metal ceramic crown over 15 years ago by an endodontist and had been asymptomatic until now.

The patient was managing his symptoms with over-the-counter analgesics. However, the patient still experienced mild discomfort on biting on the tooth.

Medical History

Unremarkable.

Dental History

The patient was a regular dental attender for routine check-ups with his general dentist and twice-a-year maintenance appointments with his dental hygienist.

Clinical and Radiographic Examination

Extraoral examination was unremarkable. Intraoral examination revealed a moderately restored and well-maintained dentition with good levels of oral hygiene.

The LR6 was restored with a well-adapted metal ceramic crown. The LR6 was tender to percussion but not tender on palpation. The periodontal probing depths and mobility of the LR6 were within normal range. No swelling or sinus tract was associated with the LR6. There were no signs of endodontic or periodontal disease associated with the adjacent teeth or opposing teeth. Occlusal assessment revealed there was group function in lateral excursions.

A periapical radiograph (PR; Figure 1.7.1) was taken to investigate the LR6. What did the radiograph reveal about the LR6?

- Normal horizontal bone levels.
- Crown with well-adapted margins.
- Existing root canal filling had several voids at the canal entrance level.
- The mesial root fillings were approximately 2–3 mm short from the radiographic apex while the distal root fillings appeared to be well condensed and to length.
- A periapical radiolucency was associated with the mesial and distal roots of the LR6.

A small field-of-view cone beam computed tomography (CBCT) scan was taken to explore other causes, such as untreated root canal(s). The sagittal CBCT (Figure 1.7.2a) revealed similar findings to the PR with a well-defined periapical radiolucency on the LR6. However, in the coronal and axial slices (Figure 1.7.2b–d), periradicular radiolucencies were detected on the buccal aspect of the mesial root and lingual aspect of the distal root. These periradicular radiolucencies were separate to and not continuous with the periapical radiolucency.

What are the limitations of periapical radiographs?

PRs compress three-dimensional structures into two-dimensional images. While the radiographic changes on mesial and distal surfaces can be appreciated on PRs, the radiographic changes on the buccal or lingual surfaces will be either missed or underestimated, especially in the multi-rooted teeth where the buccal and lingual/palatal roots overlap. ‘Anatomical noise’ such as the thick cortical plate in the posterior mandibular region may obscure the area of interest, resulting in difficulty in detecting subtle radiographic changes such as periradicular bone loss in the LR6 in this case. Parallax PRs may provide useful information about the overlapping root canals and localisation of radiographic lesions, but the information is often insufficient for accurate diagnosis and treatment planning.

Can CBCT help in diagnosing vertical root fracture?

CBCT has insufficient sensitivity and accuracy to detect a VRF *within* the root. One of the reasons is that these three-dimensional images do not have sufficient resolution. CBCT images may be impaired by beam hardening due to the presence of radiopaque intracanal materials (i.e. gutta percha, metallic posts, etc.) and/or motion/misalignments. These imaging artefacts will affect the quality of the CBCT images and may result in misdiagnosis. However, there is good evidence that CBCT is more reliable and sensitive than PRs in detecting subtle *periradicular bone loss*, which is often associated to a VRF. With CBCT, the tooth of interest can be assessed in three dimensions without any anatomical noise and distortion.

The European Society of Endodontology CBCT position statement (ESE 2019) and the Joint American Association of Endodontists and American Academy of Oral & Maxillofacial Radiology guidelines (AAE/AAOMR 2015) recommend the use of CBCT when clinical and/or PR findings are inconclusive in cases of suspected VRF. Based on the clinical and conventional PR findings only, the LR6 would have been diagnosed as previously treated symptomatic apical periodontitis, which may have resulted in a decision to attempt root canal retreatment. The isolated periradicular bone loss associated with the LR6 was clearly visualised with CBCT. The CBCT findings confirmed the diagnosis of VRF, thereby impacting clinical decision making.

Diagnosis and Treatment Planning

What is the diagnosis?

The diagnosis for the LR6 was previously treated symptomatic apical periodontitis associated with a VRF.

*What are the common clinical and radiographical findings of vertical root fracture?**What are the aetiologies of vertical root fracture?*

The exact aetiology of VRF is not well understood, but several risk factors have been suggested (Tables 1.7.1–1.7.3).

What are the treatment options for vertical root fracture?

The treatment objectives for VRF are to prevent the ingress of microorganisms into the tooth through the fracture line and prevent further destruction to the adjacent supporting periodontal tissue. In the majority of cases, extraction of the affected tooth is the only treatment choice for VRF. Treatment should

Table 1.7.1 Clinical features of vertical root fracture (VRF).

- Symptoms and/or signs of apical periodontitis (e.g. tenderness to percussion and/or palpation, swelling, etc.)
- Pain on biting
- Presence of fracture line clinically
- Deep, narrow, isolated periodontal probing depth (may be present on both sides of a root)
- Presence of sinus tract(s) (multiple sinus tracts are pathognomonic features of VRF)
- Increased tooth mobility

Table 1.7.2 Radiographic features of vertical root fracture.

Highly variable, may present with one or more of the following:

- Subtle periradicular and/or crestal bone loss
- Thickening of periodontal ligament along the lateral aspect of the root
- Classic J-shaped radiolucency and/or halo radiolucency often involving furcation region
- Frank separation of root fragments

Table 1.7.3 Risk factors for vertical root fracture in root-filled teeth.

- Minimal remaining tooth structure
- Presence of preexisting (micro)cracks and fractures
- Change in biochemical properties (viscoelasticity, dehydration, etc.) of dentine of root-treated teeth
- Parafunctional habits
- Loss of canine guidance
- Posterior location of teeth, particularly the last standing molar due to occlusal loading
- Diets inclusive of hard food such as betel nut and bones
- Root canal anatomy and morphology such as hourglass-shaped root canal cross-sections or increased root canal curvature
- Excessive removal of pericervical dentine during root canal instrumentation and/or post space preparation
- Excessive force during obturation of root canal treatment (RCT)
- Prolonged usage of intracanal irrigants and/or medicaments
- Absence of cuspal coverage restoration after RCT

be done as soon as VRF is diagnosed to prevent further periradicular bone loss that may impair future prosthodontic treatment, especially if implant placement is planned as well as to minimise acute symptoms.

In multi-root treated teeth where the root fracture is confined to a single root only, root amputation of the affected root or hemi-section may be considered

as an alternative option to preserve the tooth. Root canal treatment should be completed prior to the root resection, with the root canal filling removed below the level of root resection and sealed with composite resin or glass-ionomer cement. Root amputation and hemi-section have been reported as treatment options with long-term survival in several studies and systematic reviews, but the results of these studies should be interpreted with caution, as root resections in these studies were mostly done on teeth with perio-endo lesions rather than VRF. Therefore, the teeth included in these studies may not be as structurally compromised as teeth requiring root resection due to VRF.

Other treatment options such as surgical repair of the fractured root with restorative/bioactive materials are not recommended due to the lack of evidence in the literature.

Treatment

Due to the poor prognosis of this tooth, a decision was made to extract the LR6.

Discussion

Although VRFs may occur in teeth with vital pulps, the majority of VRFs are associated with root-filled teeth. VRFs may begin apically or coronally and are more commonly detected in the bucco-lingual plane than in the mesio-distal plane. VRF is classified into incomplete and complete VRF: incomplete if it involves only one side of the root and complete if it extends from one side to the opposite side of the root.

It is often challenging to detect and diagnose VRFs as they may develop slowly without any signs and symptoms at an early stage. In general, teeth with VRFs have poor prognoses. Therefore, it is crucial to prevent or reduce the likelihood of VRF, especially in root-filled teeth with compromised tooth structure.

How can vertical root fractures be reduced or prevented?

- Patient education on parafunction habits and management.
- Reestablishment of canine guidance.
- Occlusal splint.
- Botox to the muscles of mastication.
- Conservative (but pragmatic) access to cavity and root canal instrumentation during endodontic treatment.
- Preservation of pericervical dentine.
- Posts (when indicated) should be passively cemented.
- Timely restoration with a cuspal coverage restoration.

- The use of gold or monolithic all-ceramic materials for cuspal coverage restoration is recommended, as they require only minimal preparation of the residual tooth structure.

The presence of proximal contacts may help to mitigate excessive occlusal loading on root-filled teeth and prevent VRFs. Therefore, in the patient with multiple missing posterior teeth, replacement of the missing teeth should be considered to increase the number of occlusal contacts and distribute the occlusal forces more evenly.



Figure 1.7.1 Periapical radiograph of the LR6.

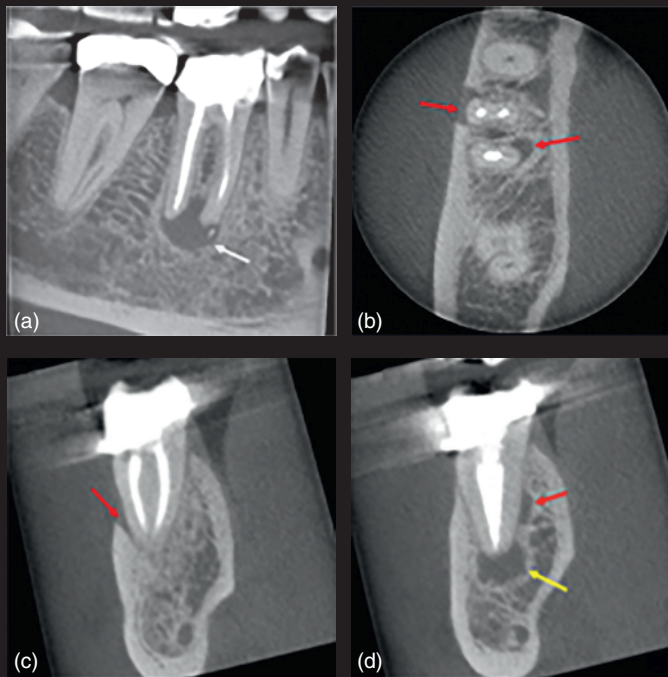


Figure 1.7.2 Small field-of-view cone beam computed tomography of tooth LR6. (a) Sagittal image revealed periapical radiolucency (yellow arrow) similar to a periapical radiograph. (b–d) Axial and coronal images revealed separate periradicular radiolucencies (red arrows) at the buccal aspect of the mesial root and lingual aspect of the distal root, which were not continuous with the periapical radiolucency (yellow arrow).

Further Reading

- AAE, AAOMR (2015). Special committee to revise the joint AAE and AAOMR position statement on use of CBCT in endodontics. AAE and AAOMR joint position statement: use of cone beam computed tomography in endodontics 2015 update. *Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology* 120: 508–512.
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- Patel, S., Bhuva, B., and Bose, R. (2022). Present status and future directions: vertical root fractures in root filled teeth. *International Endodontic Journal* 55 (Suppl. 3): 804–826.
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