

# Periodontal Signs and Symptoms Associated with Vertical Root Fracture

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**Abstract:** This report describes the clinical presentation of three cases of vertical root fractures in adult patients where an initial diagnosis of localized periodontitis had been considered. Loss of the affected tooth occurred in all of these patients. The effects of endodontic therapy and the provision of post-retained restorations are considered in relation to their potential effect of weakening the root and predisposing the tooth to vertical fracture. The last case presents an unrestored molar tooth with a complete vertical root fracture.

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**Clinical Relevance:** The aim of this report is to illustrate the difficulty in diagnosis and visualization of vertical fractures, the significance of localized periodontal lesions in endodontically treated, post-retained, previously traumatized teeth and the relationship between vertical root fracture and acute dental pain in patients with evidence of toothwear

Periodontal lesions affecting a single tooth in an otherwise periodontally sound mouth should alert the clinician to the possibility of local causal factors. In this article we shall present three cases of root fracture that have initially been considered as localized periodontal lesions.

Although root fractures in the permanent dentition are relatively uncommon, when these injuries occur they are often the result of external physical trauma, especially when they affect the maxillary incisor region in young adults.

## DIAGNOSIS

The diagnosis of root fracture is difficult because several of the associated signs

and symptoms are shared with other dental problems. The history may be useful, particularly where pain is related to masticatory function, although pulpal pain may not be a feature (e.g. where pulpal necrosis has occurred or in endodontically treated teeth). Unless fragment separation has already occurred, radiographs are often of little use in localizing the lesion, although some investigators have described a halo or ballooning appearance at the fracture site in affected teeth.<sup>1</sup>

Specific clinical methods for diagnosis include the use of the 'bite test' where a resilient material is placed between the teeth during gentle closure into occlusion.<sup>2</sup> Some authors have also recommended the use of dyes to visualize cracks<sup>1</sup> and, with the ready availability of curing lights in modern dentistry, transillumination of the teeth may also be a convenient clinical investigation.

## TYPES OF FRACTURE

Luebke<sup>1</sup> described two types of root fracture based on the separation of the

fragments:

- where total separation is visible or fragments can be moved independently this is defined as a *complete fracture*;
- an *incomplete fracture* is said to occur in the absence of visible separation.

In addition, Luebke has defined root fractures relative to the position of the alveolar crest. He suggests that *intraosseous fractures* (i.e. those terminating below the level of the alveolar bone) will result in periodontal problems whereas *supraosseous fractures* do not.

Root fracture lines may be horizontal or vertical. Horizontal root fractures are most commonly the result of direct physical trauma to the dentition. The true vertical root fracture is longitudinal and confined to the root, initiating on the internal canal wall and extending out towards the root surface. Root fractures may originate at the apical or mid-root region and may occur in a buccolingual or mesiodistal plane.

## CAUSES OF FRACTURE

It is unusual for teeth to fracture in the absence of external trauma and these lesions are generally associated with restorations. Vertical root fractures more commonly occur in endodontically treated teeth.<sup>3</sup> Suggested causes include:

- condensation forces during root canal obturation;<sup>4,5</sup>
- corrosion of posts;
- wedging effects during post cementation.<sup>6,7</sup>

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**Figure 1.** Intra-oral periapical radiograph of the maxillary lateral incisor and canine teeth for Case 1.

However, vertical root fractures in normal non-carious and non-endodontically treated teeth have also been reported.<sup>8,9</sup>

## CASE 1

### History and Clinical Presentation

A 32-year-old woman was referred for periodontal assessment following recurrent 'periodontal abscesses' associated with her right maxillary lateral incisor and canine teeth. She had been provided with replacement crowns for these teeth 6 months previously and had become aware of some sensitivity on biting. The patient was medically fit and a non-smoker.

Clinical examination revealed a well maintained dentition. Both the right maxillary lateral and adjacent canine were restored with porcelain-bonded post-retained crowns. A conventional fixed bridge retained on the canine and



**Figure 2.** Surgical flap for access to 'periodontal lesions' affecting the maxillary lateral incisor and adjacent canine teeth, which are both restored with post-retained crowns.

second premolar had replaced the maxillary left lateral and first premolar teeth. There was a fluctuant swelling on the right side of the palate in the region of the lateral incisor region, which was very tender to touch.

Periodontal health was generally good, although there were localized pockets of 6–8 mm in the labial and interproximal regions of her right maxillary lateral and canine teeth. The lateral incisor had a subgingival crown margin and suppuration was noted from the gingival tissues.

### Radiographic Findings

On radiographic examination it was noted that the root fillings in both the canine and lateral incisor teeth were overextended. In addition there was some widening of the periodontal ligament space of the canine and some crestal bone loss interproximally. The post and cores were large relative to the size of the roots (Figure 1).

### Management

The provisional diagnosis was of a periodontal-endodontic lesion and arrangements were made to carry out exploratory surgery.

Bony defects were observed on the labial aspect of the lateral incisor and distal aspect of the canine (Figure 2). At the time of surgery, despite careful inspection of the root surface, there was no evidence of any root defect such as a perforation or crack. Periodontal instrumentation including scaling root planing and curettage was carried out and an expanded PTFE (GoreTex) periodontal membrane ligated around the lateral and canine teeth (Figure 3). The flap was closed with silk sutures and tetracycline was prescribed for one-week postoperatively.

Postoperative healing was uneventful and at review 1 and 3 weeks later the area appeared to be healthy, although there was some membrane exposure. The membrane was surgically removed 6 weeks later and evidence of 'new tissue' was observed in the area



**Figure 3.** Expanded PTFE (GoreTex) barrier membrane ligated around defects affecting the lateral and canine teeth.

previously exhibiting bone loss (Figure 4).

The patient attended a further 2 weeks later complaining of a recurrence of the pain and swelling. Initial treatment consisted of drainage of the palatal swelling and adjunctive systemic ampicillin therapy for a 5-day period. On review a week later the acute symptoms had resolved and it was noted that the palatal swelling, although reduced in size, was still present. Arrangements were made for further investigative flap surgery and after careful inspection of the area an apicectomy including placement of a retrograde amalgam seal was performed on the canine. The root surface was re-examined for signs of perforation or cracks but nothing of note could be seen.

The initial response to this treatment based on clinical and radiographic findings seemed to be favourable (Figure 5). However, 3 months later the patient re-attended with a further recurrence of her symptoms, and the crowns in both the lateral and canine



**Figure 4.** Re-entry procedure to remove periodontal membrane with evidence of new tissue regenerated over intrabony defect.



**Figure 5.** Intra-oral periapical radiograph after surgery.

were mobile. At this stage she was advised that the prognosis for these teeth was hopeless and arrangements were made for their removal and subsequent prosthetic replacement. Examination of the extracted canine revealed the presence of a vertical fracture, which extended from the cervical margin of the crown to the apex (Figure 6). Further examination of the extracted tooth revealed a complete fracture, and the fragments could easily be separated (Figure 7).

## CASE 2

### History and Clinical Presentation

A 38-year-old man was referred for



**Figure 6.** Extracted canine tooth with obvious vertical fracture extending to the apex. Note the use of amalgam for the retrograde seal; although its use was common clinical practice at the time of surgery in 1992, amalgam would not be the material of choice under current guidelines.

treatment of recurrent periodontal infections associated with his right maxillary central incisor. This tooth had been restored with a post-retained restoration, constituting one of two adjacent abutments for a fixed bridge with which he had been provided following a traumatic injury sustained while playing rugby several years earlier. The patient had experienced two episodes of swelling and was aware of a bad taste, which he related to a discharge from the gums around his bridge.

His periodontal condition was generally healthy, although probing examination revealed a 10-mm pocket associated with the buccal aspect of his right maxillary central incisor. The labial gingival tissues in the region of this tooth were swollen and there was suppuration both from the gingival margin and from a sinus on the buccal gingiva.

### Radiographic Findings

There was evidence of alveolar bone loss localized to the maxillary central incisors, both of which had been restored with post-retained crowns. These supported a pontic to replace the right maxillary lateral incisor. Bone levels elsewhere were adequate, although some subgingival calculus was apparent in the molar interspaces (Figure 8).

### Management

In the first instance a course of non-surgical periodontal therapy was carried out with the emphasis on scaling and root planing of the deeper sites. Initial response to this was good and arrangements were made for review 6 weeks later.

At this stage the patient reported some improvement in symptoms, and clinical examination revealed that the swelling and redness had subsided. There remained a sinus, which was not discharging, and a deep pocket localized to the buccal aspect of the right maxillary central incisor. On closer clinical examination a small vertical crack was detected distally on the labial aspect of this tooth (Figure 9). As this was deemed to be



**Figure 7.** Fragments are easily separated, revealing the unfavourable design of the retaining post.

untreatable arrangements were made for the tooth to be extracted and provision made for a replacement bridge.

## CASE 3

### History and Clinical Presentation

A 50-year-old Asian man was referred for periodontal assessment. He had experienced pain and swelling related to his right mandibular second molar and had been prescribed a course of antibiotics and analgesics, which had initially relieved his symptoms. He was a non-smoker and had no significant medical problems. A recent increase in the severity and intensity of his symptoms prompted his general dental practitioner to make an emergency referral to the periodontal clinic. The



**Figure 8.** Intra-oral periapical radiograph of the bridge abutments in Case 2.



**Figure 9.** Clinical appearance of bridge. Note the fracture line on the labial surface of the right maxillary central incisor, visible following recession, which occurred as a result of non-surgical periodontal treatment.

symptoms in this case had developed over a period of 4 weeks. Although the general dental practitioner had prescribed antibiotics and analgesics the patient's pain worsened rapidly. The most significant complaint was pain associated with chewing.

On clinical examination there was a tender swelling on the buccal aspect of the right mandibular molar region. A discharging sinus was present on the buccal gingiva and the tooth was exquisitely tender to touch. The affected tooth was unrestored and the dentition exhibited some signs of toothwear.

### Radiographic Findings

Generalized mild horizontal bone loss was visible on the panoramic radiograph and severe vertical bone loss from the right mandibular second molar noted (Figure 10).

### Management

Further examination was undertaken under local anaesthesia and periodontal probing revealed 9–10-mm pockets associated with the mesial and distal aspects of this tooth. A vertical crack was observed running from the mesial to distal aspect of the tooth (Figure 11) and inserting a periodontal probe into this readily displaced the fragments.

It was concluded that the mandibular second molar had a complete crown and root fracture and after discussion with the patient it was extracted (Figure 12).

### DISCUSSION

The diagnosis of a vertical root fracture can frequently present difficulties for periodontists, endodontists and general dental practitioners. Clinicians faced with the diagnostic dilemma should ensure that they have taken a thorough history, with the emphasis on traumatic injuries to the maxilla in the case of upper anterior teeth. Dietary details may be more significant in the case of lower molars. A thorough clinical examination is also essential.

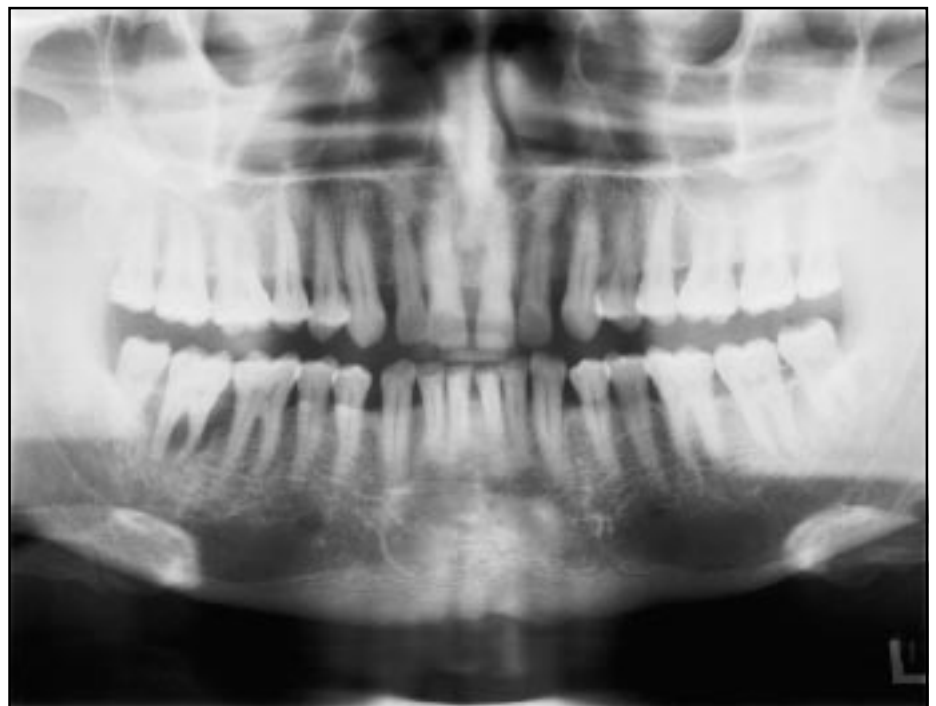
Vertical fractures can vary in their extent and are most often associated with endodontically treated and post-restored teeth. There may be some merit in the use of dyes, transillumination or bite tests when cuspal fractures occur. However, the reality is that when the crack or fracture line extends onto the root structure the prognosis is poor and treatment options are often limited to extraction. In some instances, the diagnosis can only be confirmed by inspection of the root surface after surgical exposure or when the tooth has been removed.<sup>7</sup>

In Case 1 we describe a vertical fracture presenting as a periodontal

problem which initially responded to complex periodontal therapy only to relapse a few weeks later. Diagnosis was not confirmed until after the tooth was extracted and the fracture was not detected in spite of two episodes of flap surgery. Given the complexity of the treatment carried out on this tooth, it is difficult to pinpoint the exact cause of fracture. It is likely, however, that the post design and preparation contributed to the root fracture. A wedging effect, created by occlusal loading, may have resulted in separation of the fragments.

Patients commonly describe swelling and symptoms of pain localized to the area of the fractured tooth. A discharge may often accompany this. In the case of an incomplete fracture, there may be some temporary improvement in the symptoms, as occurred in the first two cases presented in this report.

However, when a complete fracture occurs the pain is usually persistent. Periodontal examination may reveal the presence of a deep pocket localized to the affected tooth. In the absence of an obvious fracture line, radiographic investigation may be inconclusive, although some clinicians have



**Figure 10.** Panoramic radiograph for Case 3. Note bone loss localized to the right mandibular second molar.





**Figure 11.** Clinical appearance of the right mandibular second molar. A vertical fracture line is visible extending mesiodistally along the length of the tooth. Note also the extensive buccal swelling and accompanying sinuses.

described the presence of a radiolucent periradicular band in the fracture site. Testori *et al.* reported that this widening of the periodontal space (as can be seen in the initial intra-oral periapical radiograph of Case 1) is associated with a confirmed diagnosis of vertical root fracture in 75% of cases.<sup>10</sup> Certainly with the benefit of hindsight, this association would appear to be justified by the outcome of Case 1. We would advise clinicians to consider the very strong probability of a vertical root fracture when presented with a radiographic appearance indicating widening of the periodontal space all around the root (see Figure 1).

Other features to note include endodontic status and the presence of any post-retained restorations. The relationship between endodontic therapy and vertical root fracture has been well documented.<sup>1,2,7,10</sup>

Testori *et al.*<sup>10</sup> surveyed 36 clinical



**Figure 12.** The extracted molar tooth with an obvious complete vertical fracture and extensive inflammatory tissue.

cases of vertical root fracture that had occurred in endodontically treated teeth. In addition, they reviewed 32 well documented cases reported in the dental literature between 1973 and 1988 and estimated that the average period between the completion of endodontic treatment and the subsequent diagnosis of vertical fracture was about 10 years. This would suggest that, in most cases, actual root fracture may not occur as a direct result of endodontic manipulation but is more likely to be a secondary event. Luebke's classification<sup>1</sup> of incomplete root fracture may progress to a complete fracture over this time period.

Testori *et al.*<sup>10</sup> also reported that vertical root fractures in posterior teeth most frequently occur in patients between 45 and 60 years of age. Yang<sup>8</sup> described 12 molars in 11 Chinese patients that developed vertical fractures. Yeh<sup>9</sup> suggested that spontaneous root fracture in non-endodontically treated posterior teeth (also in a population of Chinese adults) was related to repetitive excessive occlusal forces and coined the term 'fatigue root fracture'. In this study the problem affected predominantly the mandibular first molar teeth of persons greater than 40 years of age and many subjects had a dietary history of prolonged betel nut chewing. In Case 3 of the series the patient exhibited significant toothwear, indicative of an abrasive diet or parafunctional habits. The complete fracture (as seen when the tooth was extracted) demonstrates the potentially destructive effect of repetitive occlusal loading in such a case.

We have demonstrated the difficulties associated with the diagnosis of vertical root fractures and, considering that this condition generally results in tooth loss, it is understandable that diagnosis is often delayed. We suggest that, in addition to the usual clinical and radiographic evaluation, a thorough history is important. Clinicians are advised that when the periodontal assessment reveals a localized severe defect, particularly at

a site not usually susceptible to the ravages of destructive periodontitis in an otherwise healthy mouth, the possibility of vertical root fracture should be considered. While there is rarely an effective treatment for vertical root fractures, it is possible to reduce the incidence of these lesions by careful endodontic therapy and avoidance of unnecessarily bulky post-retained restorations. The use of mouthguards for patients involved in contact sports is also to be encouraged in order to reduce the incidence of traumatic injuries to the maxillary anterior teeth.

Although vertical root fractures affecting unrestored molars are relatively uncommon, the clinician should be aware of this possibility in subjects with dietary habits involving abrasive foodstuffs. The compounding effect of parafunctional habits should also be considered to be an increased risk for vertical root fracture.

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