

Differentiating spontaneous vertical root fracture in endodontically treated tooth

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ABSTRACT

Although vertical root fracture (VRF) is mostly found in endodontically treated teeth, it also occurs spontaneously. If VRF is recognized after endodontic treatment, it is considered to be iatrogenic and can lead to legal trouble. However, legal problems can be averted if the dentist can prove that the VRF existed before endodontic treatment. This case report describes an unusual, spontaneous VRF in an endodontically treated tooth and presents a useful tip for determining whether a fracture is iatrogenic. We performed nonsurgical endodontic treatment on a mandibular first molar with irreversible pulpitis. After 6 months, the patient revisited with localized swelling, and we diagnosed VRF of the mesial root. We extracted the tooth and prepared it for microscopic examination. We found gutta-percha in the fracture line of the transversely sectioned root, and it appeared to have penetrated to the fracture line through the force generated from the filling. The patient was informed and agreed that the fracture occurred spontaneously before treatment. This case demonstrates the time point of VRF occurrence by identifying the presence of gutta-percha in the fracture line. We suggest that this procedure can be used to demonstrate whether VRFs in endodontically treated teeth are spontaneous or iatrogenic.

Key words: Iatrogenic, spontaneous, vertical root fracture

INTRODUCTION

Vertical root fracture (VRF) is a longitudinal fracture of the root extending through the entire thickness of dentin from the root canal to the periodontium.^[1] VRF is very difficult to diagnose accurately because in many cases, it is asymptomatic though it can present with mild pain, and its radiographic appearance varies.^[2,3] Most VRFs occur in endodontically treated teeth and stem from dental treatment, such as excessive compaction force during root canal filling procedures or excessive force exerted when inserting

a post into the root canal.^[4,5] Those causes of VRFs are considered iatrogenic. If a clinician discovers a VRF after endodontic treatment, the patient could complain that his/her dentist was responsible for this catastrophic result. Consequently, legal issues could arise.

On rare occasions, VRFs can occur in nonendodontically treated teeth, so-called spontaneous VRFs.^[6] There have

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been some reports of spontaneous VRF, especially in literature from eastern Asia.^[6-10] Yang *et al.*^[7] and Chan *et al.*^[8] reported 12 cases and 64 cases, respectively, of spontaneous VRF in nonendodontically treated teeth. Chan *et al.*^[9] also investigated 315 VRF cases in Chinese patients through a 13-year survey and found that about 40% of all cases occurred in nonendodontically treated teeth. However, in endodontically treated teeth, it is difficult to determine whether a VRF is spontaneous or iatrogenic. When a VRF occurs in a tooth they treated endodontically, dentists generally admit that the fracture was caused by treatment. If they had a way to prove that the fracture already existed and progressed spontaneously before root canal treatment, they could avoid any legal trouble related to responsibility for the VRF. However, no method for demonstrating when a VRF occurred in endodontically treated teeth has yet been suggested. Therefore, we here describe an unusual spontaneous VRF in a mandibular first molar and present a useful method for demonstrating when it occurred.

CASE REPORT

A 61-year-old man came to our dental clinic complaining of severe pain on cold stimuli. His medical history was noncontributory. When applying cold water on the right lower first molar under rubber dam isolation, the patient felt lingering pain that matched his chief complaint. The tooth showed no caries lesion or crack line. No specific problem could be seen on the diagnostic radiograph [Figure 1a]. On the basis of clinical and radiographic findings, we diagnosed irreversible pulpitis of the lower first molar and planned root canal treatment.

Under local anesthesia with 2% lidocaine solution, we prepared the access cavity. We determined the working length using an electronic apex locator (DentaPort ZX; J. Morita, Kyoto, Japan) and found no unusual signs when the file connected to the locator was inserted into all root canals. In addition, we found no crack line on the prepared cavity wall, even under a surgical operating microscope (OPMI pico; Carl Zeiss, Göttingen, Germany). We prepared the root canals using ProTaper Next nickel-titanium (Ni-Ti) rotary instruments (Dentsply-Maillefer, Ballaigues, Switzerland) until X3 reached the apex. Copious irrigation was performed with 2.5% sodium hypochlorite (NaOCl) solution. By the next visit, the patient's symptoms had disappeared. After irrigation with NaOCl and 17% ethylenediaminetetraacetic acid (Endo-prep Gel, Medclus, Cheongju, Korea),

all canals were dried and filled with gutta-percha and resin-based sealer (AHplus; Dentsply-Caulk, Konstanz, Germany) using the warm vertical compaction technique (Endo-Apex; EPdent, Seoul, Korea) [Figure 1b]. Then, we fabricated a full veneer gold crown.

After 6 months, the patient revisited complaining of dull pain and localized swelling. We found a deep, narrow periodontal pocket on the buccal aspect of the tooth. Radiographic examination revealed extensive J-shaped periodontal bone loss around the mesial root [Figure 2]. We strongly suspected VRF and planned an extraction. When the patient noticed the problem, he asked us for the cause of the VRF. Moreover, he wondered whether the fracture could have occurred during the endodontic treatment. We explained that the fracture might have been present before the treatment or that it might have been caused by the root canal filling procedure. However, we could not give him a clear answer as to which possibility was correct. Finally, we suggested that we extract and examine the tooth in detail. The tooth was extracted under local anesthesia. We found a fracture line on the mesial root [Figure 3a]. The fracture line appeared more clearly when we stained it with 1% methylene blue solution [Figure 3b].

For scientific use of the tooth, we obtained informed consent from the patient. After embedding the tooth in acrylic resin, we sectioned the specimen transversely using a low-speed microtome (ISOMET; Buehler, IL, USA). We then examined the sectioned surface under a stereomicroscope (Leica MZ16FA; Leica, Wetzlar, Germany). The fracture line was along the mesial root in the buccolingual direction. Notably, we found gutta-percha in the fracture line [Figure 4]. It appeared to have been squeezed into the fracture line by the force generated during filling. It provided clear evidence that the fracture line already existed before the root canal filling procedure. We informed the patient, who agreed that the fracture occurred spontaneously before the treatment. We then planned restoration of the missing tooth with a dental implant.

DISCUSSION

Spontaneous VRF that occurs without a predisposing endodontic or intracanal restorative procedure is apparently uncommon. However, spontaneous VRF can occur in nonendodontically treated teeth. The majority of spontaneous VRF cases have been reported in Chinese populations, and the causes

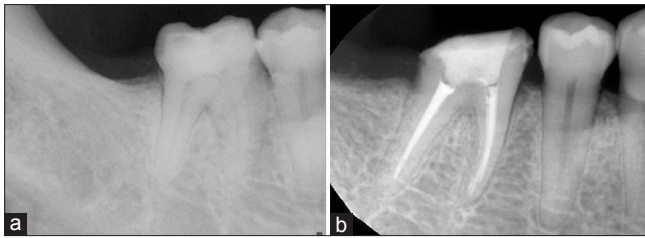


Figure 1: Radiographic features of the mandibular right first molar. (a) Diagnostic radiograph before treatment. (b) Postoperative radiograph. Symptoms were relieved after root canal treatment

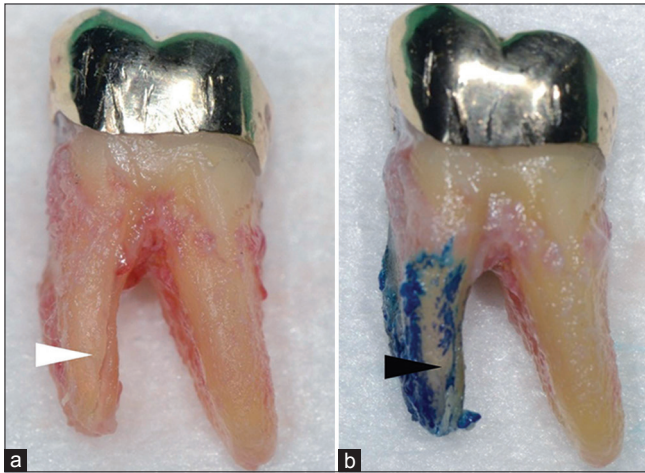


Figure 3: Clinical photographs of extracted tooth. (a) The extracted tooth showing a definite fracture line on the mesial root (white triangle). (b) The fracture line became more obvious after methylene blue staining (black triangle)

are not fully understood. Perhaps, Chinese-specific diet and chewing patterns are important factors in the occurrence of spontaneous VRF. According to Chan *et al.*^[9] and Wang and Su^[10] spontaneous VRF showed consistent patterns, occurring most often in mandibular first molars of patients between 40 and 69 years old, with a higher incidence in males than in females. Most spontaneous VRF teeth had severe attrition with no or minimal restoration. Consistent patterns related to spontaneous VRF could be related to certain diet or chewing habits, such as chewing bones, ice cubes, or hard candy. In our case report, the patient was a middle-age male, and the VRF occurred in a mandibular first molar. Furthermore, the teeth showed moderate attrition with no restoration. The conditions of the tooth in our case thus partially corresponded with the consistent patterns found in previous studies.

When a VRF occurs in an endodontically treated tooth, the dentist could be frustrated because the patient might complain that the cause of the VRF is iatrogenic. However, the fracture might have existed before treatment if the tooth shows the aforementioned



Figure 2: Radiograph at revisit after 6 months. Note the J-shaped periradicular radiolucency around the entire mesial root (white triangle)

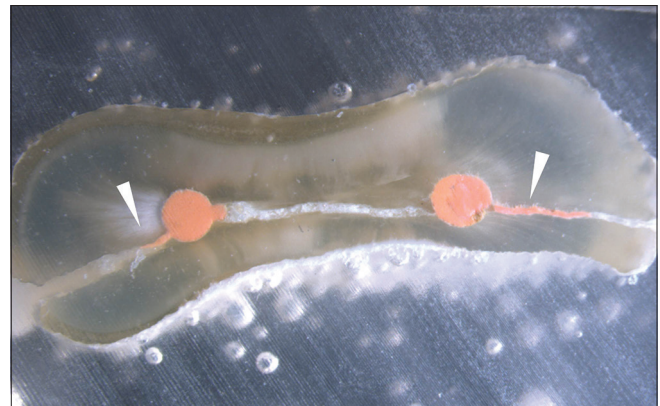


Figure 4: Stereomicroscopic view of the sectioned mesial root. Note the definite crack line containing gutta-percha (white triangles) (x20)

conditions. Herein, we offer a useful tip for verifying when a VRF occurred: extract the tooth or root, then section, and examine it. If gutta-percha is present in the fracture line of the transversely sectioned root, it can be postulated that the crack line existed before the root canal filling procedure. Without a preexisting fracture line, the gutta-percha could not penetrate into the root dentin. In our case, we found obvious gutta-percha in the fracture line. It looked like the gutta-percha had been squeezed into the fracture line by the force generated during vertical compaction [Figure 4]. That clearly indicated that the fracture line already existed before the root canal filling procedure, which meant that the VRF was not iatrogenic. The patient withdrew his claim after this verification and agreed to our plans for the future restoration of the edentulous area.

Consideration of the canal filling technique is important regarding the verification. Various methods are available, including cold lateral compaction and warm vertical compaction. Cold lateral compaction is widely

used, but it might not fill canal irregularities, such as a lateral canal, isthmus, or root fracture.^[11] On the other hand, warm vertical compaction has an advantage in terms of filling such irregularities.^[12] Moreover, endodontic sealer in the fracture line might provide alternative evidence for spontaneous VRF. However, it was very difficult to identify the sealer in the sectioned specimen in this case. The sealer might have been washed out during the sectioning or mixed with the acrylic resin used for the embedding procedure. In this respect, a thermoplasticized gutta-percha technique such as warm vertical compaction is preferred to allow gutta-percha to penetrate into the fracture line.

There might be a possibility that the VRF occurred during the root canal filling procedure. Indeed, unless this possibility is excluded, our clinical suggestion cannot be accepted. Previous studies demonstrated that the load necessary to elicit a VRF ranges between 7 and 17 kg,^[5,13,14] and the force needed to fracture a root is much higher than that formed during filling compaction. Furthermore, VRFs result from a gradual diminution of root structures that develops from preexisting defects such as microcracks or craze lines and should not be considered an instantaneous phenomenon.^[15] Even though the VRF can be assumed to be initiated by the force generated by obturation force, the fracture might be just a craze line considered as an initial defect. Consequently, this minute fracture line could not allow the penetration of semisolid gutta-percha at the moment. In this respect, it is appropriate to presume that the VRF preexisted spontaneously and it was induced by the microcrack which elicited long before.

CONCLUSION

In summary, in this case report, we explain how we verified the time point of VRF occurrence by identifying the presence of gutta-percha in the fracture

line. With that verification, we averted possible legal issues. We suggest that this clinical tip can be used to demonstrate whether VRFs in endodontically treated teeth are spontaneous or iatrogenic.

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Conflicts of interest

There are no conflicts of interest.

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