Clinical and Radiographic Characteristics of Vertical Root Fractures in Endodontically and Nonendodontically Treated Teeth

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Abstract

Introduction: A vertical root fracture (VRF) is a root fracture extending along the longitudinal axis of roots and is often noted in endodontically treated teeth. However, the clinical and radiographic characteristics of VRFs are not completely known. **Methods:** A total of 65 teeth with 68 vertical fractured roots in 58 Chinese patients were investigated. The clinical examination records and radiographic images were reviewed in detail. **Results:** A total of 24 male (41.38%) and 34 female (58.62%) patients aged 25–90 years (average = 57 years) were included; 51 (87.93%) and 7 (12.07%) patients exhibited 1 tooth and 2 teeth with VRFs, respectively, in the dentition. VRFs occurred mainly in the mesial root (20 roots, 57.14%) of the mandibular molars (29 teeth, 44.62%). Clinically, teeth with VRFs usually presented a periodontal probing depth >5 mm (44 teeth, 91.67%, $P < .001$) with a prosthesis (55 teeth, 84.62%, $P < .001$) and a relatively intact dentition (42 patients exhibited <4 missing teeth in the dentition, 77.78%, $P < .001$). Most of the nonendodontically treated VRFs exhibited attrited occlusal surfaces. Radiographic characteristics of the teeth with VRFs were typically associated with prior root canal treatment (56 teeth, 86.15%, $P < .001$), periodontal bone loss (62 teeth, 95.38%, $P < .001$), apical bone loss (52 teeth, 80.00%, $P < .001$), and periodontal ligament widening (61 teeth, 93.85%, $P < .001$). The mesial roots of the mandibular molars were most susceptible to VRFs in both endodontically and nonendodontically treated teeth. **Conclusions:** These results elucidated some clinical and radiographic and diagnostic features that facilitate VRF identification. *(J Endod 2016;■:1–7)*

Key Words

Clinical characteristics, endodontic treatment, post and core, radiography, vertical root fractures

Significance

Clinical and radiographic characteristics of vertical root fractures were examined. The findings can be helpful for discrimination with other root fractures such as cemental tears, horizontal root fractures, and so on. Results are useful for future early differential diagnosis, symptom control, treatment, and prognosis.

A vertical root fracture (VRF) is defined as a longitudinal fracture of the root with fracture lines running parallel to the long axis (1). A VRF usually initiates from the internal root canal wall and extends to the outer root surface (2). The prevalence of VRFs was reported to be 11%–20% in extracted endodontically treated teeth (3). Although the actual occurrence is unknown, VRFs are commonly observed in clinical practice. VRFs have been reported to occur in both endodontically and nonendodontically treated teeth, but the majority occur in endodontically treated teeth, with or without post insertion, and in the posterior teeth of patients older than 40 years (4, 5).

Clinically subjective or objective symptoms and signs of VRFs may be absent or minimal during the early stages, which makes accurate diagnosis of VRFs difficult. As the exacerbation of root fracture develops, patients often suffer from discomfort, mild pain near the fractured tooth, dull pain on mastication, gingival swelling accompanied by a fistula or sinus tract, sensitivity to percussion and palpation, and deep localized periodontal probing defects (4–6). Radiographic images may indicate bone loss and osseous defects resembling periodontal destruction with a fractured root,

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periradicular radiolucency, periodontal ligament widening, and sudden changes in radiographic image density or width of the root canal space (4, 5, 7).

Several contributing factors related to VRFs in endodontically treated teeth have been proposed, such as root canal overpreparation, removing an unnecessary tooth structure during instrumentation, excessive condensation force during root canal obturation, wedging forces, corrosion and expansion of root canal posts, and intracanal restorations (4, 8). Although a VRF usually occurs in endodontically treated teeth, some studies have presented nonendodontically treated teeth with VRFs, particularly in the elderly Chinese population and first molars (8–10). Several contributing factors, including a particular diet pattern, chewing habits, and repetitive heavy masticatory forces, have been proposed (4, 5, 9). Other risk factors include a worn occlusal surface and thin root morphology (5, 8). Although some consistent characteristics of VRFs in nonendodontically treated teeth have been reported, the actual causes remain unclear.

Diagnosis of a VRF is complicated because of the lack of specific symptoms, signs, and other clinical findings. Different races and populations may be more susceptible to a particular type of root fracture. However, most studies on VRFs, particularly in nonendodontically treated teeth of Chinese populations, were case reports or case series only emphasizing the clinical manifestation. This study explored the demographics, clinical and radiographic features, and diagnostic signs of teeth with VRFs or without prior root canal treatment in Chinese patients and attempted to provide some indications that would facilitate an accurate diagnosis.

Materials and Methods

This study was approval by the Ethics Committee of National Taiwan University Hospital, Taipei, Taiwan. A total of 65 teeth with 68 vertically fractured roots from 58 Chinese patients were collected between 2006 and 2016 at the National Taiwan University Hospital dental department. The selected teeth with VRFs were confirmed on the basis of at least 1 of the following diagnostic methods: clinical examination, radiographic image (including panoramic, periapical, and bitewing radiographs and cone-beam computed tomographic [CBCT] images), exploratory flap surgery, and after tooth extraction. A clear VRF line must either be visible or detected through 1 of the diagnostic methods. Cracked or split teeth, teeth with insufficient information for precise diagnosis, and incomplete clinical or radiographic data were excluded. The final diagnosis was confirmed by 2 endodontists. After verifying that all data were VRFs, the clinical examination records and radiographic images were reviewed in detail. The following parameters were recorded:

1. Demographic information
   a. Sex
   b. Age
   c. Clinical findings
   d. Number of fractured teeth in a patient
   e. Tooth type
   f. Fractured root
   g. Periodontal probing depth
   h .Prosthesis (with or without)
   i .Type of prosthesis (including single crown, splinted crown, and bridge abutment)
   j. Vitality test results of nonendodontically treated teeth (vital, nonvital, or not examined)
   k. Numbers of full mouths and missing teeth in patients (<4 or ≥4 missing teeth)
   l. Tooth wear status of nonendodontically treated teeth (with or without attrited occlusal surface)
2. Radiographic findings
   a. Prior root canal status (endodontically or nonendodontically treated)
   b. Post condition in the root canal
   c. With or without post
   d. Inserted post length (coronal, middle, or apical third)
   e. Type of the post (casting post, screw post, parapost, or fiber post)
   f. Periodontal bone loss (yes or no)
   g. Apical bone loss (yes or no)
   h. Periodontal ligament widening (yes or no)
   i. Root canal space widening (yes or no)
   j. Separation of root fragments (yes or no)
3. Final diagnostic methods (based on clinical examination, radiographic image, surgical intervention, or after extraction)

Statistical Methods

Previously described clinical and radiographic examination records have been presented in the tables and figures as the number of cases and percentages. Statistical analyses were performed using the binomial test on R Studio Version 0.99.902 (The R Foundation for Statistical Computing, Vienna, Austria) to evaluate the distribution pattern in the variables of teeth with VRFs. Differences were considered significant at $P < .05$. The following parameters were analyzed: periodontal probing depth, prosthesis (present or absent), numbers of full mouth and missing teeth in patients (<4 or ≥4 teeth), prior root canal status (endodontically or nonendodontically treated), post condition in the root canal (present or absent), periodontal bone loss (yes or no), apical bone loss (yes or no), periodontal ligament widening (yes or no),

TABLE 1. Sex and Age Distribution of VRFs in Endodontically and Nonendodontically Treated Teeth

	No. of VRFs by age group								
	20–29 y	30–39 y	40–49 y	50–59 y	60–69 y	70–79 y	80–89 y	90–99 y	Total (%)
Endodontically treated teeth									
Male	1	1	3	3	6	5	0	0	19 (29.23)
Female	0	7	9	9	5	6	1	0	37 (56.92)
Subtotals	1	8	12	12	11	11	1	0	56
Nonendodontically treated teeth									
Male	0	0	0	2	2	3	1	0	8 (12.31)
Female	0	0	0	0	0	0	0	1	1 (1.54)
Subtotals	0	0	0	2	2	3	1	1	9
Total	1	8	12	14	13	14	2	1	65 (100)