Comparison of Fracture Sites and Post Lengths in Longitudinal Root Fractures

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Abstract

Introduction: Comparing the epidemiology of fractures originating in the cervical and apical regions may help to understand the causes and risk of a vertical root fracture. We aimed to determine the frequency of vertical root fractures in different fracture sites and how the fracture site relates to fracture direction and post length. **Methods:** Teeth diagnosed with a vertical root fracture were retrospectively surveyed for age and sex of the patient, type of tooth, a fracture region in the longitudinal axial direction, site of the fracture, and presence of a post. The fracture region in the longitudinal axial direction was classified as an incomplete fracture, complete fracture, and uncertain. Incomplete fractures were further classified into a fracture originating in the cervical region, a fracture originating in the midregion, and a fracture originating in the apical region. Posts were evaluated by loss of post and length of post. **Results:** Fractures originating in the cervical and apical region occurred around the same frequency, whereas fractures originating in the midregion were extremely scarce. Of the fractures originating in the cervical region, 36.2% were in a mesial and/or distal site and 57.4% in a buccal and/or lingual site. Of the fractures originating in the apical region, 90.8% were in the buccal and/or lingual site. The number of cases of fractures originating in the apical region decreased with increased post length. **Conclusions:** Sites of fracture and post length differed greatly between fractures originating in the cervical region and the apical region, suggesting that risk factors for fractures originating in the cervical and apical regions are different. *(J Endod 2015;41:159–163)*

Key Words

Fractures originating in the apical region, fractures originating in the cervical region, post length, site of fracture, vertical root fracture

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Vertical root fractures cause rapid disruption of the periodontal tissues, and in almost all cases extraction is required. Among patients in the maintenance phase of restorative and periodontal treatment, the cause of tooth loss is reported to be caries in 7% of cases and periodontal disease in no more than 5%, whereas root fractures account for an overwhelming majority of 62% of cases (1). Therefore, the prevention and treatment of a root fracture can greatly increase the life span of teeth. There are various causes of a vertical root fracture, making it difficult to gain a full understanding of the mechanism. Endodontics and prosthetics show many of the factors associated with root fractures, but there have not been consistent results establishing them as causes.

Enlargement of the root canal is reported to reduce fracture resistance (2). Microcracks that form at the time of root canal enlargement have been identified as a possible cause of a root fracture. In particular, a number of studies have shown that cracks form more readily with a nickel-titanium rotary file than when a hand instrument is used (3–5). Prolonged irrigation of the root canal with highly concentrated irrigant solutions (6, 7) and long-term application of calcium hydroxide to the root canal are reported to decrease the strength of the dentin (8–10). Excessive pressure applied during root canal obturation is also seen as a cause of root fractures (11, 12). Cracks caused during root canal preparation can be extended by the pressure of root canal obturation (13, 14), thus greatly reducing fracture resistance (3).

Many studies have investigated the role of prosthetics in root fracture occurrence. There are reports that thinning of the root canal wall because of insertion of the post reduces fracture resistance (15) and that bonding the post to the root canal wall (16, 17) or the presence of a ferrule (18) increase fracture resistance. There have recently been numerous reports of fiber posts in relation to root fractures, but *in vitro* findings are inconclusive; for example, 1 study observed that fiber posts increase fracture resistance (19), and another reported deterioration resulting from fiber posts (20). Further clinical studies on the effects of fiber posts on fracture resistance are required (21, 22).

Neither the mechanism of vertical root fractures nor the measures to prevent them have been fully clarified yet in clinical studies. It is known that vertical root fractures may originate either from the cervical region or the apical region (23, 24), and it is probable that the 2 types of fracture are each associated with different factors. Comparison of the epidemiology of fractures in the cervical region and fractures in the apical region may help to understand the causes and risks of vertical root fractures. We aimed to determine the frequency of vertical root fractures in different fracture sites and how the fracture site relates to fracture direction and post length.

Materials and Methods

A retrospective study was performed in teeth diagnosed with a vertical root fracture at the Department of Endodontics and Periodontics, Hokkaido University Hospital, Hokkaido, Japan, between 1994 and 2012. The study was approved by the Institutional Review Board for Clinical Research of Hokkaido University Hospital. The items surveyed were age and sex of the patient, type of tooth, fracture region in the longitudinal axial direction, site of the fracture, and presence of a post.

When complete fracture could not be diagnosed by inspection or radiography, the post or root canal obturation material was removed, and the fracture was checked from inside the root canal with a microscope. When the fracture was indistinct, it was stained

TABLE 1. The Number of Tooth Root Fractures by Age at Diagnosis and Sex

	20–29 y	30–39 y	40–49 y	50–59 y	60–69 y	70–79 y	80+ y	Total
Female, *n* (%)	2 (0.7)	16 (5.3)	47 (15.5)	69 (22.7)	58 (19.1)	15 (4.9)	0 (0)	207 (68.1)
Male, *n* (%)	1 (0.3)	9 (3.0)	13 (4.3)	33 (10.9)	26 (8.6)	14 (4.6)	1 (0.3)	96 (31.9)
Subtotal, *n* (%)	3 (1.0)	25 (8.2)	60 (19.7)	102 (33.6)	84 (27.6)	29 (9.5)	1 (0.3)	304 (100)

with a caries detector or iodine tincture. When it was difficult to distinguish root fracture from root morphology such as fins, the root canal was enlarged. If the suspected fracture line disappeared during enlarging, the tooth was excluded from the study; a vertical fracture was diagnosed only if it continued as far as the periodontal ligament. The fracture region in the longitudinal axial direction was classified as an incomplete fracture, complete fracture, and uncertain. Incomplete fractures were further classified into 3 subgroups: a fracture originating in the cervical region, a fracture originating in the midregion, and a fracture originating in the apical region. The criteria for the groups and subgroups were as follows: a fracture originating in the cervical region: a fracture in the cementoenamel junction (CEJ) or in the foremost coronal side of the root if the CEJ is indistinguishable that does not extend to within 3 mm of the apical region, a fracture originating in the midregion: there is no fracture in the CEJ or foremost coronal side of the root and no fracture within 3 mm of the apical foramen, a fracture originating in the apical region: a fracture in the apical foramen or a fracture line within 3 mm of the apical foramen that extends to 2 sides (eg, the buccal and lingual sides) and no fracture in the CEJ or foremost coronal side of the root, a complete fracture: a fracture in the CEJ or in the foremost coronal side of the root if the CEJ is indistinguishable that extends to within 3 mm of the apical foramen or within 3 mm of the apical region, and uncertain: the fracture line cannot be verified satisfactorily because of curvature of the tooth root and so on. The site of fracture was classified into buccal and/or lingual, mesial and/or distal, and other (fracture affecting both buccal/lingual and mesial/distal sites).

Posts were evaluated by loss of post, material of post, and length of post. Posts that were not present in the canal at the time of visit to the clinic and posts that were lost only when connected crowns or a fixed partial denture were cut were classified as lost. The length of the post was classified according to the method of Schei et al (25) by calculating the ratio of the post length to the root length from the radiograph and was expressed as 0, ≤2/10, ≤4/10, ≤6/10, and >6/10. The length of the root was taken as the length from the apex to the CEJ or else to the gingival margin of a crown restoration.

The statistical tests used were the chi-square test and the Pearson correlation performed with SPSS Statistics Version 21 (IBM, Armonk, NY).

Results

The patients included 76 men and 174 women. The age at diagnosis was 29–84 years (mean, 57.5 ± 11.6 years) in men and 23–77 years (mean, 54.9 ± 11.1 years) in women. A total of 304 teeth were studied, 181 from the maxilla and 123 from the mandible. The age group with the highest number of vertical root fractures was 50–59 years for both men and women (Table 1). The tooth type with the greatest frequency of vertical root fracture was the maxillary second premolar followed by the maxillary first premolar and mandibular first molar. The lowest frequency was in the mandibular central incisor and mandibular third molar followed by the mandibular lateral incisor and maxillary third molar (Table 2). Seven of the teeth were vital, 2 were nonvital but without caries, and 295 had received root canal therapy.

Looking at the fracture region in the longitudinal axial direction by tooth type, a fracture originating in the cervical region was significantly ($P = .006$) more common than a fracture originating in the apical region in the maxillary central incisors and canines, with 5–10 times more fractures originating in the cervical than apical region. In the other tooth types, fractures originating in the cervical and apical region were at around the same frequency. Fractures originating in the midregion were extremely scarce, accounting for only 5 of the 304 cases (Table 2). There were no teeth with both fractures originating in the cervical and apical regions.

The overwhelming majority of fractures originating in the apical region were in buccal/lingual sites, whereas fractures originating in the cervical region occurred in both buccal/lingual and mesial/distal

TABLE 2. The Number of Vertical Root Fractures Originating in Each Region in the Longitudinal Axial Direction and Type of Tooth

	Tooth type	Cervical region	Midregion	Apical region	Complete fracture	Total
Maxillary, *n* (%)	Central incisor	10 (5.5)	1 (0.6)	1 (0.6)	5 (2.8)	17 (9.4)
	Lateral incisor	5 (2.8)	0 (0)	5 (2.8)	2 (1.1)	12 (6.6)
	Canine	10 (5.5)	0 (0)	2 (1.1)	9 (5.0)	21 (11.6)
	First premolar	8 (4.4)	3 (1.7)	14 (7.7)	15 (8.3)	40 (22.1)
	Second premolar	12 (6.6)	0 (0)	19 (10.5)	29 (16.0)	60 (33.1)
	First molar	6 (3.3)	1 (0.6)	8 (4.4)	2 (1.1)	17 (9.4)
	Second molar	2 (1.1)	0 (0)	6 (3.3)	5 (2.8)	13 (7.2)
	Third molar	0 (0)	0 (0)	1 (0.6)	0 (0)	1 (0.6)
	Subtotals	53 (29.3)	5 (2.8)	56 (30.9)	67 (37.0)	181 (100)
Mandibular, *n* (%)	Central incisor	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	Lateral incisor	0 (0)	0 (0)	1 (0.8)	0 (0)	1 (0.8)
	Canine	3 (2.4)	0 (0)	2 (1.6)	3 (2.4)	8 (6.5)
	First premolar	6 (4.9)	0 (0)	4 (3.3)	8 (6.5)	18 (14.6)
	Second premolar	15 (12.2)	0 (0)	5 (4.1)	13 (10.6)	33 (26.8)
	First molar	7 (5.7)	0 (0)	16 (13.0)	10 (8.1)	33 (26.8)
	Second molar	10 (8.1)	0 (0)	14 (11.4)	6 (4.9)	30 (24.4)
	Third molar	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	Subtotals	41 (33.3)	0 (0)	42 (34.1)	40 (32.5)	123 (100)
	Total	94 (30.9)	5 (1.6)	98 (32.2)	107 (35.1)	304 (100)