

Analysis of Factors Associated with Cracked Teeth

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Abstract

Introduction: The purpose of this study was to analyze the characteristics, distribution, and associated factors of longitudinal fractured teeth according to the well-defined criteria of the American Association of Endodontists (AAE). **Methods:** One hundred seven teeth with longitudinal fracture from 103 patients were diagnosed and analyzed. The patients' signs, symptoms, age, and sex were noted as well as the tooth number, dental arch, filling materials, size/classification of restoration, crack direction, pulp vitality, whether the patient had undergone endodontic treatment, bite test results, percussion test results, wear facet, and periodontal pocket depth. **Results:** Eighty-seven teeth were diagnosed with a cracked tooth (81.3%), 14 were diagnosed with vertical root fracture (VRF, 13.1%), 4 had a split tooth (3.7%), and 2 had a fractured cusp (1.9%); 82.2% showed a sensitive reaction on the bite test. Longitudinal tooth fractures were observed most frequently in patient in their 40s. The upper first molar (28.0%) was most frequently cracked, followed by the lower first molar (25.2%), the lower second molar (20.6%), and the upper second molar (16.8%). Most longitudinal tooth fractures (72.0%) occurred mainly in restored teeth, whereas only 28.0% were found in intact teeth. Compared with resin (4.7%) or porcelain (0.9%), the use of nonbonded inlay restoration materials such as gold (20.5%) or amalgam (18.7%) increased the occurrence of longitudinal tooth fractures. Out of 107 of longitudinal fractured teeth, 33 (30.8%) were treated endodontically and 74 (69.2%) were not. VRF was associated with endodontic treatment. **Conclusions:** The bite test is most reliable for reproducing symptoms. The combined use of various examination methods is recommended for detecting cracks and minutely inspecting all directions of a tooth. (*J Endod* 2012;38:288–292)

Key Words

Associated factors, bite test, cracked tooth, longitudinal tooth fracture, restoration materials

Cracked teeth have been defined as teeth with crack lines that appear in the vertical (occlusal-cervical) plane over a period of time (1, 2). Discomfort associated with chewing is the most frequent symptom of cracked teeth, but unexplained sensitivity to cold is often experienced by patients (3). It is hard to diagnose cracked teeth in clinical trials, not only because of the complicated and diverse symptoms associated with this condition but also because of the difficulty in locating crack lines. As a result, a combination of simple macrography, transillumination, staining with dyes, diagnostic surgery, microscopy, and a cone-beam computed tomography scan (4, 5) is necessary to identify and confirm the presence of cracks.

Even if a crack is identified, it is difficult to estimate the prognosis because there is no accurate way to know how advanced the crack has become (1, 2). This condition has always presented a restorative dilemma for dentists because a crack has an unpredictable prognosis including extraction (6, 7). The decision to treat and restore cracked teeth involves a discussion with patients about the prognosis, cost, and treatment time (2). Therefore, it is important to investigate factors related to cracked teeth that may provide helpful information about prevention.

It is unfortunate that there has been a lack of information about the distribution and characteristics of cracks according to certain criteria. In addition, many authors have proposed different terminologies and definitions for cracks in teeth (8–11). Because of confusion caused by the use of different terms, it is necessary to classify and study cracks according to a unified definition. Therefore, in this study, we classified longitudinal fractured teeth of patients according to the American Association of Endodontists (AAE) guidelines (12) and analyzed the characteristics and distribution of various factors including age, sex, symptoms, signs, direction of the cracks, type/size of restoration, and diagnostic methods.

Materials and Methods

This study was approved by the Institutional Review Board of Gangnam Severance Hospital (approval number: 3-2010-0057), and the informed consent of all human subjects who participated in the experimental investigation reported or described in this article was obtained after the nature of the procedure and possible discomforts and risks had been fully explained. Patients visiting the Department of Conservative Dentistry in Gangnam Severance Dental Hospital who were experiencing unexplainable biting pain, suspected of having longitudinal fractured teeth, or clearly presenting longitudinal fractured teeth during checkup or treatment were examined from July 2008 to June 2009. The final treatment results were recorded during follow-up until June 2010.

In order to reproduce the symptoms, biting tests were conducted using a Tooth Slooth (Professional Result, Inc, Laguna Niguel, CA), a roll of rubber, or a cotton roll, and tooth hypersensitivity was determined using an ice stick. Examination by the

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naked eye, transillumination, staining with dye, microscopy, and diagnostic surgery was also performed to diagnose longitudinal tooth fractures. Diagnoses were verified during the treatment process. The patients' signs, symptoms, age, and sex were noted as well as the tooth number, dental arch, filling materials, size/classification of restoration, crack direction, pulp vitality, whether the patient had undergone endodontic treatment, bite test results, percussion test results, wear facet, and periodontal pocket depth. The final diagnosis was recorded after verifying the initial diagnosis during treatment sessions. Final treatment processes and the history of extraction were recorded for a year after treatment completion.

Four categories listed by the AAE were used to classify the longitudinal tooth fractures: fractured cusp, cracked tooth, split tooth, and vertical root fracture (VRF). The "craze line" category was not used for this study. In total, 107 cracked teeth were diagnosed in 103 patients over a year. The results were analyzed using the R statistical language (R Foundation for Statistical Computing, Vienna, Austria) (13). The association between categorical variables was compared using the Fisher exact test. A *P* value < .05 was considered to be statistically significant.

Results

One hundred seven longitudinal fractured teeth were diagnosed and confirmed using 1 of the 5 different techniques: naked eye (48%), transillumination (18%), dye staining (17%), microscope examination (9%), and diagnostic surgery (8%). Eighty-seven teeth were diagnosed with a cracked tooth (81.3%), 14 were diagnosed with VRF (13.1%), 4 had a split tooth (3.7%), and 2 had a fractured cusp (1.9%). The ages of the patients ranged from 25 to 70 years (20–29, 6.5%; 30–39, 28.0%; 40–49, 29%; 50–59, 23.4%; 60–69, 12.2%; and 70+, 0.9%). There was no significant difference in sex (55 [51.4%] in males and 52 (48.6%) in females, *P* > .05). The upper first molar (28.0%) was most frequently cracked followed by the lower first molar (25.2%), the lower second molar (20.6%), and the upper second molar (16.8%). The prevalence of longitudinal tooth fractures found in a premolar was 6.6% and 2.8% in the maxilla and mandible, respectively (Table 1). The highest number of longitudinal fractures occurred in the mesiodistal direction (43.9%) in both jaws followed by ones in the buccolingual direction (33.6%); 22.4% of the longitudinal tooth fractures were in both the mesiodistal and buccolingual directions.

For the clinical signs and symptoms, 51% of the patients experienced bite pain, and 82.2% respond positively on the bite test (Fig. 1 and Table 2). Sixty teeth (56.1%) were negative on the percussion test, whereas 36 teeth (33.6%) showed moderate to severe cold sensitivity. Fifty-two teeth (48.6%) had normal pocket depth, 34 teeth had

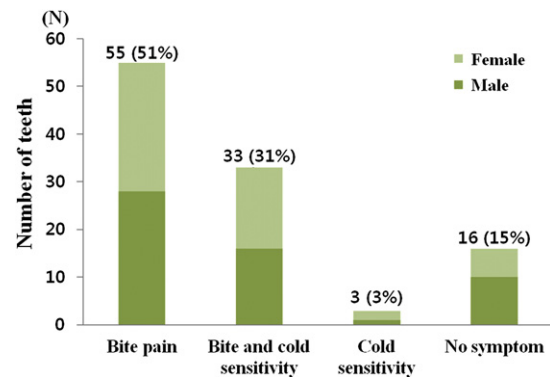


Figure 1. Clinical symptoms of longitudinal fractured teeth.

a pocket depth of 3 to 6 mm, and the pocket depth in 21 teeth (19.6%) was over 6 mm. Only 13 teeth (12.1%) showed an occlusal facet (Table 2).

For the relation with the previous dental treatment, 33 teeth (30.8%) were treated with a root canal filling, and 74 teeth (69.2%) were not. These 74 teeth were treated with direct filling (23.4%), indirect restoration (21.5%), a crown (21.5%), or were not treated at all (28.0%). According to the restoration size at the time of examination, 24.1% underwent a restoration smaller than one third of the mesiodistal or buccolingual width in the occlusal table, whereas 57.4% underwent a restoration between one third and two thirds of this width; 18.5% of the teeth had a restoration size greater than two thirds of the width. Of 54 direct fillings and indirect inlays that were performed, 74.0% and 26.0% were class I and II restorations, respectively (Tables 3 and 4).

Discussion

Several authors (9–11, 14–16) have proposed various terminologies, definitions, and classifications for discussing cracks in teeth and have reported different characteristics of this condition. For analyzing factors related to longitudinal fractured teeth, specific criteria for defining and classifying cracks are needed. The AAE categorized longitudinal tooth fractures into 5 major classes: craze line, fractured cusp, cracked tooth, split tooth, and VRF (6, 12). Craze line affect only the enamel, originate on the occlusal surface, are typically from occlusal forces or thermocycling, and are asymptomatic (6). Fractured cusp is defined as a complete or incomplete fracture initiated from the crown of the tooth and extending subgingivally, usually directed both mesiodistally and buccolingually. A cracked tooth is defined as an incomplete fracture initiated from the crown and extending subgingivally, usually directed mesiodistally. The term split tooth is defined as a complete fracture initiated from the crown and extending subgingivally, usually directed mesiodistally through both of the marginal ridges and the proximal surfaces. A "true" VRF is defined as a complete or incomplete fracture from the root at any level, usually directed buccolingually (12). In this study, 81.3% of the patients were diagnosed with a cracked tooth, and 13.1% were diagnosed with VRF. These results show that careful examination is needed because the existence of a cracked tooth and VRF is difficult to detect and represents a large proportion of longitudinal tooth fractures.

The age of the subjects with cracked teeth in this study was similar to those cited in previous publications (14, 17). Udoe and Jafarzadeh (18) and Roh and Lee (17) claimed that cracked teeth occur primarily in patients 30 to 50 years old, whereas the other studies suggested that cracks mainly appear in individuals well past middle age (3, 19). Such

TABLE 1. Distribution of Longitudinal Tooth Fractures According to the Location of the Teeth

Type of tooth	Male	Female	Total, n (%)
Maxilla			
Maxillary 1st premolar	2	2	4 (3.8)
Maxillary 2nd premolar	3	0	3 (2.8)
Maxillary 1st molar	12	18	30 (28.0)
Maxillary 2nd molar	6	12	18 (16.8)
Total	23	32	55 (51.4)
Mandible			
Mandibular 1st premolar	0	0	0 (0.0)
Mandibular 2nd premolar	1	2	3 (2.8)
Mandibular 1st molar	14	13	27 (25.2)
Mandibular 2nd molar	17	5	22 (20.6)
Total	32	20	52 (48.6)

Fisher exact test, *P* = .464 for the association between sex and the type of tooth.

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