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Original Article

The clinical findings and managements in 44 cases of cracked vital molars

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KEYWORDS
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Abstract *Background/purpose:* The aim of this study was to evaluate the associations between the clinical findings and managements in cracked vital molars that were caused by various factors including restoration and occlusion.
Materials and methods: The subjects' gender, age, chief complaint, type of tooth, percussion test results, pulp vitality, restoration material and cavity classification, clinical depth of the crack, evaluation of occlusion, depth of periodontal probing, and final management were recorded.
Results: A total of 44 vital cracked teeth (molars) were diagnosed in 40 patients. Regarding the type of tooth, a greater number of mandibular molars were affected than maxillary molars. Nonworking-side interference (NWI) was recognized in 38 cases (86.4%). Eight teeth (18.2%) had not been restored. Thirty-six teeth (81.8%) had been restored; 26 teeth (72.2%) with a metal inlay, 6 (16.7%) with an amalgam, and 4 (11.1%) with a composite resin. Regarding the final treatment in the endodontically-treated group, all 17 teeth were covered with a metal full crown. Regarding the final treatment in the pulp-reserved group, 19 teeth (70.4%) were covered with a metal full crown, and the other managements were as follows: occlusal adjustment (n = 4, 14.8%), composite resin (n = 2, 7.4%), and only follow-up without treatment (n = 2, 7.4%). All of the cases showed a good clinical prognosis.
Conclusion: The NWI group restored with 58% of metal inlay accounted for more than 86% of the cracked teeth. Thus, in order to achieve a good outcome, cracked teeth, particularly those originating due to occlusal interference should be protected with coverage-type restorations.

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Introduction

The location, direction and extent of a crack have a profound effect on the choice of treatment. Thus, the determination of these factors is important for the management of cracked teeth. The American Association of Endodontists (AAE) has clarified five types of longitudinal tooth fractures: craze lines, fractured cusp, cracked tooth, split tooth, and vertical root fracture.[1] In the present study, cracked teeth were defined according to the AAE classification. Many reports have indicated an association between cracked teeth and intracoronal restorations.[2–5] The major problem in a cracked tooth is the potential for bacteria to penetrate to the pulp, which may lead to pulpits, and ultimately to apical periodontitis.[6] The critical issues involved in saving cracked teeth are: the proper confirmation of cracks; the improvement of symptoms and signs; and the proper choice of final restorations. As a result, a combination strategy of simple macrography, transillumination, staining with dyes, diagnostic surgery, microscopy, and cone-beam computed tomography[7] is necessary when examining cracked teeth.

In the management of cracked teeth, it is important to investigate various associated factors. Although occlusal factors, such as the biting of hard substances, the excessive contact of a posterior tooth during jaw movement, malocclusion, and steep cusp inclines and deep grooves in the occlusal plane are suspected as causes of cracks,[8–14] a direct relationship between the occurrence of tooth cracks and the premature contact of occlusion, particularly nonworking-side interference (NWI)[15–17] and protrusion interference (PI),[18] has not yet been described in detail. Thus, the aim of the present study was to evaluate the associations between the clinical findings and managements of cracked vital molars that were caused by various factors, including restoration and occlusion.

Materials and methods

This clinical study was approved by the ethics committee of Nagasaki University Graduate School of Biomedical Sciences (authorized number: 1508). All of the patients were informed about the study described in this article and provided their informed consent. The cracked vital first or second molars of patients who visited the Kanamaru Dental Clinic in the three years prior to the study were examined. Forty-four cracked teeth were identified (based on the criteria of the AAE) by the naked eye, an oral miniature camera (STV-pro, Trophy Radiology Japan, Tokyo, Japan) or an operating microscope (UNIVERSA300, MOLLER-WEDEL GmbH & Co. KG, Wedel, Germany).

The following data were recorded: the subjects' gender, age, type of tooth, chief complaint, percussion test results, pulp vitality as tested using an electric pulp tester (Analytic Technology Pulp Tester, Redmond, WA, USA) and a cold aerosol, the restoration material, the classification and size of the restoration, the position and direction of the crack, the depth of periodontal probing, and the subjects' bite check results. In the present study, the teeth treated with pulpectomy showed a vital pulp but severe spontaneous pain. The infected root canal was treated if the pulp became non-vital during the observation period. An evaluation of subjects' occlusion was made to confirm NWI as a premature contact on molars, which was disclosed to guide the patients' mandibular position from the centric relation to the centric occlusion. NWI has generally been observed at the mesiolingual site of the occlusal plane in the maxillary molars and at the distobuccal site of the occlusal plane in the mandibular molars.[15,16] To facilitate the statistical analyses, the mesial, mesiolingual, and lingual sites were counted together in the maxillary molars. Similarly, the distal, distobuccal, and buccal sites were similarly counted together in the mandibular molars. These six sites were considered to be inside the fixed location; other sites were considered to be outside the fixed location. In the NWI group, the relationship between cracked teeth with or without restoration and the crack lines inside or outside the fixed locations was analyzed. Furthermore, the relationship between the crack teeth with a metal inlay (the most frequently used restoration) or without restoration and the crack lines inside/outside the fixed locations was also analyzed. Regarding the PI in the group without NWI, the relationship between restoration and crack teeth (frequently located distally in the mandible and mesially in the maxilla[18]) was also analyzed.

The extent of the cracks was clinically divided into three types: 1) to the middle part of dentin; 2) to the deep part of dentin, and 3) to the pulp, in both the pulp-reserved group and the endodontic treatment group. Five direct pulp capping cases were included in the pulp-reserved group. The relationship between the time to endodontic treatment and the extent of crack was also analyzed. Five direct pulp capping cases were included in the pulp-reserved group. The prognosis from the first visit and the final management were also recorded in both groups. Furthermore, the final treatment results were evaluated during the follow-up period (range, 1–3 years).

Statistical analysis

The data were expressed as the mean ± SD. The differences between the two groups were assessed using Student's *t*-test and the chi-squared test. *P* values of <0.05 were considered to indicate statistical significance.

Results

A total of 44 vital cracked teeth (Table 1) were diagnosed in 40 patients. The average ages of the patients were 47.4 ± 15.4 (20–74) years in males, and 46.8 ± 14.5 (17–68) years in females. There were no significant gender-based differences in the patients' ages or tooth types. The chief complaints (spontaneous pain, occlusal pain, sensitivity to heat or cold, discomfort, and the lack of symptoms) of both the pulp-reserved and endodontically-treated groups are summarized in Table 2. Five direct pulp capping cases were classified into the pulp-reserved group (n = 27), because the pulp of both the coronal and root remained vital. All direct capping procedures were performed for the cases in which the pulp was exposed during caries removal at the cracked area. No pulp treatment was performed for the remaining 22 cases, which were treated by occlusal adjustment and temporary restoration. During the

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