

Observable characteristics coincident with internal cracks in teeth

Findings from The National Dental Practice-Based Research Network

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Supplemental material is available online.

ABSTRACT

Background. This study determined if there are observable patient-, tooth- and crack-level characteristics markedly associated with whether a tooth with an external crack also has an internal crack.

Methods. Two hundred nine dentists in The National Dental Practice-Based Research Network enrolled 2,858 adults with a vital permanent posterior tooth having at least 1 observed external crack. Presence and characteristics of internal cracks were recorded for 435 cracked teeth that were treated. Generalized estimating equations were used to identify significant ($P < .05$) independent odds ratios associated with the tooth having internal cracks.

Results. Overall, 389 teeth (89%) had at least 1 internal crack, with 46% of these teeth having 2 or more internal cracks. Sixty-nine percent of treated cracked teeth were associated with 1 or more types of pain assessed before treatment; 53% were associated with cold testing, 37% with bite testing, and 26% with spontaneous pain. In the final model, biting pain, having an external crack that connected with a restoration, or an external crack that extended onto the root was each associated with more than a 2-fold increased odds of having an internal crack.

Conclusions. Essentially 9 of 10 teeth that had at least 1 external crack also had at least 1 internal crack.

Practical Implications. The external cracks that a dental practitioner should be most concerned about, because they are most likely to be associated with internal cracks in the tooth, are those in which the patient experiences biting pain, is connected with a restoration of some type, or extends onto the root.

Key Words. Cracked teeth; cracked tooth; internal crack; practice-based research; symptoms.

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The observation of teeth with cracks is an everyday occurrence for dental practitioners, but the most appropriate treatment for those teeth and the optimal timing of that treatment is often uncertain. Although there is extensive literature on the treatment of teeth with cracks, it has been pointed out that there is no widely accepted definition, diagnostics, or evaluative criteria for the word *crack* in many published studies, making interpretation of treatments and their effects difficult.¹ Treatment strategy is also complicated by the difficulty the practitioner has with reliably estimating the severity of the crack or crack system, especially the extent of penetration into the tooth. This may distinguish a crack from a craze, which is a surface crack in enamel only, and a fracture, in which 2 parts are separated.¹

Internal cracks, that is, cracks within the dentin that are unobservable from the external surface, are important because they may be associated with a higher risk of developing symptoms and needing invasive dental treatment, possibly with poorer outcomes. Unfortunately, no clinically

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available diagnostic tools are available for determining the depth of cracks into dentin or the presence of dentin cracks that eventually involve the enamel. High magnification ($\times 14$ to $\times 18$) provides profound visualization of enamel cracks,² but it is still deficient for detecting cracks in dentin in an intact tooth. Therefore, clarifying the association between observable characteristics of the patient, tooth, or crack system and the presence of internal tooth cracks would be useful for practitioners to help guide treatment decisions. Micro-computed tomography of extracted teeth was used to show a moderate but relevant association between the length of a crack on the occlusal surface and the proximal length of the crack, including the root surface.³

Determining associations between measurable characteristics and dental outcomes or conditions in an observational study requires a large sample size to provide adequate statistical power. The National Dental Practice-Based Research Network provides the ideal research context for such a study.⁴ This work represents 1 of several studies that investigated the association between the characteristics of teeth with cracks and a variety of conditions, such as tooth symptoms and crack progression.^{5,6}

Our objective was to determine if there are observable characteristics at the patient, tooth, and external crack level that are markedly associated with whether a posterior permanent tooth with at least 1 observable external crack also has an internal crack. The presence of an internal crack was visually verified during preparation of the tooth for restorative treatment.

METHODS

The detailed description of the process for enrolling patients and collecting data has been published.⁵ Overall, 209 participants in The National Dental Practice-Based Research Network (“network”) enrolled a convenience sample of 2,858 adult patients who had a vital posterior tooth with at least 1 observed external crack. For our study, an external crack was defined as an obvious break of the external contiguous structure of the tooth but involved no loss of tooth structure (for example, lost cusp). Teeth could be symptomatic or asymptomatic. Target patient enrollment per dentist was as many as possible, up to 20 within 8 weeks. The institutional review board of the lead investigators (T.J.H., J.L.F.) and those of the network’s 6 regions approved the study. Consent was obtained for all participating patients.

Patient-, tooth-, and crack-level data were collected by dentist and practice personnel who were trained in data collection. Data forms are publicly available at <http://nationaldentalpbrn.org/study-results/cracked-tooth-registry.php>. Cold, typically a refrigerant or ice, was used to confirm tooth vitality,⁷ although these or other methods used were at the discretion of the practitioner.

Of the 2,858 cracked teeth examined at baseline, 486 had a surgical treatment (extraction, endodontic, or restorative) completed at the same visit. As will be reported in a future article, teeth were most likely to be recommended for treatment when there was any evidence of pain, when caries was present, or when a crack could be observed on a radiograph (in only 5% of the teeth).⁸ Of the 486 teeth examined, dentists indicated that they could assess whether internal cracks were present on 437 teeth. Analyses are presented on 435 surgically treated cracked teeth for whom dentists indicated they were able to assess whether internal crack or cracks were present (data were missing for 2 teeth). The following characteristics of each identified internal crack were recorded: stained, connected with preexisting restoration, surface involved, cusps involved, connected with another crack, continuation of an external crack, crack included enamel, and crack included dentin.

The 435 cracked teeth were treated by 152 practitioners (range, 1-12 patients/practitioner; median, 2 patients/practitioner; interquartile range, 1-4 patients/practitioner), from April 8, 2014, through April 30, 2015. There were from 22 through 31 practitioners from across each of the 6 regions of the network, and the mean number of patients per practitioner did not vary by region ($P = .3$), ranging from 2.00 (South Atlantic) to 3.27 (Western).

As previously described,⁵ teeth were classified as symptomatic if they had pain to cold ($n = 230$; 53%), on biting ($n = 163$; 37%), or were spontaneously painful ($n = 113$; 26%). Of the 435 teeth, 69% had 1 or more types of pain ($n = 298$), and of the 298 teeth that were painful, 142 (48%) had only 1 type of pain, 104 (35%) had 2 types of pain, and 52 (17%) had all 3 types of pain (Figure 1). To distinguish a painful response from a normal response by a vital tooth, dentists were asked to test and compare a normal tooth; for example, a contralateral tooth.

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