

# Approaches to managing asymptomatic enamel and dentin cracks

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Asymptomatic enamel and dentin cracks can pose a risk for multiple pathological and undesired consequences if intervention is postponed. This article reviews asymptomatic enamel and dentin cracks, and presents current management approaches utilized by a sample of general dentists. Becoming familiar with all forms of asymptomatic enamel and dentin

cracks is crucial to adopting a proactive approach of prevention, early diagnosis, and intervention to control the potentially detrimental effects of these cracks on the dentition.

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An incomplete tooth fracture, also known as a tooth *crack*, is a fracture without visible separation of the segments along the plane of the fracture.<sup>1</sup> Incomplete tooth fractures can be subtle and difficult to diagnose, especially when asymptomatic. However, they pose a risk for multiple pathological and undesired consequences that can eventually render the tooth unsavable.

The pathological consequences can range from caries to pulpal and periodontal involvement to complete tooth fracture.<sup>2-8</sup> Walker et al demonstrated that enamel cracks provide caries-producing bacteria access to the dentin-enamel junction, thus leading to caries progression inside the tooth without any externally visible evidence.<sup>2</sup> Abou-Rass suggested that asymptomatic crack lines are precursors to the symptomatic *cracked tooth syndrome*.<sup>3</sup> Krell & Rivera found a 9.7% incidence of cracks in all teeth referred to an endodontic practice within a 6-year period, excluding cusp fracture, vertical root fracture, and split teeth.<sup>5</sup> In their study, 20% of the cases diagnosed as cracked teeth with reversible pulpitis and treated with full crown restorations nevertheless progressed to irreversible pulpitis or to necrotic pulp within 6 months.<sup>5</sup> Pitts & Natkin described periodontal involvement associated with tooth cracks as bone loss produced by chronic inflammation along the fracture line, causing a narrow isolated pocket and radiographically linear bone loss along the root surface.<sup>6</sup> In a study of cusp fracture in restored posterior teeth, Bader et al concluded that incomplete fractures are a predictor of complete cusp fractures, which have been found to have an incidence of 69.9/1000 persons each

year.<sup>7,9</sup> Finally, Braly & Maxwell concluded that fractures are the third most common cause of tooth loss behind caries and periodontal disease.<sup>10</sup>

Based on the evidence that incomplete tooth fractures can lead to major complications, and taking into consideration that the incidence of fractures increases with age, a more proactive approach, in which asymptomatic cracks are addressed early—before major complications occur—should be considered. This is especially relevant with the current aging population.<sup>7,10,11</sup>

However, there has been less agreement among dentists on which teeth are at risk of fracture, and which teeth require intervention for the prevention of fracture.<sup>12</sup> A recent literature review concluded that there is no universally accepted restorative protocol to treat cracked tooth syndrome.<sup>13</sup> Consequently, this author conducted a literature review of managing asymptomatic

enamel and dentin cracks, and conducted a survey using clinical images during multiple presentations to determine how general dentists currently manage these cracks in their general practice.

## Materials and methods

The author gave presentations on managing incomplete tooth fractures to 4 different groups of dental professionals in Northern California between March 2012 and March 2013. A total of 71 dental professionals—54 general dentists, 15 dental specialists, and 2 dental hygienists—attended these presentations. At the beginning of the presentations, clinical photographs of asymptomatic enamel and dentin cracks in posterior teeth were projected on a screen to ensure uniformity in the referenced cases. Enamel and dentin cracks were classified according to their direction (vertical or oblique)

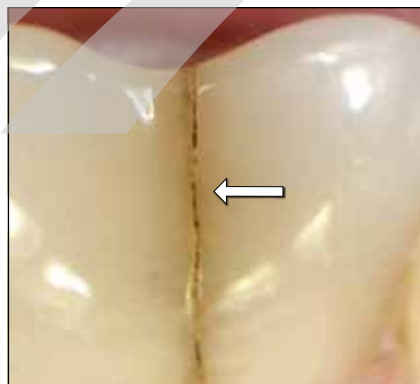


Fig. 1. Mandibular left first molar, lingual view. Stained enamel crack detectable by an explorer.



Fig. 2. Maxillary left first molar, buccal view. Oblique enamel crack originating from the corner of restoration and detectable by transillumination.

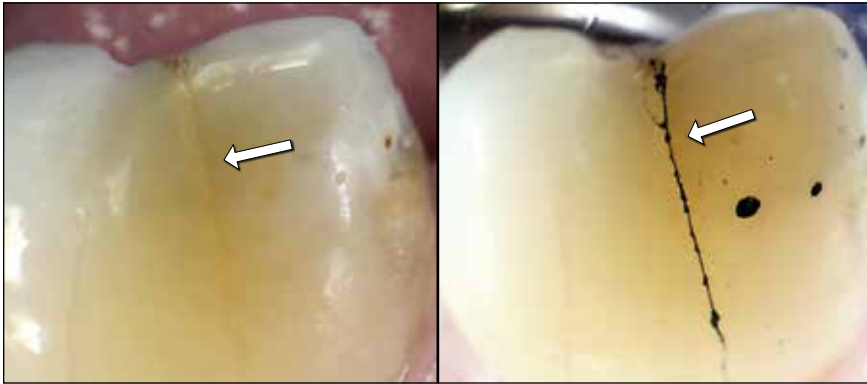


Fig. 3. Mandibular left second molar, buccal view. *Left.* Unstained vertical enamel crack. *Right.* The crack accepts methylene blue dye.

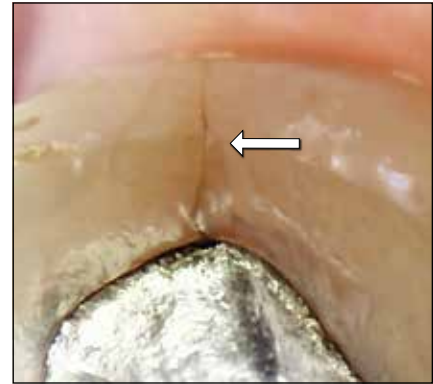


Fig. 4. Mandibular right second molar, occlusal view. Stained vertical enamel crack undetectable by an explorer.

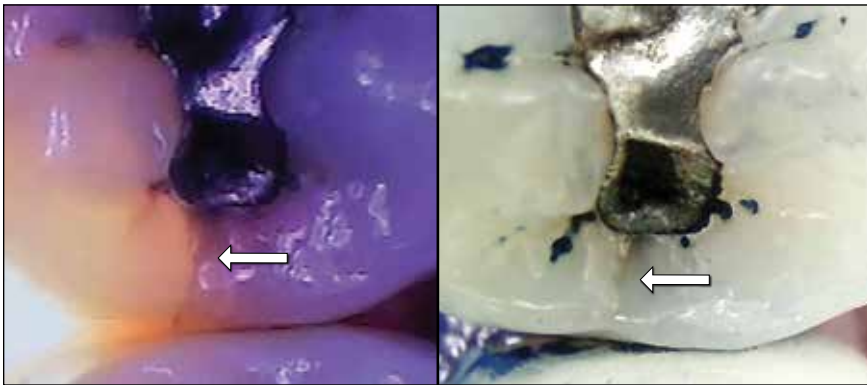


Fig. 5. Maxillary right second molar, occlusal view. *Left.* Unstained vertical enamel crack detectable by transillumination. *Right.* The crack does not accept methylene blue dye.



Fig. 6. Mandibular right first molar, occlusal view. Stained vertical dentin crack.

and the presence of stain. Enamel cracks were additionally classified based on their detection by tactile examination with an explorer, transillumination, and staining with methylene blue dye. All attendees were then asked to answer multiple choice questions regarding the approaches they utilize in their practice to manage the projected asymptomatic enamel and dentin cracks, such as when and what they recommend for intervention. To preserve anonymity, participants were asked not to write their names on their answer sheets. Some of the dental specialists who attended the presentations limited their practice to their specialty and did not directly treat asymptomatic cracks. Seven dental specialists and 2 dental hygienists did not complete the survey. Therefore, only responses from general dentists were included in the

results. Of the 54 responses from general dentists, 3 were excluded as their answers were incomplete; descriptive statistics of responses from the remaining 51 general dentists were then computed.

#### **Survey results**

The majority of the general dentists (73%) would recommend to their patients the removal of intracoronal restorations in order to explore the extension of asymptomatic vertical enamel cracks in posterior teeth when these cracks were both stained and detectable by an explorer, even though the restorations were not compromised and the teeth had no evidence of decay (Fig. 1). This was followed by 62% of the general dentists who would recommend to their patients the removal of intracoronal restorations

to explore for oblique enamel cracks originating from the corner of restorations and detectable by transillumination (Fig. 2). Twenty-nine percent would recommend removal for vertical enamel cracks that were unstained but accepting methylene blue dye (Fig. 3); 25% would recommend removal for vertical enamel cracks that were stained but undetectable by an explorer (Fig. 4); and 12% of the general dentists surveyed would recommend the removal of intracoronal restorations to explore for unstained vertical enamel cracks that were detectable by transillumination but were not accepting methylene blue dye (Fig. 5). Twenty percent of participants would not recommend the removal of intracoronal restorations to explore the extension of asymptomatic enamel cracks.



Fig. 7. Mandibular right first molar, occlusal view. Stained oblique dentin crack.



Fig. 8. Maxillary left first molar, occlusal view. Unstained vertical dentin crack.

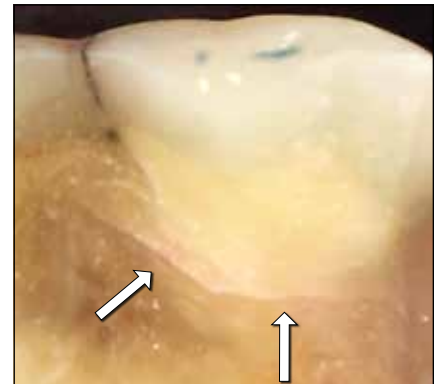


Fig. 9. Mandibular right first molar, occlusal view. Unstained oblique dentin crack.

With regard to asymptomatic dentin cracks, 86% of general dentists in the sample would recommend treatment for stained vertical dentin cracks (Fig. 6) and 84% would recommend it for stained oblique dentin cracks in posterior teeth (Fig. 7), followed by 65% for both unstained vertical dentin cracks and for unstained oblique dentin cracks (Fig. 8 and 9). Eight percent of the general dentists surveyed would not recommend any treatment for asymptomatic dentin cracks.

Participants were then asked to rank their treatment approaches (restorative and/or occlusal) for asymptomatic vertical and oblique dentin cracks noted after restoration removal, regardless of the relationship between isthmus width and cusp-to-cusp distance. Participants were able to give the same ranking to multiple treatment approaches if they would recommend them simultaneously, such as occlusal treatments in conjunction with a restorative approach. The treatments of choice (TOC) for the 47 general dentists who treat asymptomatic dentin cracks are presented in the Table. The majority of participants were in favor of occlusal coverage restorations, such as full crown and onlays. Protective occlusal hard bite plates and occlusal adjustments of opposing and cracked teeth were the primary TOC when used in conjunction with restorative treatments.

## Literature review

### Diagnosis of asymptomatic cracks

Asymptomatic enamel and dentin cracks can be very subtle and difficult

to diagnose. They can be evaluated by transillumination, staining with dyes such as methylene blue dye, and tactile examination with a sharp explorer.<sup>14-16</sup> Visual examination can also be enhanced by magnification with tools such as magnifying loupes, intraoral photography, and microscopes.<sup>14,15,17</sup>

### Management of asymptomatic enamel cracks

The traditional classifications of cracks placed less emphasis on the possibility of underlying pathologies of enamel cracks.<sup>17</sup> Fortunately, more modern approaches are taking asymptomatic enamel cracks into consideration.

Clark et al classified asymptomatic enamel cracks based on the risk of underlying pathologies such as dentin cracks, decay, and severely undermined enamel that allow microleakage.<sup>17</sup> According to their analysis, cracks with wedge-shaped enamel ditching and cracks that either detour from or do not follow anatomic grooves have a moderate risk of underlying pathology.<sup>17</sup> Diagonal cracks, cracks that house debris, and cracks with a brown, gray, or white corresponding “halo” have a high risk of underlying pathology.<sup>17</sup> The greater the risk, the more strongly it is recommended to remove the restoration for further evaluation, followed by treatment of any underlying pathology as needed, even if the tooth is asymptomatic.<sup>17</sup>

Table. The treatment of choice (TOC) for asymptomatic vertical and oblique dentin cracks chosen by general dentist survey participants (n = 47).

	TOC for vertical dentin cracks (%)	TOC for oblique dentin cracks (%)
Full crown restoration	51	40
Indirect occlusal coverage restoration (such as porcelain onlay restoration)	19	32
Direct bonded composite intracoronal restoration	17	13
Direct occlusal coverage restoration (such as bonded composite onlay restoration)	4	2
Protective occlusal hard bite plate <sup>a</sup>	21	23
Occlusal adjustment of opposing tooth <sup>a</sup>	17	17
Occlusal adjustment of cracked tooth <sup>a</sup>	13	19

<sup>a</sup>Occlusal treatments were mainly chosen as the TOC in conjunction with restorative treatments. As a result, the responses do not add up to 100%.

In their study of cusp fracture in restored posterior teeth, Bader et al concluded that external fracture lines that are detectable with an explorer should be considered strong indicators of elevated risk of complete fracture.<sup>7</sup> However, it has been emphasized that even dramatic enamel cracks may not necessarily indicate the presence of any underlying pathology.<sup>8,17</sup>

Ratcliff et al classified posterior enamel cracks based on the presence of stain and restorations, and suggested that stained cracks are most likely to be treated due to their appearance.<sup>11</sup> The authors also concluded that equilibrating the occlusion for maximum intercuspation and eliminating excursive interferences may prevent the propagation of asymptomatic cracks.<sup>11</sup>

Walker et al also suggested that stained cracks should be considered as permeable or permeated by cariogenic bacteria, and that cracks displaying a shadow under transillumination indicate the presence of caries.<sup>2</sup> Intervention is recommended for these cracks to block bacterial invasion and stop the progression of caries.<sup>2</sup>

### **Management of asymptomatic dentin cracks**

Taking a more proactive approach of assessing enamel cracks based on the possibility of underlying pathologies—such as dentin cracks—brings another dilemma to practitioners regarding what to do when an asymptomatic dentin crack is discovered.

Dentin cracks should be considered structural cracks and therefore protection from occlusal forces to minimize fracture propagation is indicated.<sup>3,8,17</sup> However, Clark et al speculated that intracoronal restorations and occlusal adjustments might be proven insufficient to stop structural breakdown associated with cracks, and that occlusal coverage is mandatory.<sup>17</sup> Replacing an asymptomatic cracked cusp with a restoration when 1 cusp is involved has been recommended.<sup>8</sup> When more than 1 cusp is involved or there are asymptomatic vertical cracks, placing a full crown restoration is recommended.<sup>3,8</sup>

Currently the literature—including clinical trials—focuses mainly on the treatment of symptomatic cracks. However, the principles used to treat symptomatic cracks can be applied to the treatment of asymptomatic teeth predisposed to cracking; this includes the treatment of

asymptomatic cracks to limit their progression and thus prevent any subsequent undesired consequences.<sup>4</sup>

Occlusal adjustment has been recommended as an initial treatment for cracked tooth syndrome.<sup>4</sup> Although there is no universally accepted restorative protocol in the treatment of symptomatic cracks, it is generally agreed that the aim of restorative therapy is to immobilize the segments of the tooth that tend to move during loading.<sup>13</sup> Opdam et al found that direct composite restorations maintained the pulp vitality of >90% of cracked, painful teeth, resulting in a complete elimination of pain in 75% of the affected teeth over a 7-year period.<sup>18</sup> The authors also had more success with cuspal coverage than without.<sup>18</sup> Modern approaches advocate reinforcing resin-based restorations with leno-weave ultra high modulus polyethylene ribbon fibers in order to bridge cracks and strengthen teeth against fractures.<sup>19,20</sup> Crown restorations were successful in maintaining pulp vitality in 80% of cracked teeth diagnosed with reversible pulpitis over a 6-year period.<sup>5</sup> Additionally, altering traditional crown preparations (such as beveling fractured cusps), using bases and build-ups under crown restorations, and placing margins more apically were suggested to minimize external forces and prevent the propagation of fractures underneath crown restorations.<sup>21</sup> Additional clinical trials comparing these direct and indirect treatment options are required to determine the best treatment for the various forms of incomplete tooth fractures.<sup>18,22</sup>

### **Prevention of cracks**

Whenever possible, the proactive prevention of tooth cracks is the optimal treatment choice. This requires a deep understanding of the etiology of tooth cracks in an effort to control the contributing factors to their formation. The etiology of teeth cracks is complex and multifactorial; Lynch & McConnell proposed 10 factors that contribute to cracked teeth, citing 17 examples.<sup>23</sup> The most commonly emphasized etiologic factors are the loss of dentin support due to relatively large intracoronal restorations, and traumatic occlusal forces, especially when accompanied by excursive interferences.<sup>4,7,11</sup>

The susceptibility of teeth to fracture has been measured in terms of isthmus width in relation to cusp-to-cusp distance.<sup>24</sup> If teeth have been weakened due to wide cavity preparations, they need to be stabilized via indirect restorations, such as full cuspal coverage or bonded inlays.<sup>25</sup> However, the isthmus width is not the only factor that needs to be considered. The depth of the restoration along the isthmus width can be a more accurate measurement of the lack of dentin support.<sup>7</sup>

Recent research has shown that the prevalence of cusp fractures in amalgam restored teeth was found not to be significantly different than resin composite restored teeth.<sup>26</sup> These new findings may further shift the emphasis away from treatment plans that are based mainly on the choice of restoration materials, as these may result in designs that weaken the teeth. Conservative cavity preparations that preserve tooth structure without connecting multiple occlusal preparations have been advocated.<sup>17</sup> Additionally, rounded internal line angles have been recommended over sharp line angles to avoid stress concentrations.<sup>23</sup>

Nonrestorative approaches have also been recommended to prevent cracks. Occlusal adjustment of nonfunctional cusps of teeth predisposed to cracking—such as teeth with excessive cuspal wear, heavy wear facets, worn restorations, or posterior malocclusion—has been recommended, especially when the patient has a history of cracked tooth syndrome.<sup>4</sup> Although occlusal guards have not been directly linked to preventing cracks and limiting their progression, they are considered useful protectors of teeth against the damage caused by bruxism. Thus they are an option worthy of consideration in patients with a history of symptomatic cracks and evidence of bruxism.<sup>27</sup>

### **Summary**

The majority of the general dentists who completed this survey would recommend intervention for some forms of asymptomatic enamel cracks, but were more proactive when it came to treating asymptomatic dentin cracks, emphasizing restorations that provide occlusal coverage. Becoming familiar with the existence of all forms of asymptomatic enamel and dentin cracks, the modern methods of

their diagnosis, and the levels of risk of underlying pathologies is crucial to adopting a proactive approach of prevention, early diagnosis, and intervention before major complications occur. In the wake of limited available knowledge, and until more evidence validates the necessity and the different modes of intervention for all forms of asymptomatic cracks, clinicians must rely on their clinical experience in weighing the benefits and risks of observation vs intervention, and then guide their patients to make informed decisions.

### Author information

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