

# Definitive Diagnosis of Early Enamel and Dentinal Cracks Based on Microscopic Evaluation

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## ABSTRACT

The diagnoses of cracked teeth and incomplete coronal fracture have historically been symptom based. The dental operating microscope at  $\times 16$  magnification can fundamentally change a clinician's ability to diagnose such conditions.

Clinicians have been observing cracks under extreme magnification for nearly a decade. Patterns have become clear that can lead to appropriate treatment prior to symptoms or devastation to tooth structure occur. Conversely, many cracks are not structural and can lead to misdiagnosis and overtreatment. Methodic microscopic examination, an understanding of crack progression, and an appreciation of the types of cracks will guide a doctor to making appropriate decisions.

Teeth can have structural cracks in various stages. To date, diagnosis and treatment are very often at end stage of crack development.

## CLINICAL SIGNIFICANCE

This article gives new guidelines for recognition, visualization, classification, and treatment of cracked teeth based on the routine use of  $\times 16$  magnification. The significance of enamel cracks as they relate to dentinal cracks is detailed.

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Macroscopic and symptom-driven diagnoses have been the accepted modalities for cracked teeth. The inherent limitations of the lack of visual confirmation result in therapies that often come too late in the treatment process. One lasting first impression of vision through a clinical microscope is the staggering array of cracks that exist within tooth structures. Traditional visualization (unaided

or ocular assisted) limits the clinician's ability to assess the presence or severity of the majority of these cracks (Figure 1).

At extreme magnification levels ( $\times 14$  and greater), the translucent nature of enamel yields a wealth of information. Subtle color changes within the enamel may indicate early decay, microleakage, and a lack of structural integrity of dentin and

enamel. Being able to see previously invisible clues can lead restorative dentists to more appropriate early treatment of compromised teeth before devastating fractures, pulpal involvement, and periodontal breakdown occur. The value of early diagnosis of the structural breakdown of teeth will become even more significant with our aging population coupled with increased tooth retention in this population.

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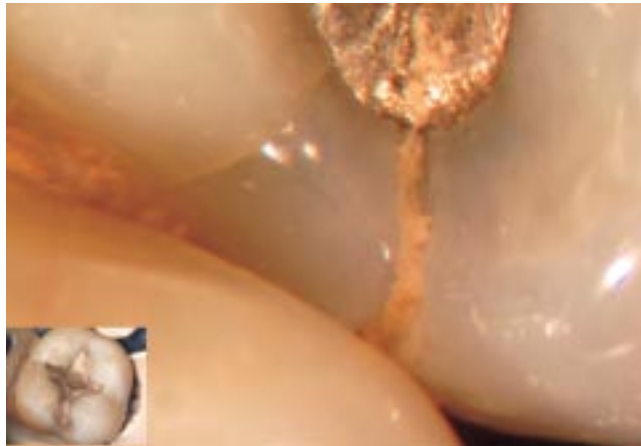


Figure 1. Lower first molar. Unimpressive at lower ( $\times 2-6$ ) magnification, this crack gives a wealth of information when observed with the microscope. A significant vertical crack was observed in the dentin after amalgam removal.

The purpose of this article is to present an intuitive system for detecting and describing enamel and dentinal cracks based on visual examination at  $\times 16$  magnification. Experienced clinicians using the clinical microscope have reached a general consensus that  $\times 16$  provides an ideal magnification level for the evaluation of enamel cracks, with a range of  $\times 14$  to  $18$ .<sup>1</sup> A  $\times 16$  magnification level provides optimal information about enamel cracks and falls within the range of magnification the majority of current microscopes feature today.

To highlight the contents of this article, numerous clinical photographs are shared depicting enamel and dentinal cracks. *Unless otherwise noted*, at the time the photographs were taken, all teeth shown were asymptomatic and had been previously restored with Class I amalgams.

#### REVIEW OF THE LITERATURE

A significant effort has been made internationally to describe the con-

ditions of the cracked tooth, producing numerous classification and nomenclature systems in an attempt to assist the clinician in the diagnosis (Table 1). The primary emphasis in existing literature has been centered on symptom-driven diagnosis. The current nomenclature and classification has been formulated for dramatic end stages in which pulpal involvement, bone loss, and often devastating weakening of the dentinal structure have occurred. To date there is little description or classification of enamel cracks based on a visual diagnosis done with a clinical microscope.

Current American and Canadian literature on this topic group cracks

TABLE 1. COMMONLY USED NOMENCLATURE IN LITERATURE FOR INCOMPLETE DENTAL FRACTURES.

Nomenclature	Study (yr)
Cuspal fracture odontalgia	Gibbs <sup>2</sup> (1954)
Fissured fracture	Thoma <sup>3</sup> (1954)
Incomplete tooth fracture	Ritchey et al <sup>4</sup> (1957)
Fissural fracture	Down <sup>5</sup> (1957)
Crack lines	Sutton <sup>6</sup> (1961)
Greenstick fractures	Sutton <sup>7</sup> (1962)
Cracked tooth syndrome	Cameron <sup>8</sup> (1964)
Hairline fracture	Wiebusch <sup>9</sup> (1972)
Incomplete crown-root fracture	Hiatt <sup>10</sup> (1973)
Incomplete coronal fracture	Talim and Gohil <sup>11</sup> (1974)
Split-root syndrome	Silvestri <sup>12</sup> (1976)
Enamel infraction	Andreasen <sup>13</sup> (1981)
Hairline tooth fracture	Caufield <sup>14</sup> (1981)
Crown craze/crack	Johnson <sup>15</sup> (1981)
Craze lines/tooth structure cracks	Abou-Rass <sup>16</sup> (1983)
Cracked cusp syndrome	Kruger <sup>17</sup> (1984)
Tooth infraction	Lost et al <sup>18</sup> (1989)

and fractures as incomplete coronal fractures, cracked tooth syndrome, horizontal root fractures, and retrograde root fractures. Fractures are either incomplete or complete.<sup>2-18</sup> The British approach differs. The term *incomplete tooth fracture (ITF)* is used to describe all cracks. Additionally, vertical cracks in virgin anterior teeth are included in this ITF classification system.<sup>19</sup> In North American journals the authors typically classify vertical cracks in virgin anterior teeth as craze lines.

#### HISTORIC VISUAL EVALUATION TECHNIQUES

Historically, methylene blue dye, caries indicator, transillumination, and alternative hydration and dehydration of tooth structure have aided in the visualization of cracks. Transillumination is probably the most common modality for traditional crack diagnosis. There are two drawbacks to using transillumination without magnification. First, transillumination dramatizes all cracks to the point that craze lines appear as structural cracks. Second, subtle color changes are rendered invisible.

Methylene blue dye has been used extensively by endodontists to highlight radicular cracks and fractures. It is beginning to be promoted as an aid for visualizing coronal cracks. Methylene blue dye is helpful because of its pooling tendency. Its flocculent nature makes it different from other dyes such as caries indicator. However, the limitations of methylene blue dye should be recognized and are as follows:

- Plaque stains profusely, and repeated deplaqueing may be required.
- Lightly decalcified enamel and dentin absorb the dye, actually obscuring any cracks (Figure 2).
- Prolonged exposure to sodium hypochlorite can cause massive absorption of dye by dentin. Therefore, it is recommended that when searching for radicular cracks, one applies the stain as soon as pulp chambers and root canal systems are accessed.
- Methylene blue obscures subtle color changes deeper in the enamel.
- Methylene blue may lead clinicians inexperienced with the use of the clinical microscope to mistakenly believe that benign cracks or simple anatomic grooves are structural cracks.
- Over-reliance on dyes may handicap a clinician's ability to routinely discover early cracks.

#### PROTOCOL FOR MICROSCOPIC EXAMINATION

This article focuses on the assessment of cracks in the posterior dentition because anterior and posterior teeth have significant differences in crack propagation. These differences relate to the different anatomic design of the teeth and the direction and intensity of occlusal forces. Anterior cracks will be evaluated in future articles.

A cleaning and desiccation protocol is important prior to crack inspection because plaque and moisture make microscopic cracks virtually impossible to visualize at any magnification. All posterior teeth to be evaluated are polished with a rubber cup and coarse pumice slurry. The teeth are then completely desiccated. If desired, methylene blue is applied with a disposable applicator tip. The tooth is viewed through the clinical microscope in the mag-

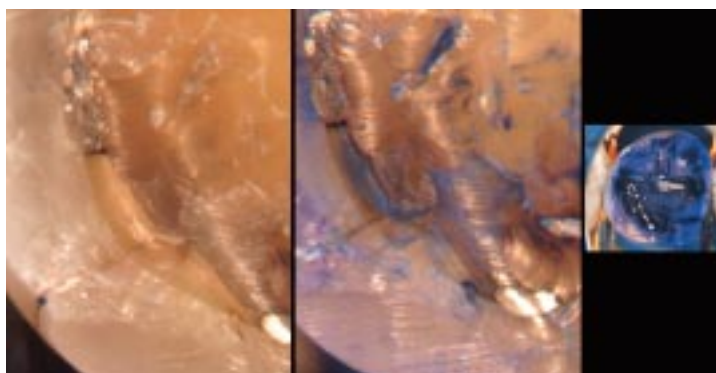


Figure 2. Upper first molar. Occlusal reduction for the crown is in progress. An oblique dentinal crack was better visualized before dye application. When this occurs a 10-second etch with phosphoric acid removes most of the unwanted dye and the dye in the crack remains. Another important clue is demonstrated; the crack itself is often less obvious than is the color difference of dentin on either side of the crack.

nification ranges of  $\times 14$  to  $18$ , with the maximum lighting intensity setting. This view provides an opportunity for photograph taking for documentation, patient education, patient records, or research.

Debris retention can also be an important diagnostic aid. Particle size of coarse pumice (Henry Schein laboratory pumice coarse 100-2796, Melville, NY, USA) can vary from  $200$  to  $700 \mu$  (Figure 3). Significant pumice retention indicates that crack width is at least  $200 \mu$ . As deplaquing of the tooth should be part of the microscopic protocol, debris or pumice retention in significant cracks is a constant.

Posterior teeth with mesio-occlusodistal restorations provide some of our greatest challenges to microscopic visualization. They require exquisite deplaquing and, for deeper restorations, gentle tissue

retraction with an explorer or brief placement of an interproximal wedge. The coaxial shadowless light from the microscope further assists in the inspection of this important area.

Although additional technologies are being developed that will enable us to measure the structural integrity of teeth, these products are not currently available. Visual examination, therefore, remains our most critical part of diagnosis.

#### NOMENCLATURE AND CLASSIFICATION SYSTEM FOR ENAMEL CRACKS

With the introduction of high-level magnification and illumination through the clinical microscope, a refined nomenclature and classification system for enamel cracks is indicated. The following is a proposed template for a classification system of enamel cracks based on a combination of visual observation

at  $\times 16$  and existing opinions in the current literature. It is important that the clinician recognize that these are diagnostic “clues” and not a definitive diagnosis. The clinician must also bear in mind while assessing enamel cracks that other variables, such as the age of the patient, the location of wear facets, parafunctional activity patterns, and the actual position of the crack as it relates to occlusal loading and existing restorations, must be considered in the diagnostic process. As additional research is added to this current clinical data, it will provide a more systematic approach for diagnosis and treatment.

#### Type I: Little or No Risk of Underlying Pathology

It is proposed that type I cracks include the following:

- A. Craze lines—these are usually linear and vertical and do not widen or become more pronounced as they extend from gingival to occlusal (Figure 4)
- B. Vertical cracks not associated with restorations and without environmental stain penetration
- C. Cracks that follow natural anatomic grooves (Figure 5)
- D. Cracks with superficial environmental stain penetration (Figure 6)
- E. Cracks that result from polymerization shrinkage of composites (Figure 7)

Proposed treatment modalities for type I defects include preventive

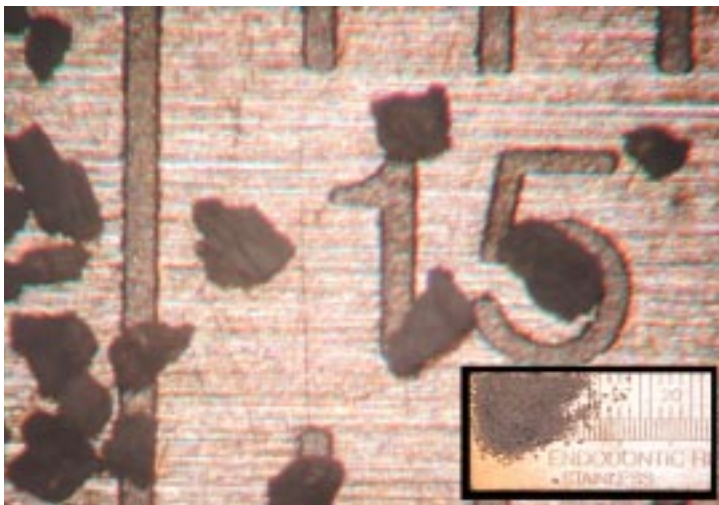


Figure 3. Coarse pumice at  $\times 24$ .





Figure 4. Lingual view of a lower first molar. Craze lines (right and left) are present along with a diagonal crack (center). In this example subtle brown and gray halos are centered over the diagonal crack in a bull's-eye pattern.



Figure 5. Occlusal view of a lower second bicuspid. Many posterior teeth in adults have these types of cracks. No treatment is indicated.

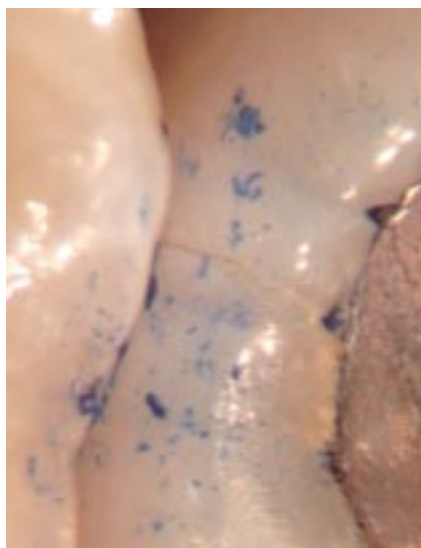


Figure 6. Distal marginal ridge of an upper first molar. During subsequent crown preparation (not pictured), no underlying dentinal cracks were observed that corresponded with this enamel crack.

measures such as no treatment, continued observation, occlusal adjustments, and protective occlusal splints.

### Type II: Moderate Risk of Underlying Pathology

It is proposed that type II cracks include the following:

- A. Wedge-shaped enamel ditching resulting from a loss of enamel tooth structure with no prior restoration, often associated with a wear facet and localized occlusal loading centered over an otherwise benign crack
- B. Wedge-shaped enamel ditching resulting from a loss of enamel tooth structure with an adjoining restoration, often associated with a wear facet and localized occlusal loading centered over an otherwise benign crack (Figure 8)

- C. Cracks that detour from or do not follow anatomic grooves (Figure 9)

Proposed treatment modalities for type II defects include preventive measures, a review of patient history of thermal and functional sensitivity, restorative investigation, or definitive restorative treatment if the current restoration is deemed compromised.

### Type III: High Risk of Underlying Pathology

It is proposed that type III cracks include the following:

- A. Diagonal cracks branching off from a vertical crack; these often are indicative of a late-stage oblique incomplete fracture (Figure 10)
- B. Horizontal or diagonal cracks that normally emanate from the

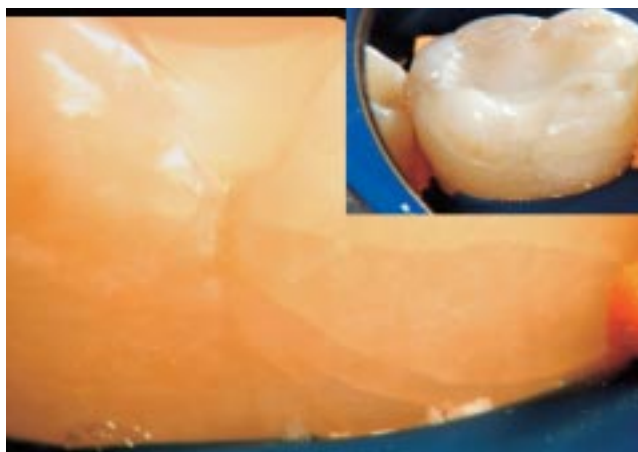


Figure 7. An undermined mesiolingual cusp was no match for polymerization shrinkage of a bonded composite. Several horizontal enamel cracks are present but do not extend into the dentin.



Figure 8. Occlusal view of a lower second bicuspid. Although dramatic, this type II-B crack (wedge-shaped enamel ditching centered over an otherwise benign crack) will be monitored.

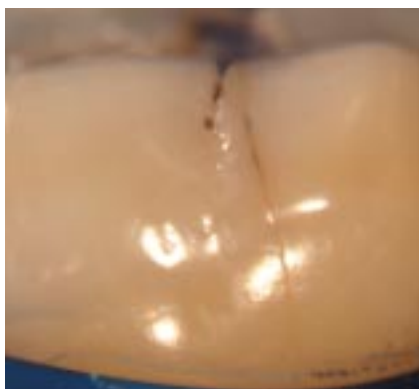


Figure 9. Lingual view of a lower second molar. Note the lingual groove to the left and crack to the right. The crack is nonlinear, nonvertical, and widens as it extends occlusally. Significant vertical and oblique dentinal cracks were viewed after amalgam removal.



Figure 10. Upper first molar. The vertical crack readily accepts dye. The diagonal crack (arrows) does not accept the dye. A diagonal crack is an indicator of the final stage of cuspal fracture.

corner of a restoration; they narrow as they extend gingivally and are typically nonlinear (see Figures 4 and 11)

- C. Cracks that house debris, with or without previous restorations (indicative of a crack size of approximately 200  $\mu$  or greater) (see Figure 1)
- D. Pairs of cracks that outline an area (cusp[s] or marginal ridge) of discolored enamel; these show a high potential for an underlying dentinal crack and future complete fracture (see Figures 1 and 12)
- E. Cracks with a corresponding “halo” of brown, gray, or white centered on the crack (see Figures 4 and 13)

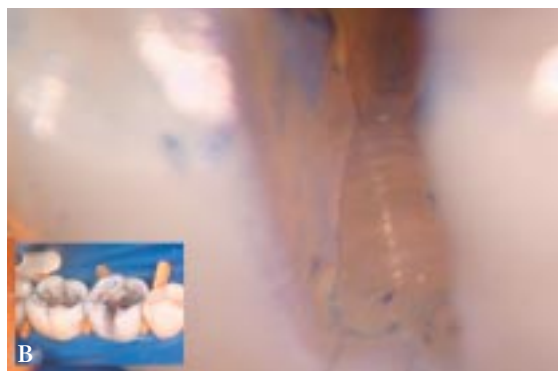
There are several proposed treatment modalities for type III defects. The protocol for high-risk enamel cracks calls for removal of the old restoration, if present. If decay or microleakage is the underlying pathology, standard treatment is recommended. If a dentinal (structural)

crack is the underlying pathology, protection of the incomplete fracture from occlusal forces is indicated. How early and in what manner teeth with microscopic dentinal cracks should be treated depends upon the clinician's assessment.

#### CUMULATIVE DIAGNOSIS

The sources of enamel cracks can be multifactorial and can develop over lengthy time frames. The presence of enamel cracks, even dramatic ones, does not necessarily indicate the presence of an incomplete coronal fracture or cracked tooth syndrome because enamel cracks do not always penetrate into dentin. Also, significant enamel cracks often exist in the absence of dentinal cracks. Three types of underlying pathology are often seen accompanying enamel cracks: dentinal cracks, decay, and severely undermined enamel that allows microleakage.

Recognition of most enamel crack types becomes routine after significant experience with the micro-



Figures 11. A and B, Three cracks are present on a facial view of the lower right first molar. After the amalgam is removed, we observe that a diagonal crack on the left has severely undermined the distobuccal cusp. A vertical crack (center) was insignificant. The tooth was symptomatic.



Figure 12. Distopalatal cusp with subtle darkening. This tooth was symptomatic. The palatal view is featured in Figure 10. A significant dentinal crack was observed after amalgam removal. The patient was frustrated because her previous dentist could not find anything wrong with the tooth.

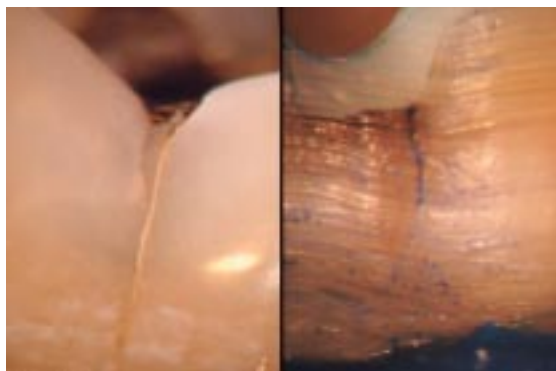


Figure 13. Lingual view of the lower left first molar. A subtle darkening or halo is centered on a crack that does not follow the anatomic groove and houses very fine debris. The prepared tooth shows a dentinal crack. The occlusal view of this tooth is shown in Figure 15.

scope. The exception is that types II-A and II-B (wedge-shaped enamel ditching centered over a benign groove) can be mistaken for type III-C (cracks that houses debris). Type II-A and II-B cracks are common and dramatic in appearance at high magnification. At first appearance they give the impression that the tooth is splitting. However, they are misleading and, in fact, are often fairly superficial (Figure 14). There are two keys to differentiation. An enamel ditch does not retain pumice and debris. It is not a true crack. Additionally, a ditch is shallow and does not continue apically. This is revealed at clinical examination at  $\times 16$  to  $24$  (Table 2).

Dentinal cracks should be considered structural cracks. They typically fall into two types: vertical, generally positioned in the middle of the pulpal floor; and oblique, generally positioned at line angles of cavity preparations (Figure 15).<sup>20</sup> These very early fractures are preliminary

and need protection to minimize crack propagation (Figure 16).

#### CRACK PROGRESSION

Vertical cracks can initiate via several pathways. If the tooth is unrestored, the crack initiates in the enamel and progresses to the dentinal layer. If a Class II restoration is

present, depending on the design and surfaces involved, the crack can begin in enamel or dentin. They are most commonly observed in the center of cavity preparations. The cracks then progress apically (Figure 17). Most vertical cracks extend in a mesiodistal direction, but they can occasionally extend from a buc-

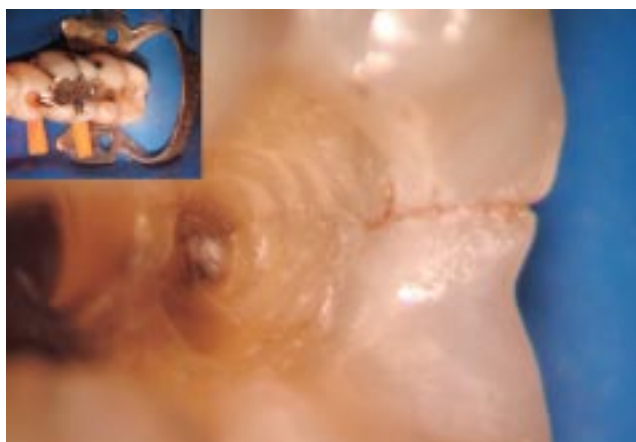


Figure 14. Lower right second molar. Enamel ditching is present centered over a benign crack. It looks dramatic under the microscope until the old restoration is removed. It is clear that no dentin is involved. The tooth is structurally sound; however, the distal marginal ridge will continue to deteriorate. Either the occlusal contact or the finish line will need to be moved if an intracoronal restoration is to be placed.

**TABLE 2. QUICK REFERENCE GUIDE FOR MICROSCOPIC CRACKS IN POSTERIOR TEETH.****General rules**

- Most teeth in aging adults display enamel cracks.
- Enamel cracks, even dramatic ones, do not necessarily indicate that the tooth is cracked.
- Many enamel cracks do not penetrate significantly into dentin.
- Many enamel cracks have multiple features; many teeth have multiple cracks.
- Three types of underlying pathology produce enamel cracks: dentinal cracks, decay, and undermined enamel often contributing to microleakage around a restoration.
- Dentinal cracks should be considered structural cracks.
- Dentinal cracks fall generally into two types: (1) vertical, generally positioned in the middle of the pulpal floor—“preradicular,” and (2) oblique, generally positioned at line angles of cavity preparations—“precuspal.”
- Many teeth exhibit both types of dentinal cracks; hybrid cracks are also common. Rigorous classification is less important than early recognition and treatment. All teeth with dentinal cracks should be considered structurally unsound.

**Associated microscopic findings**

- Microscopic cracks in restorative materials can also indicate a lack of coronal structural integrity (see Figure 16).
- Well-defined discoloration of a cusp or cusps can indicate a lack of structural integrity (see Figure 12).
- Unusual or unilateral gapping between an occlusal restoration and tooth structure can indicate a lack of structural integrity.

often follow the internal line angles as they progress. Visualization of cracks in the internal portions of tooth preparations presents unique challenges. Crisp line angles can masquerade as cracks and vice versa. Magnification of  $\times 24$  with additional contrast provided by dyes and alternate hydration/dehydration are all indispensable tools and techniques.

Oblique cracks may have a vertical component if the crack crosses a marginal ridge or a buccal/lingual groove. In such a situation the term *oblique* is not completely reflective of the crack's three-dimensional nature. As the crack nears complete fracture, diagonal or horizontal crack lines begin to appear in enamel. These diagonal and horizontal enamel cracks are subtle in the early stages, and visualization may require levels of magnification higher than  $\times 16$ . Additionally, the external manifestations of incomplete fracture are so slight that they

cal position lingually. Complete vertical fractures have been observed in virgin teeth by many clinicians (Figure 18).<sup>20</sup>

Oblique cracks typically initiate in dentin. A commonly observed starting point is at the line angle directly under the cusp, and cracks most



Figure 15. Lower first molar. A tiny crack in the alloy corresponds to a significant crack on the distal marginal ridge. Once the alloy is removed, a significant oblique dentinal crack is visible.

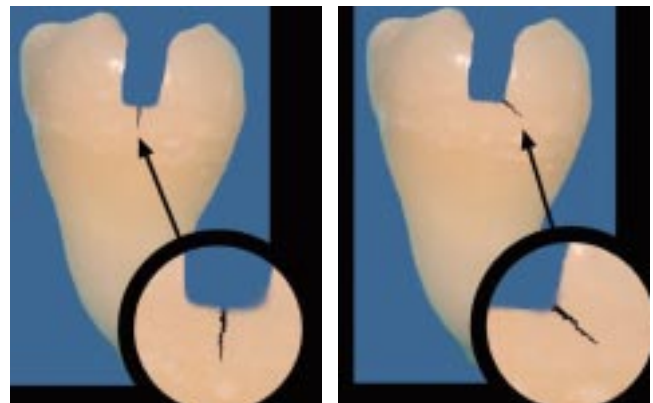


Figure 16. A very early (microscopic) coronal dentinal crack falls into one of two categories: a vertical (pulpal floor) crack (left) or an oblique (line angle) crack (right).



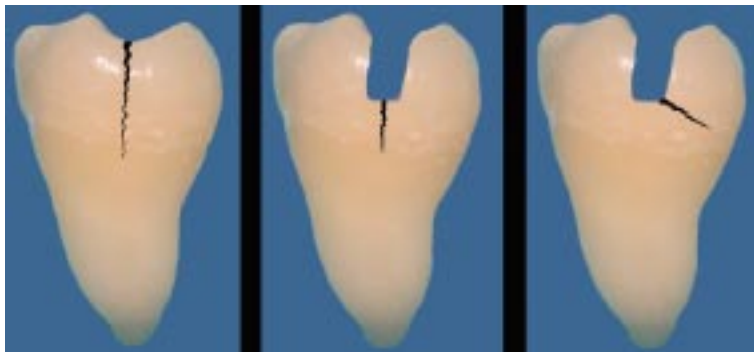


Figure 17. Late-stage progression of coronal cracks. Endodontic, periodontal, and restorative problems are now brought into play. Regular microscopic examinations can significantly reduce the number of teeth that reach traditional symptom-driven diagnosis and treatment.

generally do not accept methylene blue dye (see Figure 9).

A clinician has unimpeded vision when a restoration is removed. This is the opportunity to absolutely verify the presence or absence of structural dentinal cracks.

#### PREVENTIVE CAVITY DESIGN AND PROACTIVE TREATMENT

Traditional cavity designs and materials for incipient lesions are being questioned as to whether they predispose posterior teeth to fracture.<sup>21-23</sup> Minimally invasive preparations combined with the flexibility of composite bonded restorations provide alternative treatment options to the traditional designs and materials.<sup>24</sup> The goal of preventive preparations is to minimally involve dentin and to avoid connecting individual occlusal preparations to each other or to interproximal cavity preparations (Figures 19-21). A better understanding of crack propagation could allow more preventive design preparation modifications.

Once the diagnosis of structural dentinal cracks has been made, appropriate preparation design selection is critical. Some authors have recommended equilibration and bonded intracoronal restorations to stop crack progression.<sup>25,26</sup> However, future research may indicate that this is insufficient to stop structural breakdown and that



Figure 18. Unrestored upper left first molar with a complete vertical tooth fracture. The tooth was subsequently extracted. Note that the fracture did not follow the anatomic groove distally.

more protective extracoronal coverage is indicated.

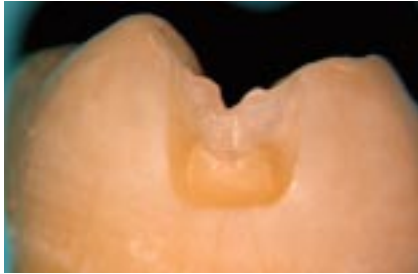
Vertical cracks often extend into the periodontium. When this occurs the choice must be made as to the location of the gingival margin as it relates to the biologic width. This may leave vertical cracks that extend apical to the gingival margin. Long-term outcomes of this choice will



Figure 19. An extracted lower third molar has a traditional interproximal cavity preparation in the left side of the tooth. On the right side a conservative interproximal cavity preparation is finished. A fissurotomy (red arrow) is in progress. Each enamel defect (black arrows) should be accessed individually. The traditional cavity preparation tempts us to "connect the dots." An enlightened understanding of crack progression will direct more preventive designs.



Figure 20. An interproximal view of a traditional class II preparation reveals the inherent weakening that is caused.



*Figure 21. Little dentin is removed with a conservative preparation. Note the preservation of a bridge of dentin and enamel. This is the area where many oblique (line angle) cracks originate when the occlusal and interproximal cavity preparations are joined. Tunnel preparations are taught as being conservative, but they may weaken the tooth because they involve the dentin.*

need study. Idiopathic periodontal breakdown is a concern (Figure 22).

#### CONCLUSIONS

For some clinicians the microscope is to cracks as radiographs are to decay. The nature of very early incomplete fractures requires the use of high-level magnification for discovery. The clinical microscope at magnification levels of  $\times 14$  and above allows detection of significant cracks long before incomplete coronal fractures and cracked teeth become symptomatic. Increasing numbers of clinicians are beginning to visualize these conditions through the clinical microscope. The preponderance and magnitude of enamel and dentinal cracks is just now beginning to be revealed. The microscope provides clinicians, especially restorative dentists and periodontists, the opportunity to circumvent potential devastation to posterior teeth.

Prevention of dental disease in the past has meant brushing, flossing,



*Figure 22. This patient had an upper second molar crowned 15 years previously. A stoma presented on the distal side at a recall examination. An electric pulp test indicated that the tooth was vital and that no mobility was present. Surgical exploration of the lesion with an operating microscope revealed a hopeless furcal bone loss. The osseous lesion was not consistent with typical periodontal breakdown. An idiopathic periodontal lesion associated with a deep vertical crack was the diagnosis.*

fluoride, and sealants. Today prevention of oral disease has a much broader definition and should include early methodic detection of enamel and dentinal cracks. Use of the clinical microscope makes possible the treatment of asymptomatic but structurally unsound posterior teeth. Although this may require a fundamental change in the thought process for some clinicians, waiting for symptoms in teeth with high-risk enamel cracks may eventually be compared with waiting until symptoms occur to treat decay.

#### DISCLOSURE AND ACKNOWLEDGEMENTS

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## COMMENTARY

### DEFINITIVE DIAGNOSIS OF EARLY ENAMEL AND DENTINAL CRACKS BASED ON MICROSCOPIC EVALUATION

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The use of magnification as a means for enhanced visual assessment and diagnosis of conditions within the dentition and supporting tissues has become progressively more prevalent over the past 10 to 15 years. As evidence of the likelihood that this trend will be sustained, many dental schools now strongly recommend or even require the use of magnifying loupes by the entering students. Once the bar is raised to allow a new level of diagnostic sensitivity, it is unlikely that a regression toward a lesser capability will occur.

This article does an outstanding job of focusing on the use of the surgical optical microscope within the specific example of identification of enamel cracks. The review presented herein provides exceptionally important information for the restorative dentist from several different perspectives. The authors provide excellent pictorial examples of cracks that are “native,” and they give the reader the understanding with which to differentiate native cracks from those cracks caused by other factors, including the placement of intracoronal restorations. The article also clearly identifies the importance of training oneself on the use of microscopic evaluation so that false-positive identification does not result in overtreatment. Such training to increase the specificity of one’s examination is essential to proper use of the additional information gained, whether it pertains to assessing enamel cracks or evaluating the radicular pulp orifices during root canal therapy.

The clarity and quality of the photographic images presented demonstrate to the reader the facility and importance of using the microscope for diagnosis and patient education. As a means to structure one’s assessment of enamel surfaces for cracking, the authors have provide a structured approach for screening cracks found during microscopic examination and have given the clinician the ability to immediately implement a valuable diagnostic tool upon installation of a microscope into the practice.

Many clinicians who use microscopes in their practice as opposed to or in addition to loupes, use the microscope as an adjunctive device for enhanced sensitivity in viewing certain aspects of their treatment. Examples commonly cited are marginal preparations within crown and bridge preparations, marginal integrity assessments of cast restorations, and finishing of resin composite restorations. This article provides clear examples of how the microscope can have great value for patient care, even if used only some of the time or within certain scenarios.

As the authors emphatically point out, it is important to be as precise as possible since the microscope provides increased sensitivity. Having said this, one can recognize the important role future randomized controlled clinical trials will have in determining the appropriate treatment for enamel cracks of various sorts, now that they are so much more visible under microscopic examination. In the meantime, this article gives clinicians a means by which to hone their microscopic skills and to understand more about what they are seeing. Patients can immediately benefit from the use of the tools described in this important article.

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