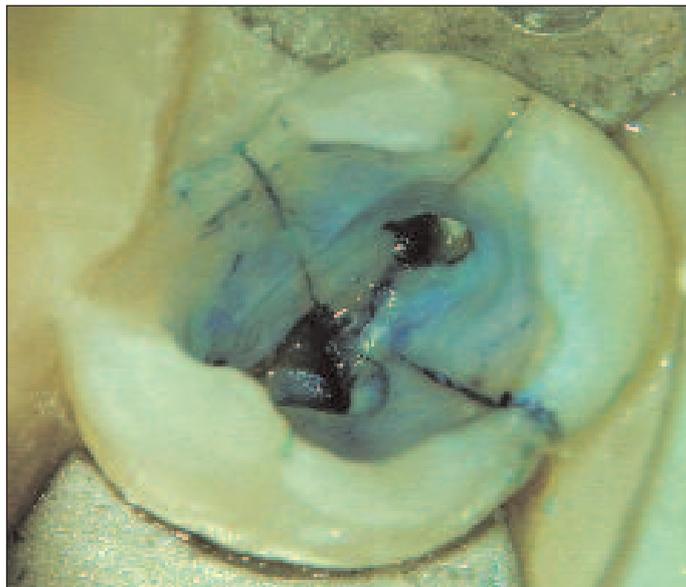


The cracked tooth

Diagnosis and evaluation

Dr Raphael Bellamy looks at the rising incidence of the cracked tooth and describes the five different types that could affect your patients



When talking to my dental colleagues, whether its over the telephone, at meetings throughout the year or, in particular, at the 2005 IDA conference in Killarney, I have been taken aback by the prevalence of the cracked tooth discussion.

Obviously there has been an increased incidence of this condition in recent years. The reasons why are beyond this article, but I often think that whatever the incidence now, it will increase exponentially with each percentage rise in interest rates if and when they come!

The combination of more of the public attending for dental treatment, keeping teeth for longer as we live longer and the increased stress in our lives provoking paranormal habits has probably lead to this increased incidence. To do nothing to these teeth is to invite disaster.

As a profession we have a responsibility to be proactive in this clinical situation.

Cracked teeth require immediate treatment, otherwise loss is inevitable. If a diagnosis of a cracked tooth is made, then there is no justification for the placement of a sedative dressing to 'see if it settles down'. These fractures always propagate and will result in the loss of the tooth. Correct assessment of the tooth is critical before electing to carry out any treatment.

Quick action on the part of the dentist can improve the chances of saving the tooth. If a crack is suspected, steps should be taken immediately to confirm the presence of a crack, determine the type of crack, and formulate an appropriate treatment plan.

If a crack is suspected, several diagnostic steps should be taken to confirm the suspicion. The tests performed and results achieved will vary between teeth that have or have not had endodontic treatment. If

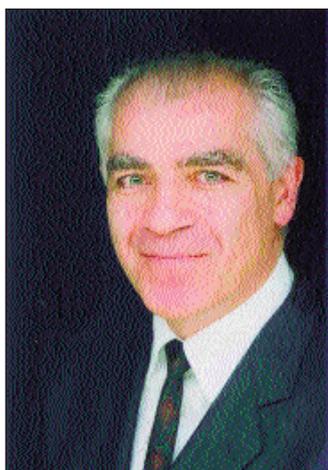
the suspect tooth has been endodontically treated, symptoms will be limited to those caused by the affected periodontium because the tooth has no remaining vital pulp tissue. For the tooth that has a vital pulp, the following steps will only confirm the presence or absence of a crack. Further pulpal and periodontal testing will be necessary to determine the need for endodontic treatment.

Dental history

Check for either a history of repeated occlusal adjustments with only temporary relief of symptoms or evaluation by several practitioners without a conclusive diagnosis. Also check for a history of periodontal disease with extensive bone loss in the area. Decreased bone support has been thought to lead to increased stress on dentine, predisposing the roots of a tooth to cracking. Additionally, check for a history of other cracked teeth, because many of the anatomical and behavioural factors that predispose teeth to cracks often affect more than one tooth.

Subjective examination

Ask the patient to point to the tooth that is sensitive, keeping in mind, however, that patients can be wrong. Ask if the patient remembers accidentally biting a hard object. Such an incident may correspond to a sudden onset of pain. Also ask about damaging habits, such as clenching or grinding the teeth, or chewing on ice, pens, hard sweets or other objects.



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Isolated deep probing – 11mm here

Visual examination

Start with the face, checking for enlarged jaw muscles, which may indicate a habit of overstressing the teeth during mastication. Then check for wear facets, which may indicate a history of clenching, bruxism or biting and chewing with excessive force. Next, check the teeth for tight cuspal fossae relationships that may cause excessive occlusal stresses. Note any steep cusps or developmental grooves, because these may predispose teeth to cracks. Finally, check tooth surfaces carefully in a dry field. Note any craze lines or darker cracks.

Generally, the darker the stain in a crack, the longer the

crack has been present. Also check for cracked restorations or unusual gaps between restorations and tooth structure. Enhanced magnification and illumination can be helpful in visual identification of a crack.

Tactile examination

Scratch the surface of the tooth with the tip of a sharp explorer. The tip may catch in a crack. Palpate the gingival around the tooth, checking for possible evidence of an underlying dehiscence or fenestration typical of a vertical root fracture.

Bite tests

Use a rubber wheel, wood stick or other instrument to

focus biting pressures on specific cusps to reproduce the patient's complaint. Specially designed instruments are commercially available. Place the instrument on each cusp or fossa and have the patient bite down with moderate pressure and release. Test several teeth and cusps. Be sure to use controls. Watch the patient's facial expression for response to pain upon biting pressure or release. If the patient has a painful response, ask if the pain is the same as he or she has been experiencing.

Pain during biting or chewing is considered a classic symptom and may be the only conclusive evidence early in the crack's development. The absence of pain during biting, however, does not rule out the possibility of a crack.

Periodontal probing

Thorough probing in small increments around the entire circumference of the tooth

may reveal a narrow periodontal pocket. The narrow pocket that forms along a crack will restrict side-to-side motion of the probe, making it easy to differentiate from the broad-based defect characteristic of a periodontal disease pocket.

Radiographs

Cracks rarely show up on radiographs. Mesial-distal cracks can never be seen. Buccal-lingual cracks will only appear if there is actual separation of the segments or the crack happens to be at exactly the same angle as the X-ray beam.

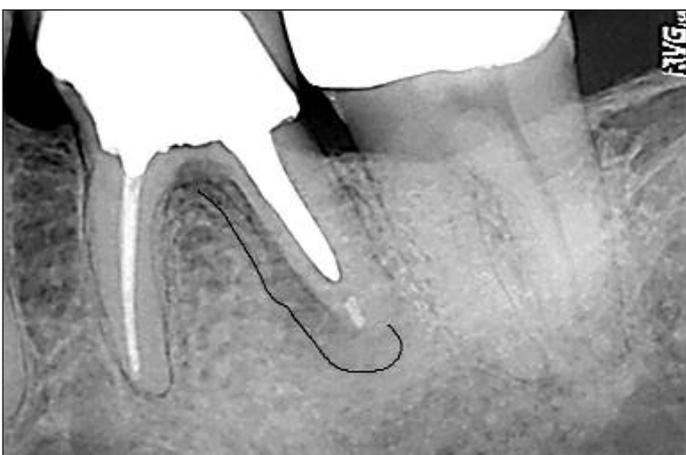
Changes in the pulp chamber, canal or periradicular space, however, may suggest the presence of a crack.

Radiographic evidence tends to be more likely as the crack progresses and a bony defect develops. Taking periapicals from more than one angle and taking bitewings may increase the chance of catching a crack-induced defect early in its development.

Buccal sinus

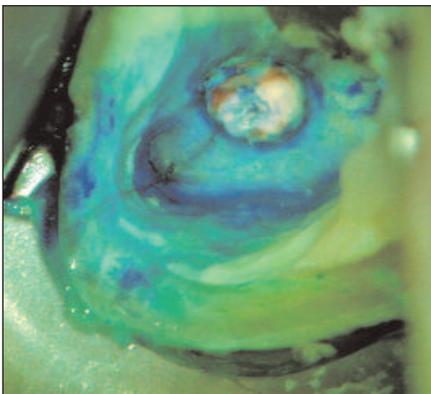


'J'-shaped lesion associated with root fracture





Significant cracks in heavily restored teeth



Crack visualised under clinical microscope extending to MB root access

A thickened periodontal ligament space or a diffuse longitudinal radiolucency, especially one with an elliptical or J-shape appearance apically may indicate a crack. Check also for restorations held in place by pins, which can predispose teeth to cracking. In endodontically treated teeth, rare but significant findings include a radiopaque line where gutta percha or sealer has been expressed into the crack during obturation. A consistent radiolucent line along the length of the root canal filling material may indicate space caused by a crack but should not be considered conclusive, because it could be caused by other entities.

Because the size, design, and placement of posts often contribute to cracks, check endodontically treated teeth for long posts, short-wide posts, custom metal posts, or posts with threads that bind

with tooth structure.

Radiographs can also help rule out other possible diagnoses. Look for evidence of perforations, or internal or external resorption. Also check for signs that previous endodontic treatment may be failing.

Restoration removal

This allows visual examination of the remaining cavity. Carefully check the mesial and distal marginal ridges, which tend to be weak areas. Magnification can be helpful.

Staining

Cracks may be disclosed through staining. A dye, such as methylene blue, can be applied to the external tooth surface, in the cavity after restoration removal, or on a surgically exposed root.

Transillumination

In transillumination, a fibre-optic or other similar light source is applied directly to the tooth surface. The light beam is positioned perpendicular to the plane of the suspected crack. A crack will block the light. Structurally sound teeth, including those with craze lines, will transmit the light throughout the crown.

Surgical assessment

Surgical exploration allows for

visual examination of the root surface for the appearance of a crack and should only be used if the crack is highly suspected and cannot be confirmed by all other possible diagnostic means.

Performing diagnostic surgery, however, can help early detection of untreatable situations, sparing the need for endodontic or restorative treatment on an ultimately hopeless case. A consultation with an endodontist or periodontist may be advisable prior to surgical assessment.

Whenever surgery is performed to detect a crack, the patient should be fully informed that it is a diagnostic

procedure. One factor that contributes to the confusion surrounding the issue of cracked teeth is that various authors have suggested a number of inconsistent terms to describe tooth cracks. For instance, 'complete' and 'incomplete' have been used to refer to a variety of crack features, including degree of pulpal involvement, degree of root involvement, or extent of the crack. Because the location, direction and extent of a crack have a profound effect on the choice of treatment, clarity is important. For consistency in this article, the five types of tooth cracks are described as follows:

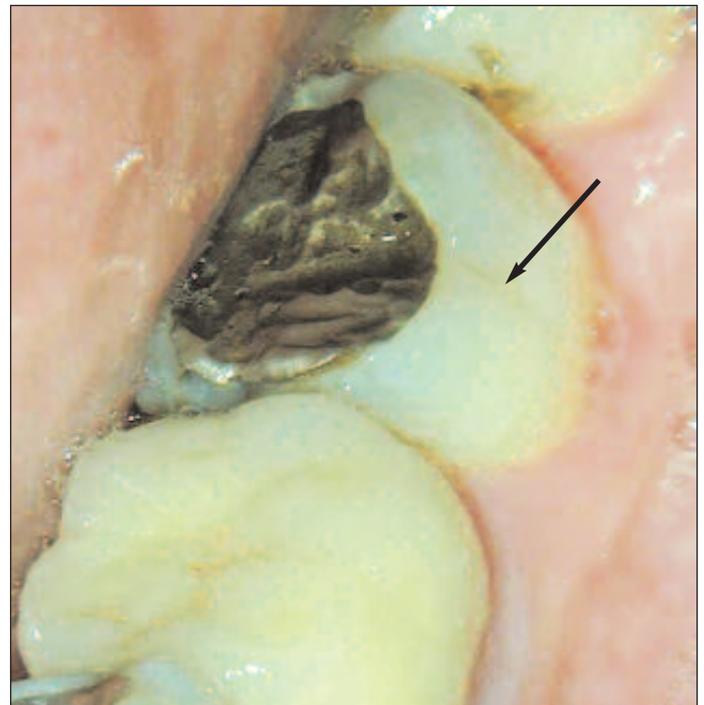
- Craze line
- Fractured cusp
- Cracked tooth
- Split tooth
- Vertical root fracture

Craze lines

Craze lines affect only the enamel. Fractured cusp, cracked tooth and split tooth begin on the occlusal surface and extend apically, affecting enamel and dentine, and possibly the pulp.

Vertical root fracture begins in the root. Fractured cusp, cracked tooth, split tooth and vertical root fracture are found

Craze line in buccal enamel





Total cuspal fracture

most often in posterior teeth. The cracks discussed in this article exclude cracks caused by impact trauma, which are more common in the anterior teeth, tend to result in more horizontal fractures and require considerably different treatment.

Fracture cusp

Of all cracks affecting dentine, cuspal fractures are the easiest to identify and treat. Their treatment also has the best prognosis, especially when the crack does not extend below the gingival attachment. The fractured cusp usually results from a lack of cuspal support due to a weakened marginal ridge.

Occlusally, it is common for the crack to have both a mesial-distal and a buccal-lingual component. The crack will cross the marginal ridge and continue down a buccal or lingual groove to the cervical region. It may terminate parallel to the gingival margin or slightly

subgingivally. Generally, only one cusp is affected. It may be necessary to remove a restoration, stain the tooth, and/or transilluminate to locate the crack. Magnification may be helpful in determining the extent of the crack.

Diagnostic clues

Class II restorations or extensive caries can contribute to weakened marginal ridges. Pain is mild and occurs only to stimulus. Generally, bite tests will elicit brief, sharp pain, especially with release of biting pressure. Tapping on selective tooth margins and cusps may help identify the area of the crack. The pulp is usually vital. Radiographs are inconclusive. The affected cusp may break off during restoration removal, possibly resulting in relief of symptoms when the cusp breaks off.

Treatment

The tooth is treated by

removing the affected cusp and restoring the tooth with a full crown that covers the crack margin. Root canal treatment is only necessary in the rare event that the crack affects the pulp chamber or has resulted in irreversible pulpitis.

Cracked tooth

The crack in the picture below extends from the occlusal surface of the tooth apically without separation of the two segments. Occlusally, the crack is more centred than a cuspal fracture. Therefore, it is more likely to cause pulpal and periradicular pathosis as it extends apically. Cracked tooth occurs most commonly in mandibular molars, followed by maxillary premolars. The crack may cross one or both marginal ridges and is most often mesiodistal, shearing toward the lingual root surface. The crack may be buccal-lingual in mandibular molars. Cracked tooth does not occur in anterior teeth and rarely in mandibular premolars.

The signs and symptoms of a cracked tooth will vary significantly depending on the progress of the crack.

Differential diagnosis

In its early stages, the crack will probably be invisible to the naked eye and impossible to disclose with staining. The cracked tooth may only exhibit acute pain on mastication or, possibly, sharp, brief pain to cold. Unless the crack has progressed to involve the pulp or periodontal tissues, it may be impossible to distinguish from a cuspal fracture. Craze lines may be differentiated by transillumination. In the case of

craze lines, light will be transmitted throughout the tooth. In the case of cracked tooth, the crack will block and reflect the light. The restorative history of the tooth, while diagnostically helpful for cuspal fracture, is not as helpful with a cracked tooth. Restorations can contribute to a cracked tooth, and the crack may be evident across the cavity floor after a restoration is removed. However, unrestored teeth that are free of caries and teeth with conservative restorations frequently experience these cracks.

Teeth with class I restorations crack as frequently as those with class II restorations. If a crack can be detected, test for movement of the segments to differentiate a cracked tooth from a fractured cusp or split tooth. A fractured cusp may break off under slight pressure, while the segments will remain in place, but will separate if the diagnosis is split tooth.

The position of the crack may also help differentiate a cracked tooth from a fractured cusp. The cracked tooth break occurs more toward the centre of the occlusal surface than the cuspal fracture. More centred cracks tend to go deeper toward the apex before completely separating the tooth into two segments. If the crack has progressed to involve the pulp or periodontal tissue, the patient may have thermal sensitivity that lingers after



Crack in mesial marginal ridge



Mesial to distal split of a premolar

removal of the stimulus, or slight to very severe spontaneous pain consistent with irreversible pulpitis, pulp necrosis or apical periodontitis. There may even be pulp necrosis with periradicular pathosis.

Split tooth

These cracks are usually mesiodistal, cross both marginal ridges and split the tooth completely into two separate segments. A crack that is more centred on the occlusion will tend to extend more apically. Most often, the split tooth is the result of long-term progression of a cracked tooth. A split tooth is identified by a readily apparent or easily disclosed crack with segments that separate when probed with an explorer. Patients will usually complain of marked pain on chewing and significant soreness of the jaw or gums. Periodontal involvement, however, may result in a mistaken diagnosis of periodontal abscess. Split teeth can never be saved intact, but the position of the crack and its extent apically will determine the prognosis and treatment. An extremely mobile segment may indicate that the split surfaces in the middle to coronal third of the root. In many of these cases, the smaller segment can be removed and the remaining segment restored. If the crack extends more apically, treatment would result in a

deep periodontal defect and extraction is indicated.

Vertical root fracture

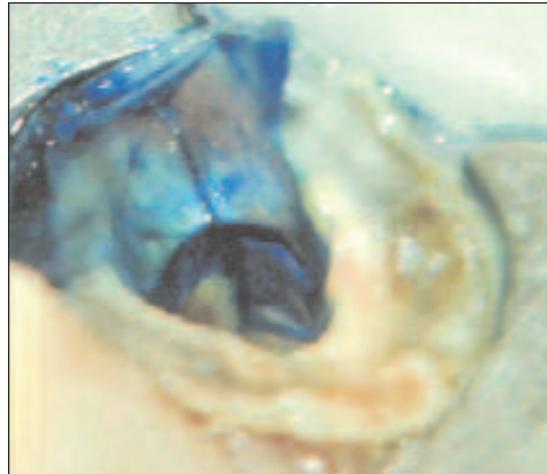
Vertical root fractures (VRF) begin in the root, usually in the buccal-lingual plane. A VRF may extend the length of the root or occur as a shorter crack at any level along the root. The crack may or may not extend to both buccal and lingual surfaces.

Because VRFs present minimal signs and symptoms, they generally go unnoticed until periradicular pathosis occurs. Then they are very difficult to diagnose because they mimic other conditions. Because the recommended treatment is almost exclusively extraction or removal of the cracked root, care must be taken to avoid incorrect diagnosis. However, because VRF may mimic periodontal disease or failed root canal treatment, these cases often result in referral to a periodontist or endodontist for evaluation.

Aetiological factors

Many causes for vertical root fracture have been suggested. Two have been demonstrated: post placement and excessive compaction force during root canal obturation.

Roots that are wide facially and lingually but thinner mesially and distally tend to fracture more often. Examples would be mandibular incisors and premolars, maxillary second premolars, mesiobuccal



Root fracture stained with methylene blue

roots of maxillary molars, and mesial and distal roots of mandibular molars.

Roots of maxillary central incisors, lingual roots of maxillary molars and maxillary canines tend to be rounder and more resistant to VRF

Diagnostic clues of VRF

Patients typically present with only mild signs and symptoms. The tooth may or may not be mobile. A periodontal abscess may be present or in the patient's dental history. Virtually all VRFs have a history of root canal treatment. Periodontal probing can be helpful. Because the crack may occur at any level along the root and may not reach from apical to cervical, some VRFs show normal probing patterns. However, most will allow deep probing in narrow or rectangular patterns typical of cracked tooth lesions. Deep probing may be only on the facial or lingual aspect or on both. Percussion and palpation tests may be inconclusive.

Radiographic evidence varies. Only rarely will there be visible separation of the segments.

Marked bone resorption from the apex along the lateral root surface can indicate a VRF. Such resorption may or may not extend to the cervical region. The appearance of a radiolucency may be mistaken for root canal treatment failure.

Surgical assessment of VRF

Vertical root fracture may require surgical inspection for conclusive diagnosis. When

soft tissue is reflected, a 'punched-out' oblong bony defect filled with granulomatous tissue overlying the root is characteristic. The defect may be a dehiscence or a fenestration. When the inflammatory tissue is removed, the crack is usually evident. In some cases, a crack may be detected when a resected root end is examined under magnification. Even if the crack is not readily detectable, the characteristic bony defect is usually considered conclusive evidence.

It is my intention to cover the treatment of the cracked tooth in a further article. This will include the immediate stabilisation of a cracked tooth and the definitive restoration. One must fully understand that the cracked tooth may never be quite right, as the crack exists whatever treatment is carried out. However, with prompt intervention and expert clinical care these teeth can continue to function for years. There is nothing as good as the natural tooth. 

Reference

Cracking the cracked tooth code, Endodontics Colleagues for Excellence, American Association of Endodontics Fall/Winter 1997

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