

# The Cracked Tooth: An Engima for the Clinician

## Abstract

With an increase in the life expectancy, people are living longer and keeping their teeth longer. As a result, patients are more likely to have complex restorative and endodontic procedures leaving teeth more susceptible to cracks. Stressful lifestyle resulting in parafunctional habits such as clenching and bruxism and consumption of paan, betel nut etc. are important contributory factors. Additionally, in recent years, practitioners have been more aware of the existence of cracks and, therefore, more cracks are being diagnosed. Thus the diagnosis and management of cracked teeth is an integral part of dental practise today. This review article aims to highlight the different types of cracks, their diagnosis, associated signs and symptoms and treatment.

## Key Words

Cracked tooth syndrome; bruxism; bite test; staining; craze line

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## INTRODUCTION

Cameron coined the term cracked tooth syndrome (CTS) to define the condition as “an incomplete fracture of a vital posterior tooth that involves the dentin and occasionally extends to the pulp”.<sup>[1]</sup> In recent times, the definition has been modified as follows: “A fracture plane of unknown depth and direction passing through tooth structure that, if not already involving, may progress to communicate with the pulp and or periodontal ligament”.<sup>[2]</sup> Cracked or incompletely fractured teeth can become symptomatic. Patients often present with a protracted history of pain of varying intensity; the origin of which may be difficult to locate. While intermittent pain on biting is the most consistent complaint associated with these teeth, cracks in teeth may result in a wide range of symptoms ranging from occasional discomfort to severe and prolonged pain. Symptoms are often dependent on the depth and direction of the crack and the tissues involved.<sup>[3]</sup> Cracks in teeth may occur in both horizontal and vertical directions involving the crown and/or root. The etiology is generally a result of occlusal forces and iatrogenic procedures.<sup>[4]</sup> Crown and crown-root fractures are usually

incomplete fractures commencing in the crown of posterior teeth from an internal line angle at the floor of a restoration, and often involving a marginal ridge with the fracture extending in a mesiodistal direction. The fracture commences in the crown and may terminate in the vicinity of the cemento-enamel junction or extend apically into the root.<sup>[5]</sup> Vertical root fractures are longitudinally orientated fractures of the root that extend from the root canal to the periodontium.<sup>[6]</sup> These fractures are usually complete and extend a variable length along the root generally in a bucco-lingual direction and may extend into the crown.<sup>[7]</sup> This article reviews the classification, diagnosis and management of cracked teeth in dental practise.

## Classification

The American Association of Endodontists, in a document titled “Cracking the Cracked Tooth Code”<sup>[8]</sup> identified five types of cracks in teeth. **Craze lines** are found in the majority of adult teeth and only involve enamel. In posterior teeth, craze lines are usually evident crossing marginal ridges and/or extending along buccal and lingual surfaces. Long vertical craze lines are often found in anterior teeth (Fig. 1). **Fractured cusps** usually result from



Fig. 1: Craze lines in enamel

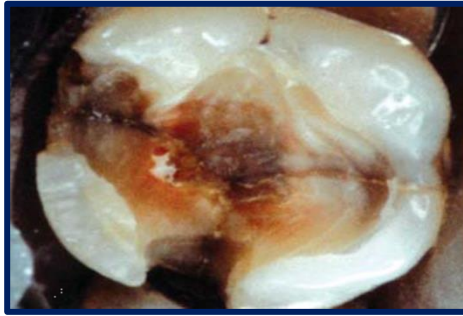


Fig. 3: Craze lines in enamel

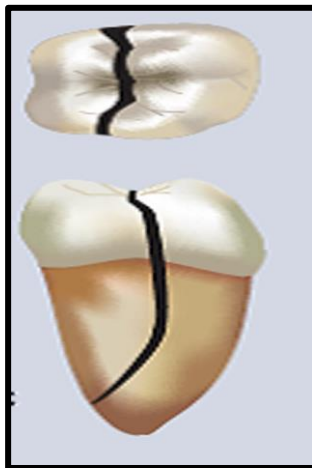


Fig. 4b: Craze lines in enamel

insufficient cusp support when the marginal ridge is weakened by an intra-coronal restoration (Fig. 2). The crack often extends in mesio-distal and bucco-lingual directions commonly involving one or both marginal ridges as well as a buccal or lingual groove and terminates in the cervical region either parallel to the gingival margin or slightly subgingival. A **cracked tooth** is indicative of a crack extending from the occlusal surface of the tooth apically without separation of the two segments. The crack is generally located centrally in a mesio-distal direction and may involve one or both marginal ridges (Fig. 3). A **split tooth** is indicative of a crack extending through both marginal ridges usually in a mesio-distal direction splitting the tooth completely into two separate segments (Figs. 4a-b). The crack is generally

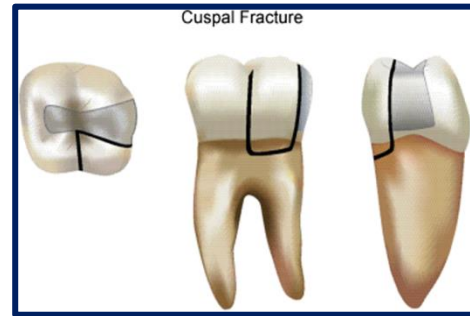


Fig. 2: Occlusal, lingual and distal/proximal



Fig. 4a: Craze lines in enamel

located centrally in the tooth and this entity is the result of crack propagation of a cracked tooth. **Vertical root fractures** commence in the root generally in a bucco-lingual direction (Fig. 5). The crack is generally complete though may be incomplete and involve only one surface. The crack may involve either the entire root or only a portion of the root.<sup>[3]</sup>

#### Incidence

The presence of a cracked tooth occurs primarily in adulthood. Cameron<sup>5</sup> reported that 80% of 102 cracked teeth occurred with patients over 40 years of age. Other reports<sup>[9,10]</sup> about the incidence and prevalence of cracked teeth were commonly associated with intracoronal restorations and most prevalent in mandibular molars. The wedging effect of the prominent mesio-palatal cusp of the maxillary first molar may account for this observation.<sup>[9]</sup> The disto-lingual cusp of mandibular molars is the most susceptible cusp for fracture. Nonfunctional cusps may be more susceptible to fracture than functional cusps.<sup>11</sup> This observation may be a result of cuspal dimension as functional cusps are significantly larger in a bucco-lingual dimension and are covered with a thicker layer of enamel.<sup>[12]</sup> While functional cusps are supported on the inner and outer inclines by the opposing tooth, non-functional cusps may be more susceptible to fracture from lateral excursive occlusal forces due to the lack of support from the outer incline.<sup>[11]</sup>

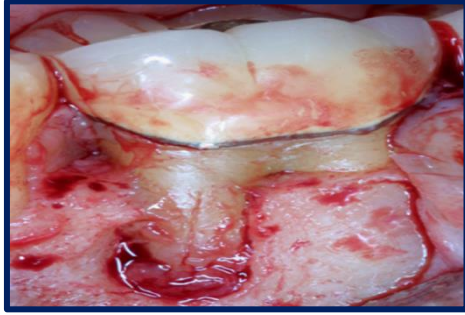


Fig. 5: Vertical root fracture around the mesial



Fig. 7: Transillumination test

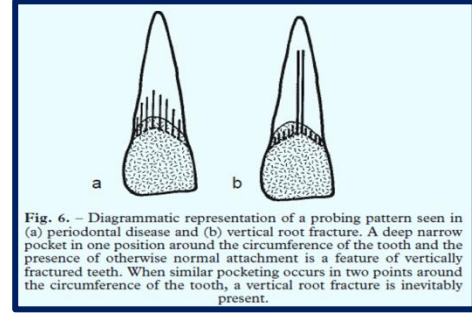


Fig. 6. – Diagrammatic representation of a probing pattern seen in (a) periodontal disease and (b) vertical root fracture. A deep narrow pocket in one position around the circumference of the tooth and the presence of otherwise normal attachment is a feature of vertically fractured teeth. When similar pocketing occurs in two points around the circumference of the tooth, a vertical root fracture is inevitably present.

Fig. 6: Diagramtic representation



Fig. 8: Radiograph of lower first molar

### Clinical Symptoms

Classically, the symptoms related to these teeth are pain on biting and sensitivity to thermal changes, particularly cold.<sup>[5]</sup> Pain associated with the release of pressure, ‘rebound pain’ is also a consistent finding.<sup>[13]</sup> Occasionally, there is sensitivity to sweets.<sup>[9]</sup> A chronic pulpitis with no clinical symptoms can exist as a result of microleakage of bacterial by-products and toxins. Pulpal and periodontal symptoms may occur when the fracture extends to involve the pulp.<sup>[14]</sup> The character, duration and the stimuli of pain has important implications for both diagnosis and treatment.<sup>15</sup> An understanding of the mechanism of pain will often aid in assessment of the extent and direction of the crack. Luebke<sup>16</sup> suggested the following terms to diagnose pain from a cracked tooth:

1. Dentin pain - A brief, sharp twinge.
2. Pulpal pain - The deep, demanding, radiating pain precipitated by thermal shock to an inflamed pulp. The pain at times may be spontaneous.
3. Periodontal pain - The aggravating throbbing of a sore tooth.

The pain associated with an incomplete fracture of a cusp is generally accepted to be due to the rapid movement of dentin fluid in the dentin tubules according to the “Hydrodynamic theory of dentin sensitivity” as proposed and investigated by Brännström.<sup>[17]</sup> The clinical presentation of a vertical root fracture is variable. Teeth with vertical root fractures often present with a history of

discomfort and localized chronic inflammation. Patients may complain of a bad taste and pain on biting. If swelling is present it is generally broad-based and any sinus tract is located in or close to the attached gingiva rather than in the apical area. Double or multiple sinus tracts are common.<sup>[3]</sup>

### DIAGNOSIS

Basic steps in crack detection includes,

#### 1. History

Patient’s history should be assessed very carefully. History of any masticatory accidents, Para functional habits like bruxism, past dental treatment (iatrogenic factors),<sup>[18]</sup> dietary habits, beetle nut chewing, trauma or accidents may give a clue to our diagnosis. History of previous cracked teeth due to many anatomical<sup>[12]</sup> and developmental factors<sup>[18]</sup> may predispose teeth to crack. History of periodontal disease with extensive bone loss in the site can cause increased stresses on dentin predisposing the tooth to crack.<sup>[19]</sup> Cracks in root canal treated teeth are often due to size, design and placement of posts.<sup>[8]</sup>

#### 2. Visual examination

Extra oral examination, shows enlarged masseter muscles due excessive stress on mastication or Para functional habits like bruxism.<sup>[20]</sup> Intraoral examination should be done using rubber dam in a clear and dry field. Visualisation of cracks becomes easier in Contrasting and brighter colour of rubber dam. Check for the wear facets. Brown studied that teeth subjected to thermal cycling between 90 to 140 degrees had severe cracking, check for

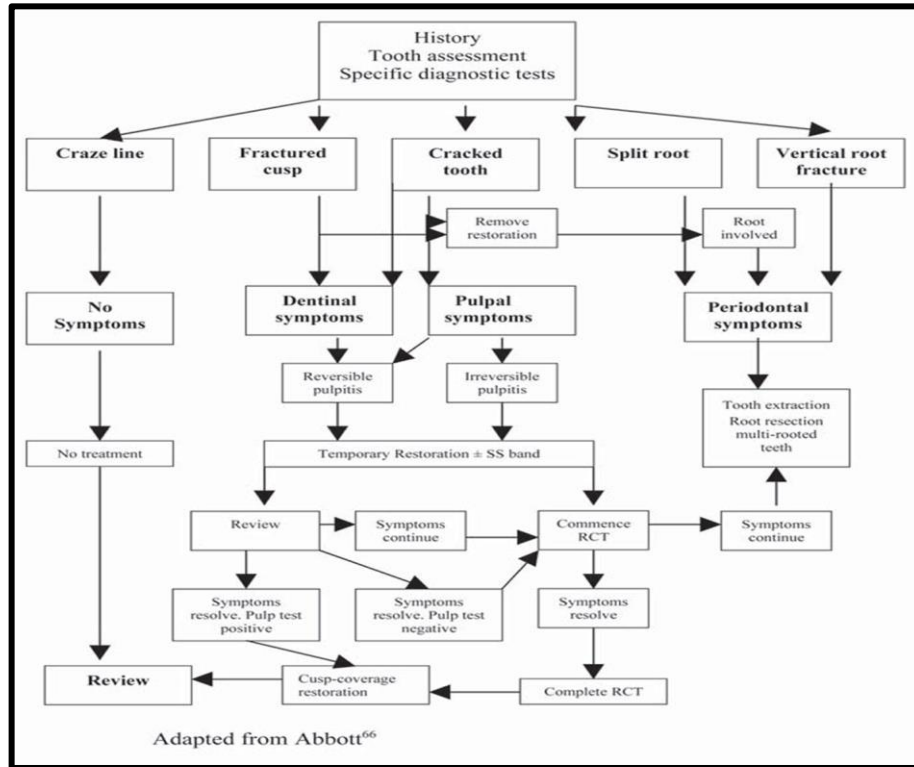


Fig. 9: Treatment flow chart for AAE classification of teeth

abfraction lesions. Abfraction lesions are found to be associated with 94.5% of occlusal wear facets. Excessive occlusal loading has been suggested to be a possible cause of fracture in some unrestored teeth with abfraction lesions.<sup>[5]</sup> Steep cusps and wedging effect of cusp fossae relationship create hammer and anvil “chewing effect” that can propagate cracks. Wide and deep restorations also predispose to cracks. Magnifying loupes with illumination enhances our vision in crack detection.<sup>[21]</sup>

### 3. Tactile examination

Palpate the gingiva around the tooth for any dehiscence or fenestration typical of vertical root fracture. Palpation may show tenderness and swelling over the root and in Periapical region in cases of vertical root fracture. Running the tip of a sharp probe along the tooth surface produces a clicking sound when it passes over the fracture line.<sup>[22]</sup>

### 4. Bite tests

Rubber wheel, wooden stick or tooth sloth fracture detector can be placed on the cusp of the suspected tooth and ask the patient to bite down with moderate pressure and then release. Pain during biting or chewing is a classic symptom.<sup>[10]</sup>

### 5. Periodontal probing

Localised bone loss can result in excessive stresses on the exposed dentin predisposing crack formation.<sup>[19]</sup> Careful periodontal probing in small

increments will restrict the movement of the probe thus helps to locate a crack.<sup>[8]</sup> A deep narrow isolated periodontal pocket is present in cases of vertical root fracture (Fig. 6).<sup>[23]</sup>

### 6. Staining

2% Methylene blue, 0.25% sodium fluorescein ophthalmic solution, snoop caries detecting dye can be used to disclose a crack on surgically exposed roots or crack in the cavity after removal of the restoration. Wright, in his study proved that methylene blue combined with Transilluminaton was the best in crack detection.<sup>[21]</sup>

### 7. Transilluminaton

A fibre optic light source combined with magnification helps in visualisation of cracks on tooth surface.<sup>[16]</sup> The light beam is directed in a horizontal direction perpendicular to the plane of the suspected crack. Cracks will block the light beam from reaching the part of the tooth beyond the fracture, whereas sound teeth will transmit light through the crown.<sup>[21]</sup>

### 8. Radiographs

Radiographs are not conclusive in detecting cracks<sup>[24]</sup> in the earlier stages unless there is separation of segments of the tooth. Typical radiographic features for vertical root fracture includes

1. When a well condensed root canal filling appears very close to one wall of the root.<sup>[25]</sup>

2. Vertical radiolucent line running across fracture line.<sup>[25]</sup>
3. Extrusion of root canal filling material through the apex due to vertical root fracture may
4. show a tangle of accessory points at the apex (apical spaghetti)<sup>[25]</sup>
5. Wide enlargement of periodontal ligament space through the whole length of the root.<sup>[26]</sup>
6. Pitts and Natkin described halo like radiolucency running around the tooth (Fig. 8).<sup>[6]</sup>
7. Step like bone defect may be seen when fracture runs obliquely across the root.<sup>[6]</sup>
8. V shaped radiolucency which is widest at the crestal bone and narrowest towards the apex.<sup>[6]</sup>
9. Thickened periodontal ligament space or a diffuse radiolucency with J-shaped appearance in the apical region.<sup>[25]</sup>

Occlusal adjustment – destructive, short term	
Remove segment – highly destructive	
Immobilisation of segment:	
Copper ring	difficult and periodontally damaging
Orthodontic band	time consuming, possibly not available
Temporary crown	highly destructive, time consuming
Direct composite splint	quick, low cost, readily available and non-invasive

Table 1: Immediate treatment options for cracked tooth

Ultrasound imaging system is capable of imaging cracks in simulated human tooth and would be a possible diagnostic tool in the future.<sup>[27]</sup>

### 9. Restoration removal

Bulky restorations or restorations with pin head designs<sup>[28]</sup> should be cautiously examined for a crack. Removal of restorations allows for visual examination of the crack. Marginal ridges should be closely examined for a crack.<sup>[23]</sup> Thin marginal ridges predispose to cracks. Magnifying loupes and staining the tooth can aid in crack detection.

### 10. Surgical assessment

Surgical exploration remains the last option when all the other diagnostic means had failed to detect a crack. This consists of elevation of a full thickness

flap and examination of bone and roots directly under high magnification and illumination.<sup>[23]</sup>

### Prognosis

Clark & Caughman<sup>[29]</sup> have categorized the prognosis of cracked teeth as excellent, good, poor and hopeless.

1. Excellent: (a) Cuspal fracture confined within the dentin that angle from the facio-pulpal or linguo-pulpal line angle of a cusp to the cemento-enamel junction or slightly below. (b) Horizontal fracture of a cusp not involving the pulp.
2. Good: A coronal vertical fracture that runs mesio-distally into the dentin but not into the pulp.
3. Poor: A coronal vertical fracture that runs mesio-distally into the dentin and pulp but is confined to the crown.
4. Hopeless: A coronal vertical fracture that runs mesio-distally through the pulp and extends into the root.

### Treatment

A rough guideline for therapy of fractured teeth is given in Fig. 9.

#### Immediate Therapy (Table 1)

To avoid irreversible damage, it is imperative that a cracked tooth be treated as soon as possible. Occlusal adjustment of affected teeth must be done immediately to reduce the stress on the tooth and prevent further damage to the tooth. If the tooth in question presented with a preexisting restoration, it should be removed. This may cause the affected cusp to “splinter off” and the further treatment protocol can then be decided.<sup>[30]</sup> In case there is no splintering, immediate immobilization should be employed, using an “immediate extra-coronal circumferential splint.” A copper ring or a stainless steel orthodontic band can be used for this purpose.<sup>[31]</sup> The use of full coverage acrylic provisional crowns has been advocated for “immediate splinting”.<sup>[32]</sup> Another available option is the use of bonded composite resin to splint the teeth, which is known as a “direct composite splint” (DCS).<sup>[33]</sup>

#### Definitive therapy

In case of non splintering teeth, intra coronal restorations, without cuspal coverage may also be used. Dental amalgam, composite resin and glass-ionomer cements are most commonly used. The strength of the tooth can be restored by using these materials. Amalgam overlays have been found to increase the fracture energies of cracked teeth to

levels equivalent to that of intact teeth. Hence direct restorations with cuspal coverage have been advocated as a primary mode of treatment.<sup>[30]</sup> In cases where aesthetics is not a matter of great concern, cast metal inlays with cusp coverage or partial crowns with circumferential external splinting are applied or else, adhesive ceramic restorations can also be used. Full coverage crowns are the most appropriate form of restoration for cases where the crack extends from the occlusal incline to the cervical third of the clinical crown.<sup>[32]</sup> It has been reported by a number of authors that the loss of vitality following the application of full coverage single unit crowns is in the range of 15-19%. Loss of pulpal vitality is an obvious problem following the preparation of teeth to receive a full coverage crown. In CTS, reversible pulpitis would already be a pre-existing condition so the problem appears to be further compounded.<sup>[34]</sup>

### CONCLUSION

A cracked tooth is a complex condition and can present with a wide variety of symptoms. Early diagnosis is of paramount importance in preventing further propagation of the crack. It is important to diagnose and differentiate between dentin, pulpal and periodontal pain before treatment is commenced. Though various treatment options have been outlined for the management of cracked teeth very little evidence is available in literature to substantiate their use. The extent of the fracture, the time of intervention and the type of restoration are crucial parameters in determining the outcome of the treatment. So we as dentists must take all these factors into account and help the patients decide and initiate a proper treatment plan.

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