Cracked Tooth Syndrome-Decoding the Enigma

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Abstract

Cracked tooth syndrome is a diagnostic enigma to many practitioners. This article is with the aim to shed light on the understanding cracked tooth syndrome as a condition in itself by focusing on areas like type of crack, its clinical features, diagnosis and management of cracked tooth syndrome (CTS). The condition refers to an incomplete fracture of a vital posterior tooth that occasionally extends into the pulp. A lack of awareness of the condition coupled with its varied clinical features can make diagnosis of CTS difficult. Common symptoms include an uncomfortable sensation or pain from a tooth that occurs while chewing hard foods and which ceases when the pressure is withdrawn. The patient is often unable to identify the offending tooth or quadrant involved, and may report a history of numerous dental procedures with unsatisfactory results. Successful diagnosis and management requires an awareness of the existence of CTS and the appropriate diagnostic tests. Management options depend on the nature of the symptoms and extent of the lesion. These options include routine monitoring, occlusal adjustments, placement of a cast restoration and endodontic treatment.

Key Words: cracked tooth syndrome; cracked tooth therapy; crack lines; craze type of crack tooth.

Introduction

The term cracked tooth syndrome (CTS) refers to an incomplete fracture of a vital posterior tooth that involves the dentin and occasionally extends into the pulp.[1-3] The term "Cracked tooth syndrome" was coined in 1964 by Cameron[3]. The basis of the term was attributed to the correlation between occurrence of CTS and size of restoration.

Ellis et al (1991) describes it as "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."[7]

Incidence & Patterns of Cracked Tooth Syndrome (CTS)

Incidence of CTS is more often in 30-50 years of age.[8-10] This condition has equal gender predilection.[11]

Mandibular second molars, followed by mandibular first molars and maxillary premolars, are the most commonly affected teeth.[2,12] While the crack tends to have a mesio-distal orientation in most teeth, it may run buccolingually in mandibular molars.[11]

CTS manifests two classic patterns of crack formation-[1]

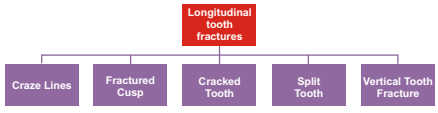
1. The first occurs when the crack is centrally located, and following the dentinal tubules may extend to the pulp;
2. The second is where the crack is more peripherally directed and may result in cuspal fracture.

Pressure applied to the crown of a cracked tooth leads to separation of the tooth components along the line of the crack. Such separation in dentine results in the movement of fluid in the dentinal tubules, stimulating odontoblasts in the pulp as well as the stretching and rupturing odontoblastic processes lying in the tubules,[3] thus stimulating pulpal nociceptors. Ingress of saliva along the crack line may further increase the sensitivity of dentine.[13] Direct stimulation of pulpal tissues occurs if the crack extends into the pulp.

Classification Types of Crack[2]

The location, direction and extent of a crack have a profound effect on the choice of treatment. There are five types of longitudinal tooth fractures, which are:

1. Craze Lines
2. Fractured Cusp
3. Cracked Tooth
4. Split Tooth
5. Vertical Root Fracture



Craze lines affect only the enamel. Fractured cusps, cracked teeth and split teeth begin on the occlusal surface and extend apically, affecting enamel, dentin, and possibly, the pulp. Vertical root fractures begin in the root. All types except craze lines are found most often in posterior teeth. Unlike a broken bone, the fracture in a cracked tooth will never heal.

Major challenge is the lack of knowledge concerning the type, characterization and variety of fractures may lead to misunderstanding with incorrect diagnosis and inappropriate treatment. These five categories of longitudinal fractures have been devised to provide global definitions that researchers and clinicians can use to decrease this confusion of classification of type of fracture, especially that related to prognosis and treatment modalities.

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. Classification schemes that only consider whether a fracture is complete versus incomplete will not readily illuminate these differences.

Types of the cracks and fractures discussed here could be called "vertical fractures." Also, each fracture that involves the tooth root, whether originating from the coronal (enamel) or apical (root)[2] portion of the tooth, can be termed "vertical root fractures." Therefore, a crack that extends from crown to root in a mesiodistal direction, a split tooth and a "true" vertical root fracture that involves only the root, have been termed "vertical root fractures."

Craze Lines[2]

In posterior teeth, craze lines are usually evident crossing marginal ridges and extending along buccal and lingual surfaces (Fig. 1). Long vertical craze lines commonly appear on anterior teeth. As they only affect the enamel, they cause no pain and are of no concern beyond the aesthetic. On examination of teeth for cracks, it is observed that most adult teeth have craze lines.

Fractured Cusp[2]

The term "fractured cusp" is defined as a complete or incomplete fracture initiated from the crown of the tooth and extending subgingivally, usually directed both mesiodistally and buccolingually. The fracture usually involves at least two aspects of the cusp by crossing the marginal ridge and also extending down a buccal or lingual groove. The fracture will extend to the cervical third of the crown or root.

Of all cracks affecting dentin, cusp 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 cusp support due to a weakened marginal ridge. Occlusally, it is common for the crack to have both a mesiodistal and a buccolingual 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 (Fig. 2). Generally, only one cusp is affected. It may be necessary to remove a restoration, stain the tooth and/or transilluminate to locate the cracks. Magnification may be helpful in determining the extent.

Cracked Tooth[2]

As per definition"cracked tooth" is as an incomplete fracture initiated from the crown and extending subgingivally, usually directed mesiodistally. The fracture may extend through either or both of the marginal ridges and through the proximal surfaces. The fracture is located in the crown portion of the tooth only or may extend from the crown to the proximal root (Fig. 3). Cracked teeth are described as incomplete (greenstick) fractures, which also describes their form. Occlusally, the crack is more centered and apical than a fractured cusp and, therefore, more likely to cause pulpal and periapical pathology as it extends apically (Fig. 3).

Cracked teeth occur most commonly in mandibular molars, followed by maxillary premolars. The crack may rarely be buccolingual in mandibular molars. They do not occur in anterior teeth and are rare in mandibular premolars.

Split Tooth[2]

The term "split tooth" is defined as a complete fracture initiated from the crown and extending subgingivally, usually directed mesiodistally through both of the marginal ridges and the proximal surfaces. The fracture is located coronally and extends from the crown to the proximal root (Fig. 5). A crack that is more centered on the occlusion will tend to extend more apically. A split tooth is the end result of a cracked tooth; the fracture is now complete and extends to a surface in all areas. The root surface involved is in the middle or apical third, usually extending toward the lingual. There are no dentin connections; tooth segments are now entirely separate (Fig. 5). The split may occur suddenly, but it more likely results from long-term growth of an incomplete cracked tooth.

Identification of a split tooth is by a readily apparent or easily disclosed crack with segments that separate with wedging forces, such as probing with an explorer or instrument placed into the occlusal cavity preparation (Fig. 5).

Patients will usually complain of marked pain to chewing and significant soreness of the jaw or gums. Periodontal involvement, however, may complicate the diagnosis of CTS and may mislead the clinician towards periodontal abscess.

Vertical Root Fracture (VRF)[2]

A "true vertical root fracture" is defined as a complete or incomplete fracture initiated from the root at any level, usually directed buccolingually. The fracture may involve one proximal surface (buccal or lingual) or both buccal and lingual proximal surfaces. The fracture is located in the root portion of the tooth only, and may extend coronally toward the cervical periodontal attachment (Fig. 6).

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 (Fig. 6).

VRF present with minimal signs and symptoms, and hence, they tend to go unnoticed until periapical pathology-develops. But once this happens, these are very difficult to diagnose because they mimic other conditions. The recommended treatment for VRF is extraction or removal of the cracked root.

Etiology of CTS

Common causes include masticatory accidents, such as biting on a hard, rigid object with unusually high force,[3,4] or excessive removal of tooth structure during cavity preparation.[14] Parafunctional habits such as bruxism are also associated with the development of this condition.[1,14]

Commonly, the tooth has been structurally compromised by removal of excessive amount of tooth substance during restorative procedures.[14] Occlusal contact occurring on extensive occlusal or proximo-occlusal intra-coronal restorations (either cast metal or plastic restorations) subject the remaining weakened tooth structure to lateral masticatory forces, particularly during chewing.[3,4,11] Such cyclic forces result in the establishment and propagation of cracks.[3,11,17]

Deep cuspfossa relationships due to over-carving of restorations, or cast restorations placed without proper consideration for cuspal protection, also render the tooth vulnerable.[8,18,19]

Excessive condensation pressures, expansion of certain poorer quality amalgam alloys when contaminated with moisture, placement of retentive pins, and extensive composite restorations placed without due care for incremental technique (resulting in tensile forces in the tooth structure due to polymerization contraction) predispose to fracture formation.[3]

Other iatrogenic causes of CTS include excessive hydraulic pressure in luting agents when cementing crowns or bridge retainers.[8,18] Long-span bridges exert excessive torque on the abutment teeth, leading to crack generation.[3]

Table 1. : The Etiology of Cracked Tooth Syndrome

Classification	Factors	Examples
	Inadequate design features	Over-preparation of cavities Insufficient cuspal protection in inlay/onlay design Deep cusp-fossa relationship
Restorative Procedures	Stress Concentration	Pin Placement Hydraulic pressure during sealing of tightly fitting cast restorations
	Stress Concentration	Physical forces during placement of restoration, e.g., amalgam or soft gold inlays (historical) Non-incremental placement of composite restorations (tensile stress on cavity walls) Torque on abutments of long-span bridges
	Masticatory Accident	Sudden and excessive biting force on a piece of bone
	Damaging horizontal forces	Eccentric contacts and interferences (especially mandibular second molars)
Occlusal	Functional Force	Large untreated carious mlesions Cyclic forces
	Parafunction	Bruxism
Developmental	Incomplete fusion areas of calcification	Occurrence of cracked tooth syndrome in unrestored teeth
	Thermal cycliong	Enamel cracks
Miscellanceous	Foreign body	Lingual barbell
	Dental instruments	Cracking and crazing associated with high-speed handpieces

Symptoms & Diagnosis

Successful diagnosis of CTS requires awareness of its existence and of the appropriate diagnostic tests. The history elicited from the patient can give certain distinct clues. Pain on biting that ceases after the pressure has been withdrawn is a classical sign.[1,3] Incidences usually occur while eating, or where objects such as a pencil or a pipe are placed between the teeth. The patient may have difficulty in identifying the affected tooth (there are no proprioceptive fibres in the pulp chamber).[4] Vitality testing usually gives a positive response, and the tooth is not normally tender to percussion in an axial direction.[1,2,4] Significantly, symptoms can be elicited when pressure is applied to an individual cusp. This is the principle of the bite tests.[3,4,14]

Here the patient is instructed to bite on various items such as a toothpick, cotton roll, burlew wheel, wooden stick, or the commercially available Tooth Slooth (Professional Results, Inc., Laguna Niguel, Calif.).[2,13,14] Pain increases as the occlusal force increases, and relief occurs once the

pressure is withdrawn (though some patients may complain of symptoms after the force on the tooth has been released). The results of these "bite tests" are conclusive in forming a diagnosis.[13]

The tooth often has an extensive intra-coronal restoration.[6,15] There may be a history of courses of extensive dental treatment, involving repeated occlusal adjustments or replacement of restorations, which fail to eliminate the symptoms. The pain may sometimes occur following certain dental treatments, such as the cementation of an inlay, which may be erroneously diagnosed as interferences or "high spots" on the new restoration.[16] Heavily restored teeth may also be tested by application of a sharp probe to the margins of the restoration.[1,16,19] Pain evoked in this manner can indicate the presence of a crack in the underlying tooth, which may be revealed upon removal of the restoration.[1,17]

Visual inspection of the tooth is useful, but cracks are not often visible without the aid of magnifying loupes, specialized techniques such as transillumination or staining with dyes such as methylene blue.[3,16,17] Areas such as mesial and distal marginal ridges are more prone to crack formation.[14,17] Occasionally, cracks are stained by caries or food and are visible to the unaided eye. Not all stained and visible crack lines lead to the development of CTS.

Radiographic examination is usually inconclusive as cracks tend to run in a mesiodistal direction.[2,11]

Treatment of CTS

Immediate treatment of the tooth depends on the size of the involved portion of the tooth. If the tooth portion is relatively small and avoids the pulp (Cameron's "peripherally located crack"), it may be fractured off and the tooth restored in the normal way.[2,14] If, however, the portion is very large or involves the pulp (Cameron's "centrally located crack"), the tooth should be stabilized immediately with an orthodontic stainless steel band.[2,11] Stabilization, along with occlusal adjustment, can lead to immediate relief of symptoms.[14] Care should be taken to prevent microleakage along the crack line, as this could result in pulpal necrosis.[2,8,11] A high success rate has been reported when full-coverage acrylic provisional crowns were used to stabilize the compromised tooth.[23] The tooth should be examined after 2 to 4 weeks and if symptoms of irreversible pulpitis are evident, endodontic treatment should be performed.[2]

Ultimately the tooth needs to be restored with protection and permanent stabilization in mind.[14] This can be achieved with an adhesive intra-coronal restoration[2,4] (e.g., bonded amalgam, adhesive composite restorations) or a cast extra-coronal restoration (e.g., full-coverage crown, onlay or three-quarter crown with adequate cuspal protection) to bind the remaining tooth components together.[18,19]

Where vertical cracks occur or where the crack extends through the pulpal floor or below the level of the alveolar bone, the prognosis is hopeless and the tooth should be extracted.[11]

Conclusion

The major problem for treatment of cracked tooth syndrome is the detection and identification of CTS. Every practitioner should be aware of the existence of CTS, and the condition must always be considered when a patient complains of pain or discomfort on chewing or biting. A good history will provide vital assistance in the search for a diagnosis. Careful clinical examination and inspection, supplemented by specialized tests such as the non-axial application of pressure to cusps, will help in deriving a proper diagnosis. Treatment of CTS will depend on the position and extent of the crack. Management options vary according to clinical need, from replacement of the fractured cusp with a simple restoration to placement of an extra-coronal restoration with adequate cuspal protection. Armed with the necessary awareness and conscientiousness, the dental practitioner should have no significant difficulty diagnosing and managing the CTS.

References

References are available on request at editor@healtalkht.com

Legends

Fig. 1. Craze lines, such as those on the occlusal surface of this tooth, are sometimes mistaken for other types of cracks.

Fig. 2. Occlusal, lingual and distal/proximal views of a fractured cusp involving the distolingual cusp of the mandibular right molar. A restoration is typically present; usually one cusp is involved and the fracture is not centered as viewed from the proximal.

Fig.3(A) Occlusal and distal/proximal views of a cracked tooth affecting the distal marginal ridge of the mandibular right molar; the crack has not yet extended onto the root.

Fig.3(B) Growth/propagation of the crack to include both mesial and distal marginal ridges and extending onto the distal root surface; a restoration is usually not present and the crack is more centered as viewed from the proximal.

Fig.3(C) Further propagation results in a split tooth in which a separable segment is detected; mesial and distal marginal ridges are involved and the fracture extends deeply in the root.

Fig. 4. Cracks may be evident across the floor of the cavity after restoration removal.

Fig.5.(A) Split tooth is visualized and,

Fig.5.(B) Confirmed by using wedging forces, which resulted in separation of the tooth segment.

Fig.5.(C) The extracted tooth highlights the fracture line extending from the mesial marginal ridge, through the floor of the cavity preparation, also involving the distal marginal ridge.

Fig.5.(D) The proximal view of the extracted tooth shows a complete fracture that extends deeply to the root surface with infiltration of granulomatous tissue.

Fig. 6. Facial view of a vertical root fracture, a horizontal cross-section of a VRF affecting only the lingual root surface, and a horizontal cross section of a VRF affecting both the buccal and the lingual root surfaces; root canal-filling material is shown in the canal space.

Fig. 7. The Tooth Slooth. The concave surface of the head is placed against the suspect cusp. Using the Tooth Slooth to identify damaged cusps.

Fig. 8. A flowchart for sequential treatment for CTS.

Fig. 1

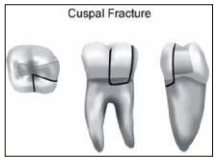


Fig. 2

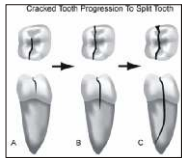


Fig. 3

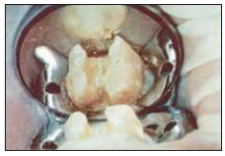


Fig. 4

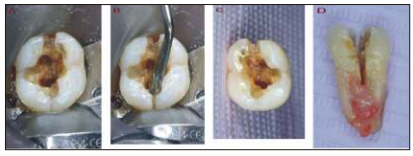


Fig. 5

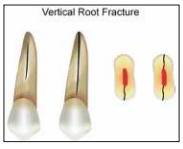


Fig. 6

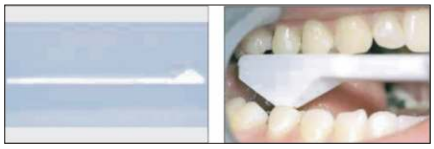


Fig. 7

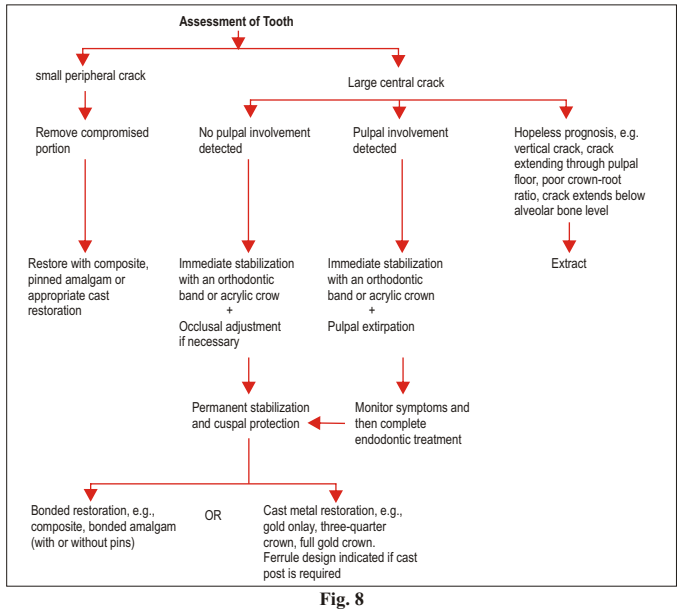


Fig. 8