

CRACKED TOOTH SYNDROME: AN ALTERNATIVE CRITERION

*¹Dr. Amoghavarsha L., ²Dr. Dharam Hinduja, ³Dr. Abdul Mujeeb, ⁴Dr. Raghu K. N. and ⁵Dr. Ashwini K. S.

¹(Postgraduate), SJM Dental College and Hospital, Chitradurga.

²(Professor and Head of the Department), SJM Dental College and Hospital, Chitradurga.

³(Professor), SJM Dental College and Hospital, Chitradurga.

⁴(Reader), SJM Dental College and Hospital, Chitradurga.

⁵(Senior lecturer), SJM Dental College and Hospital, Chitradurga.

Received date: 17 June 2021

Revised date: 07 July 2021

Accepted date: 27 July 2021

*Corresponding Author: Amoghavarsha L.

(Postgraduate), SJM Dental College and Hospital, Chitradurga.

ABSTRACT

Pain is defined as an “unpleasant sensory and emotional feeling which is associated with actual or potential injury of tissue or expressed in terms of such injury.” Tooth pain usually refers to pain around the teeth or jaws mainly as a result of a dental condition. Therefore, evaluation by both dentists and physicians are sometimes necessary to diagnose medical illnesses causing “toothache.” Cracked tooth syndrome (CTS), the term was coined by Cameron in 1964, which 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 variable, bizarre clinical features is a major diagnostic challenge in clinical practice. The management of CTS varies from one case to another or from one tooth to another in the same individual based on the severity of the symptoms and depth of tooth structure involved. Early diagnosis has been linked with successful restorative management and good prognosis. This presentation provides a detailed literature on the causes, classification, signs and symptoms, diagnosis, and treatment planning of cracked tooth syndrome.

KEYWORDS: Cracked tooth syndrome, diagnosis, tooth pain, tooth fractures.

INTRODUCTION

The Cracked tooth syndrome (CTS) may be defined as a fracture plane of unknown depth, which originate from the crown, passes through the tooth structure and extends subgingivally, and may progress to connect with the pulp space and/or periodontal ligament.^[1]

A cracked tooth is a tooth in which there exists a partial or complete fracture of a stress plane that commonly occurs in that tooth. A tooth stress plane results from occlusal forces that are commonly imposed on that tooth that may cause, during a masticatory cycle, an instance of higher energy to occur within the stress plane.^[2] Gibbs in 1954, first described the clinical symptoms of incomplete fracture of posterior teeth involving the cusp, naming it “cuspal fracture odontalgia”.^[3] Cameron in 1964 coined the term “cracked tooth syndrome.” Here, the signs and symptoms were not apparent, and the teeth showed painful response to cold or pressure applications and became necrotic, however, the pulp and periodontium were apparently healthy.^[4] The term ‘incomplete fracture of posterior teeth’ is often used

interchangeably with that of cracked tooth syndrome,^[5] while the terms ‘green-stick fracture,’ ‘fissured fractures,’ or ‘split tooth syndrome’ have also been used synonymously.^[6]

Cracks in teeth are one of the major causes of devastating and hopeless tooth prognosis leading to extraction after dental caries and periodontal diseases. Early enamel cracks are often neglected as they are asymptomatic. However, when the cracks are in the deeper layers of enamel or superficial dentin, the teeth tend to show hypersensitivity, but once the crack reaches the deep dentin layers or pulp, it will lead to more serious complications such as pulpitis and apical periodontitis.^[7] Bicuspid and molars frequently are fractured and split mesiodistally into buccal and lingual fragments.^[4]

Early intervention for cracked teeth is more likely to produce a better long-term prognosis, it can also avoid drastic consequences such as pain, periapical pathoses, or the need for tooth extraction. However, if cracked teeth have advanced to developing pulpitis or periapical

periodontitis, the prognosis is poor. The early diagnosis of a cracked tooth is the key factor in determining whether the treatment plan is successful and prognosis is positive.^[8]

Classification

Several classifications have been proposed based on: (a) The type or site of the crack, (b) the direction and degree

of the crack, (c) the risk of symptoms, (d) pathological processes.

The American Association of Endodontists,^[9] in a document titled “cracking the cracked tooth code” identified five types of cracked teeth [Table 1].

Classification	Originate	Direction	Symptoms	Pulp Status	Prognosis
Craze Line	Crown	Variable	None	Vital	Excellent
Fractured cusp	Crown	M-D and/or F-L	Mild and generally, only to biting and cold	Usually vital	Good
Cracked tooth	Crown±Root	M-D often Central	Acute pain on biting occasionally sharp pain to cold	Variable	Questionable: Dependent on depth and extent of the crack
Split tooth	Crown+Root	M-D	Marked pain on chewing	Often root filled	Poor unless crack terminates just subgingivally
Vertical root fracture	Roots	F-L	Vague pain Mimics periodontal disease	Mainly root filled	Poor: Root resection in multi-rooted teeth

Craze Line

Enamel crazing (or enamel infraction)^[10] are visible longitudinal fracture. These are common in adults.^[11] located only in the enamel portion of the tooth structure and there are no pulp symptoms. 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.^[12] No treatment is required but enamel crazes have the potential to progress to become cracks in the tooth and should therefore be monitored.

Fractured cusp

Fractured cusps are identified by a separated cusp from the rest of the tooth by complete or incomplete fracture. So, 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 mesio-distally and facio-lingually; the fracture usually involves at least two aspects of the cusp by crossing the marginal ridge and also extending down a facial or lingual groove. The fracture will extend to the cervical third of the crown or root.^[11] These fractures are typically seen in the buccal cusp of maxillary bicuspids, mesiobuccal, and distobuccal cusp of maxillary molars. Bader et al. also found lingual cusp fractured more commonly than buccal cusp in mandibular molars.^[13]

Cracked tooth

A cracked tooth is defined by the AAE as a crack extending from the occlusal surface of the tooth apically without separation of the two segments.^[11] The crack is generally located centrally in a mesio-distal direction and may involve one or both marginal ridges. 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. Cracked teeth are also described as incomplete (greenstick) fractures, which describes their form.^[14] The cracked tooth is a variation of the cusp fracture except that the associated fracture is centered more occlusally. The effects of cracked teeth tend to be more devastating because their extent and direction are more centered and more apical. Cracks that are causing pulp and periradicular diseases require treatment, the nature of which varies considerably depending on the position, direction and extent of the crack.

Split tooth

A split tooth is the evolution (end result) of a cracked tooth. The term ‘split tooth’ is defined as a complete fracture initiated from the crown and extending subgingivally, usually directed mesio-distally through both of the marginal ridges and through the proximal surfaces.^[11] The crack is generally located at the center of the tooth and this entity occurs due to crack propagation. The split may occur suddenly but it is more likely the result of long-term growth in an incomplete cracked tooth.

Vertical root fracture

Some authors^[15,16] describe cracks as “vertical,”^[17] “oblique,”^[15] or “horizontal.” However, one cannot unambiguously differentiate between different crack types based on the “directions” of their fracture planes within a tooth, given that fracture planes are irregularly shaped.

According to the AAE, VRF has been defined as complete or incomplete fracture initiated from the root and is usually in buccolingual direction.^[14] The fracture may involve one proximal surface (facial or lingual) or both facial 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.^[18] VRFs can occur in endodontically treated teeth as well as non-endodontically treated teeth. Vertical root fracture mimics other conditions. Because treatment invariably consists of either tooth extraction or removal of the fractured root, an error in diagnosis has serious consequences.

Etiology

The aetiology of incomplete fractures of posterior teeth is multi-factorial. In an article by Guersten et al.^[19]

Mandibular molar teeth seem to be most commonly involved, followed by maxillary premolars, maxillary molars and mandibular premolars. In a recent clinical audit, mandibular first molar teeth were most commonly affected by CTS possibly due to the wedging effect of the opposing prominent maxillary mesio-palatal cusp onto the mandibular molar central fissure.^[20] It is stated that 'excessive forces applied to a healthy tooth or physiologic forces applied to a weakened tooth can cause an incomplete fracture of enamel or dentine'. Lynch et al.^[21] have subdivided the causes of cracks into four major causative categories, hence: 'restorative procedures', 'occlusal factors', 'developmental conditions' and 'miscellaneous factors'.

Table-1:

Classification	Factor	Examples
Restorative procedure	Inadequate design features	Over-preparation of cavities Insufficient cuspal protection in inlay/onlay design Deep cusp-fossa relationship
	Stress concentration	Pin placement Hydraulic pressure during seating of tightly fitting cast restoration Physical force during placement of restoration, Eg., amalgam or soft gold inlay (historical) Non-incremental placement of composite restoration (tensile stress on cavity wall) Torque on abutment of long-span bridges
Occlusal	Masticatory accident	Sudden and excessive biting force on a piece of bone
	Damaging horizontal forces	Eccentric contacts and interferences (especially mandibular second molars)
	Functional forces	Large untreated carious lesion Cyclic forces
	Parafunction	Bruxism
Developmental	Incomplete fusion of areas of calcification	Occurrence of cracked tooth syndrome in unrestored teeth
Miscellaneous	Thermal cycling	Enamel cracks
	Foreign bodies	Lingual barbell
	Dental instrument	Cracking and crazing associated with high-speed handpieces

a more recent study revealed the presence of cracks in about 60% of the evaluated molar teeth with no restorations. In another investigation, nonvital teeth with minimal or no restorations were evaluated in which pulp necrosis was thought to have occurred secondary to longitudinal fractures.^[22] It is also well established that the high and steep cusp inclinations of tooth play a vital role in tooth cracks. Steep cusp inclines and deep grooves have been of concern as one of the predisposing factors for the incidence of tooth fracture in posterior natural dentition.

Symptoms and Diagnosis

The history elicited from the patient can give certain distinct clues. Patients reported tooth sensitivity when cold food and beverages came in contact with certain teeth.^[23] Pain on biting that ceases after the pressure has

been withdrawn is a classical sign. These symptoms can be explained by the hydrodynamic theory of pain first described by Feiglin^[24] and substantiated experimentally by Brännström.^[25] This theory is based on the concept that rapid movement of dentinal fluid in the dentinal tubules causes pain. This movement stimulates mechanoreceptors in close proximity to the odontoblast cell body, which then activate delta nerve fibers (faster myelinated fibers), resulting in a short sharp pain. Incidences usually occur while eating, or where hard objects are placed between the teeth. On vitality testing it gives a positive response. Symptoms can be elicited when pressure is applied to an individual cusp. Principle called "bite tests" is performed where the patient is instructed to bite on various items such as a toothpick, cotton roll, burlow wheel, wooden stick or the commercially available Tooth Sloth. Bite test reveals the

pain increases as the occlusal force increases, and relief occurs once the pressure is withdrawn or may complain of symptoms after the force on the tooth has been released. If the pulp is involved, there may be signs and symptoms of irreversible pulpitis or necrosis with periradicular pathosis. If the crack extends to the root surface, there may be a periodontal pocket. However, cracks can be finally identified when a variety of symptoms exist, a restoration is removed or significant periodontal defect is identified.^[26]

The tooth often has an extensive intracoronal restoration. 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 point” on the new restoration. Recurrent debonding of cemented intracoronal restorations such as inlays may indicate the presence of underlying cracks. Heavily restored teeth may also be tested by application of a sharp probe to the margins of the restoration. 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.^[27]

Cracks are sometimes 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. Other clues evident on examination include the presence of facets on the occlusal surfaces of teeth (identifies teeth involved in

eccentric contact and at risk from damaging lateral forces), the presence of localized periodontal defects.

Management of CTS

Tiny cracks are common and usually do not cause problems. In such cases, regular check-ups are important to manage such problems in early stage. Various treatment modalities are available for advanced cracks (incomplete fracture). The choice depends on the location, direction, and extent of the crack. Cracks may be superficial, affecting the cusp of a tooth or deep to involve the root of the tooth. Some affect only the enamel; others may extend to the dentin or the pulp. Before treatment, reduction or elimination of occlusal contacts is essential to avoid an overload of a split tooth.

While some advocate the removal of the affected cusp, followed by restoration of the residual defect or subtractive occlusal adjustments,^[28] the consensus approach for the management of incompletely fractured posterior teeth would generally appear to involve the immobilisation or splinting of the affected tooth, so as to prevent the independent movement of the fractured portions upon occlusal loading. Immobilisation in this manner may also prevent further progression of the fracture plane.^[29]

Acute management has generally been provided using immediate extra-coronal circumferential splints (such as copper rings, orthodontic bands or provisional crowns)^[30] or by the application of direct (intra-coronal or extra-coronal splints) usually involving some form of tooth preparation.

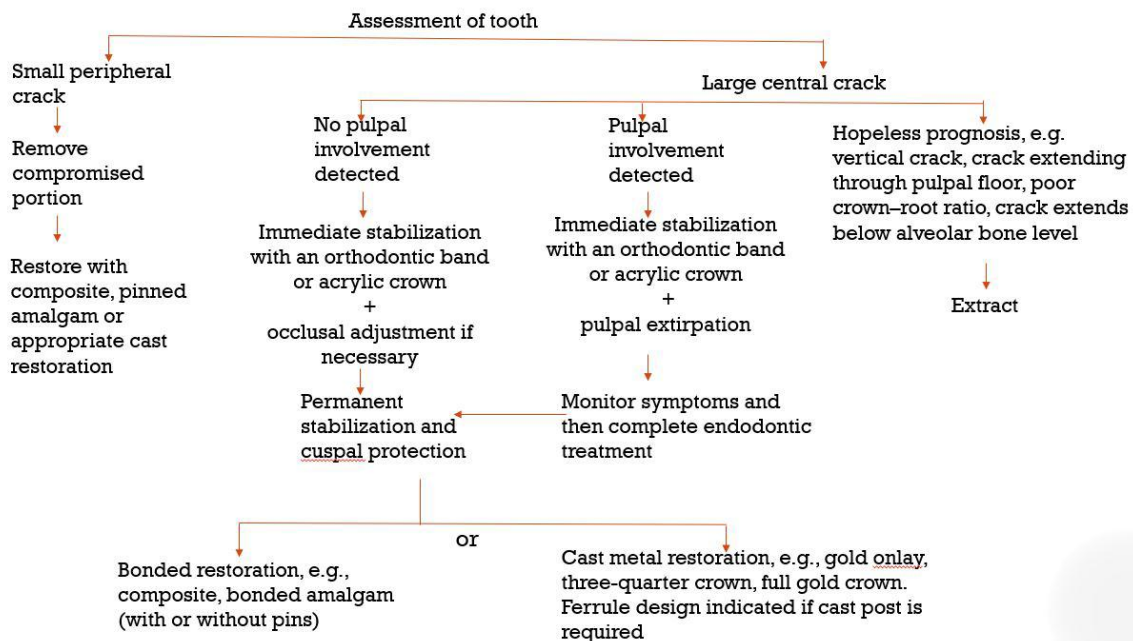


Fig. 1.

A decision flowchart of treatment options is presented in Fig. 1. 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^[4].

Care should be taken to prevent microleakage along the crack line, as this could result in pulpal necrosis. A high success rate has been reported when full-coverage acrylic provisional crowns were used to stabilize the compromised tooth.^[31] The tooth should be examined after 2 to 4 weeks and if symptoms of irreversible pulpitis are evident, endodontic treatment should be performed. As for extracoronal restorations, certain modifications of tooth preparation have been suggested for cracked teeth, such as including additional bracing features in the area of the crack, i.e., extending the preparation in a more apical direction, bevelling the cusps of the fractured segment more than usual to minimize damaging forces, using bases to prevent contact with the internal surface of the casting, and using boxes and grooves on the unfractured portion.^[31] Cracks extending subgingivally often require a gingivectomy to expose the margin; however, an unfavourable crown-root ratio may render the tooth unrestorable.

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.^[32] It is worth remembering that it is possible for a crack to progress after placement of an extracoronal metal restoration or crown, when occlusal forces are particularly strong.

CONCLUSION

The diagnosis and management of CTS in dental practice can sometimes prove to be highly taxing on the operator. There is a need for an effective technique to provide immobilisation. However, there is a need for further research into this technique as well as into alternative forms of management as discussed above, in order to support (or indeed contraindicate) the notion of any one approach (inclusive of a given dental material and or restoration form) being superior to another.

REFERENCES

- Hasan S, Singh K, Salati N. Cracked tooth syndrome: overview of literature. *International Journal of Applied and Basic Medical Research*, 2015 Sep; 5(3): 164.
- Mamoun JS, Napoletano D. Cracked tooth diagnosis and treatment: An alternative paradigm. *European journal of dentistry*, 2015 Apr; 9(2): 293.
- Gibbs JW. Cuspal fracture odontalgia. *Dent Dig.*, 1954; 60: 158-60.
- Cameron CE. Cracked-tooth syndrome. *J Am Dent Assoc*, 1964; 68: 405-11.
- Geurtsen W, Schwarze T, Gunay H. Diagnosis, therapy and prevention of the cracked tooth syndrome. *Quintessence Int*, 2003; 34: 409-417.
- Trushkowsky R. Restoration of a cracked tooth with a bonded amalgam. *Quintessence Int*, 1991; 22: 397-400.
- Alsolaihim AN, Alsolaihim AA, Alowais LO. In vivo and in vitro diagnosis of cracked teeth: A review. *Journal of International Oral Health*, 2019 Nov 1; 11(6): 329.
- Tang W, Wu Y, Smales RJ. Identifying and reducing risks of potential fractures in Endodontically treated teeth. *J Endod*, 2010; 36: 609-17.
- American Association of Endodontists. *Endodontics: Colleagues for Excellence-Cracking the cracked tooth code*. Chicago, IL: Fall/ Winter, 1997.
- Abbott P, Leow N. Predictable management of cracked teeth with reversible pulpitis. *Australian dental journal*, 2009 Dec; 54(4): 306-15.
- RIVERA EM, WALTON RE. Longitudinal tooth fractures: findings that contribute to complex endodontic diagnoses. *Endodontic Topics*, 2007 Mar; 16(1): 82-111.
- Kahler W. The cracked tooth conundrum: terminology, classification, diagnosis, and management. *American journal of dentistry*, 2008 Oct 1; 21(5): 275.
- Bader JD, Martin JA, Shugars DA. Incidence rates for complete cusp fracture. *Community dentistry and oral epidemiology*, 2001 Oct; 29(5): 346-53.
- Ailor Jr JE. Managing incomplete tooth fractures. *J Am Dent Assoc*, 2000; 131: 1168-1174.
- Wright EF, Bartoloni JA. Diagnosing, managing, and preventing cracked tooth syndrome. *Gen Dent*, 2012; 60: e302-7.
- Dewberry JA. Vertical fractures of posterior teeth. In: *Weine FS, editor. Endodontic Therapy*. St. Louis: CV Mosby, 1982; 8-15.
- Schetritt A, Steffensen B. Diagnosis and management of vertical root fractures. *J Can Dent Assoc*, 1995; 61: 607-13.
- Tamse A. Vertical root fractures in endodontically treated teeth: diagnostic signs and clinical management. *Endod Topics*, 2006; 13: 84-94.
- Geurtsen W. The cracked-tooth syndrome: clinical features and case reports. *International Journal of Periodontics & Restorative Dentistry*, 1992 Oct 1; 12(5).
- Banerji S, Mehta SB, Millar BJ. Cracked tooth syndrome. Part 1: aetiology and diagnosis. *British dental journal*, 2010 May; 208(10): 459-63.
- Lynch CD, McConnell RJ. The cracked tooth syndrome. *Journal-Canadian Dental Association*, 2002 Sep 1; 68(8): 470-5.
- Ricucci D, Siqueira Jr JF, Loghin S, Berman LH. The cracked tooth: histopathologic and histobacteriologic aspects. *Journal of endodontics*, 2015 Mar 1; 41(3): 343-52.
- Opdam NJ, Roeters JM. The effectiveness of bonded composite restorations in the treatment of painful, cracked teeth: six-month clinical evaluation. *Operative dentistry*, 2003 Jul 1; 28(4): 327-33.
- Feiglin B. Aspects of dentinal and pulpal pain. Diagnosing dental pain. *Annals of the Royal Australasian College of Dental Surgeons*, 1994 Apr 1; 12: 143-52.

25. Brännström M. The hydrodynamic theory of dentinal pain: sensation in preparations, caries, and the dentinal crack syndrome. *Journal of endodontics*, 1986 Jan 1; 12(10): 453-7.
26. Tanumihardja M. Cracked tooth syndrome.
27. Lynch CD, McConnell RJ. The cracked tooth syndrome. *Journal-Canadian Dental Association*, 2002 Sep 1; 68(8): 470-5.
28. Agar JR, Weller RN. Occlusal adjustment for initial treatment and prevention of the cracked tooth syndrome. *The Journal of prosthetic dentistry*, 1988 Aug 1; 60(2): 145-7.
29. Liebenberg W H. Partial coverage indirect tooth coloured restorations; steps to clinical success. *Am J Dent*, 1999; 12: 201–209.
30. Ehrmann E H, Tyas M J. Cracked tooth syndrome: diagnosis, treatment and correlation between symptoms and post-extraction findings. *Aust Dent J*, 1990; 35: 105–112.
31. Guthrie RC, Difiore PM. Treating the cracked tooth with a full crown. *Journal of the American Dental Association (1939)*, 1991 Sep 1; 122(9): 71-3.
32. Banerji S, Mehta SB, Millar BJ. Cracked tooth syndrome. Part 2: restorative options for the management of cracked tooth syndrome. *British Dental Journal*, 2010 Jun; 208(11): 503-14.