CASE REPORT

Endodontic Management of a Cracked Tooth: A Case Report

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Abstract

Aim: This case report presents an overview of clinical presentation, diagnosis, and non-surgical endodontic management of a cracked tooth.

Background: The cracked tooth is a distinct type of longitudinal tooth fracture. Clinical diagnosis is difficult because the signs and symptoms are variable. Timely and proper management of cracked teeth is necessary to save the tooth.

Case description: A 67-year-old male patient reported pain in the upper left back tooth. On examination tooth-26 presented with a crack line in the palatal aspect. The case was diagnosed as pulp necrosis with symptomatic apical periodontitis in relation to 26 due to crack. The case was managed by sealing of crack, banding of the tooth, nonsurgical endodontic treatment, and a full metal crown.

Conclusion: Treatment of cracked tooth depends on the position and extent of the crack. Management options vary from routine monitoring, occlusal adjustments, placement of a cast restoration, and endodontic treatment. This case report presents a successful management of a cracked tooth by combined use of restorative sealing of crack, banding of the tooth to prevent further crack propagation, followed by endodontic and prosthodontic intervention.

Clinical significance: Cracks can act as a pathway for the bacterial penetration which has the potential to cause pulpal and periapical pathology. They should be addressed both biologically and mechanically for the successful management. Early diagnosis and appropriate treatment plans are equally important.

Keywords: Banding, Cracked tooth, Endodontic treatment, Longitudinal fractures.

Conservative Dentistry and Endodontic Journal (2021): 10.5005/jp-journals-10048-0106

Introduction

A cracked tooth is defined 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. It is located in the crown portion of the tooth only or may extend from the crown to the proximal root. The location, direction, and extent of a crack have a profound effect on the choice of treatment.[1] Occlusally, the crack is more centered and apical than a fractured cusp and, therefore, more likely to cause pulpal and periapical pathosis as it extends apically.[2] Some other longitudinal tooth fractures include craze lines, split tooth, fractured cusp, and vertical root fracture (VRF). Craze lines affect only the enamel, while fractured cusps, cracked teeth, and split teeth begin on the occlusal surface and extend apically, affecting the enamel, dentin, and possibly, the pulp. Vertical root fractures begin in the root. Cameron in 1964 coined the term "cracked tooth syndrome (CTS)."[3] The term incomplete fracture of posterior teeth is often used interchangeably with that of CTS. Greenstick fracture and split tooth syndrome have also been used synonymously.

The occurrence of CTS is unknown, but an incidence rate of 34–74% has been documented.[3] It occurs frequently in individuals within the age range of 30–50 years, with a female predilection.[3] The most commonly affected tooth is the mandibular molar followed by the maxillary premolar, maxillary molar, and mandibular premolar. In 2006, Roh and Lee reported that cracks were found more frequently in maxillary molars (57.2%) than in mandibular molars (36.3%).[4]

Cracked tooth syndrome has a multifactorial etiology. Lynch and McConnell subdivided the etiology into four major categories: Restorative procedures, occlusal factors, developmental factors, and miscellaneous factors[5] (Table 1).

Restorative procedures and occlusal factors can lead to crack formation, which, when left unattended, can progress to the pulp chamber and cause endodontic infections. During endodontic treatment, excessive removal of intraradicular dentine and use of chelating agents can cause further crack propagation. According to Gokturk et al.,[6] among the various irrigants, 5% sodium hypochlorite irrigant has the potential to reduce the physical strength of root dentine and cause cracks. Internal wedging forces can also lead to progression of crack lines. So, the compaction of root canal filling material should be carefully controlled. Posts weaken the roots and should be used only when absolutely necessary.

The properties of the restorative material being used are of great significance in preventing the occurrence of cracked teeth. Metallic restorations are more likely to cause cracks than

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How to cite this article: Vijay SL, Geetha P, Kunjusankaran RN, *et al*. Endodontic Management of a Cracked Tooth: A Case Report. Cons Dent Endod J 2021;6(2):50–54.

Source of support: Nil

Conflict of interest: None

Table 1: Etiological factors in cracked tooth syndrome[3,5]

Classification	*Factors*	*Examples*
Restorative procedures	Inadequate design features	Overpreparation of cavities (excessive tooth removal)
		Deep cusp-fossa relationship
		Insufficient cuspal protection in inlay/onlay design
	Stress concentration	Pin placement (friction lock or self-threading dentin pins)
		Non-incremental application of composite resins (tensile stress on cavity walls)
		Pressure exerted during the seating of tightly fitting cast restorations
		Physical forces during placement of the restoration, e.g., amalgam or soft gold inlays (historical)
Occlusal factors	Masticatory trauma	Sudden and excessive cutting force on a piece of hard object (bone)
	Trauma from occlusion	Eccentric contacts and interferences (especially mandibular second molars)
	Functional forces	Large untreated carious lesions
		Cyclic forces
	Parafunctional habits	Bruxism and bruxomania
Developmental factors	Incomplete fusion of areas of calcifications	Occurrence of cracked tooth syndrome in unrestored tooth or teeth with minor restorations
Miscellaneous factors	Thermal cycling	Enamel cracks

non-metallic restorations.[7] The difference in the thermal expansion coefficient between the tooth and the restorative material may lead to cracks. The restorative material deforms under the action of an external force or the influence of the oral environment, thereby causing abnormal bite force distribution, which easily leads to CTS. The amalgam restoration tends to expand and contract with temperature change, unlike the tooth. This can eventually develop cracks. As the size of amalgam filling increases, the chance of developing a fracture or CTS is more. In addition to restoration material, cavity preparation can also lead to cracks. Tooth longevity is possible, provided that the tooth biodome is not violated much, the intercuspal ridge is preserved, and there are no sharp line angles. Type of composite material and the restorative technique, if selected properly, composite is the material of choice to replace dentine.

Cracked tooth syndrome presents with varied clinical signs and symptoms according to the position and extent of the incomplete fracture. History of the discomfort of several months and sharp pain when biting or when consuming cold food/beverages, sugar-containing substances may be elicited. Rebound pain on the release of pressure upon intake of fibrous foods is a consistent feature. Another study has reported that pain on chewing is more common than rebound pain.[8] Chronic pulpitis with no clinical symptoms may be seen as a result of microleakage of bacterial by-products and toxins. Cracks with pulpal involvement may result in pulpal and periodontal symptoms.

This case report presents an overview on clinical presentation, diagnosis, and the endodontic management of a cracked tooth.

Case Report

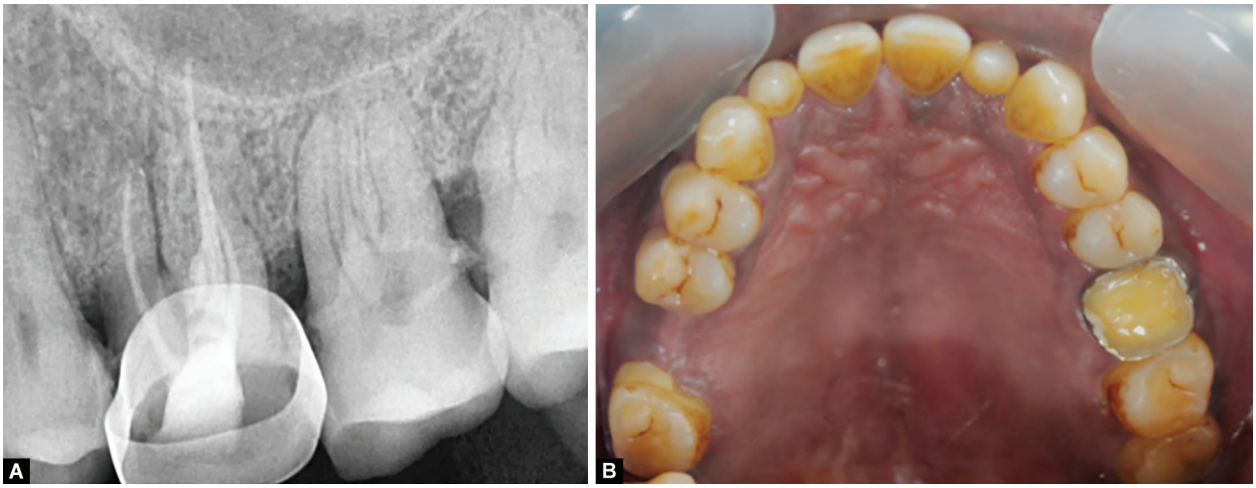
A 67-year-old male reported to the Department of Conservative Dentistry and Endodontics with the complaint of pain in the upper left back tooth region on chewing. He also gave the history of traumatic bite a few weeks back.

He had a class V glass ionomer restoration on a buccal surface of 26. On further examination, crack lines on the mesial and palatal aspects of the crown were seen. Tenderness on percussion and bite test had a positive response. A probing depth of 3 mm was present on the mesio-palatal aspect. Vitality test using electric pulp tester revealed no response in 26. The case was diagnosed as pulp necrosis with symptomatic apical periodontitis-26 due to crack (Fig. 1).

Fig. 1: Preoperative radiograph showing extension of the crack line

Treatment Procedure

The occlusal reduction was done before initiating root canal treatment on 26. On access opening, necrotic pulp tissue was present. After the extirpation of tissue, visual examination using a magnifying loupe with LED light was done. A palatal crack line was seen extending to the dentine terminating just above the pulp floor. There was another mesial crack line on the occlusal fourth of the mesial wall. The crack lines were removed using no: 1/4 round bur to a depth till crack lines were removed. Then the tooth was etched along the crack region and sealed with flowable composite resin restoration (COMPO-flo, D-tech). Banding was done using stainless steel band material (0.180″ × 0.006″). Instrumentation of the canals was started with hand files with minimal force, followed by rotary instrumentation up to 25/4% Neoendo Flex files. Irrigation was done using 3% NaOCl solution and saline. Inter appointment intracanal calcium hydroxide medication was placed.



Figs 2A and B: Postoperative radiograph and photograph

Fig. 3: After crown placement

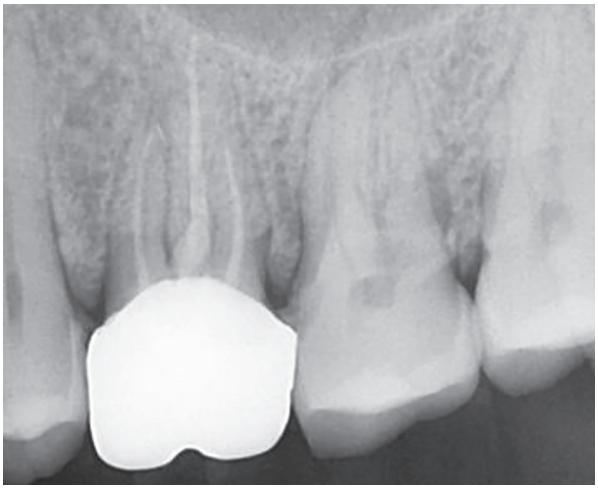


Fig. 4: Review after 8 months

Obturation was done using Gutta-percha and zinc oxide sealer by lateral condensation technique. Care was taken to apply minimal force during lateral condensation. Gutta-percha was sheared off at orifice level, and post-endodontic restoration was done using GIC liner, fiber-reinforced composite, and dentine bonding bulk-fill composite 1 week after obturation. After root canal treatment, follow-up evaluation was done at 1st and 3rd months. Clinical and radiographic evaluation revealed no pathologic changes. The band was removed by placing a groove along the welded line of the band using a diamond bur and splitting it. The tooth was prepared minimally, and prosthetic rehabilitation was done using a full metal crown. A review after 8 months showed asymptomatic and functional 26 with the intact periapical area (Figs 2 to 4).

Discussion

Timely diagnosis of a cracked tooth is the key to successful management. But having multifactorial etiology, early diagnosis is often a dilemma. Proper dental history, visual examination, periodontal probing, radiographic examination, transillumination test, bite test, removal of existing restoration, tactile examination, dyes, periapical tests, and vitality testing can help in the diagnosis of a crack tooth. Visual examination can be enhanced by a dental operating microscope (DOM) and loupes. Dental operating microscope can offer a wide range of magnification. Swept-source optical coherence tomography (SSOCT) is a promising technique for the detection and analysis of incipient enamel caries and early CTS.[9] Li et al.[10] confirmed the practicability of using indocyanine green-assisted near-infrared fluorescence (ICG-NIRF) imaging to detect enamel-dentin and enamel cracks *in vitro*. Ultrasonic systems, infrared thermography, and near-infrared 810 nm diode laser are some of the other diagnostic aids in the detection of cracks.

The resolution of cone-beam computed tomography (CBCT) being only approximately 80 µm, it is not suitable for the diagnosis of cracked teeth and detecting early VRFs.[7] In an *in vitro* study, Yuan et al. demonstrated that compared to the conventional approach, scanning using CBCT can be enhanced using meglumine diatrizoate as a contrast agent as it can objectively and effectively show hidden cracks.[11]

In the present case, the crack line was evident in the radiograph. The primary objective of the treatment plan was to stop the further propagation of the crack. This was achieved by reducing the occlusal height of the tooth, sealing of crack, and banding of the tooth using stainless steel band. Pane et al. have reported that stainless steel banding has the ability to reduce the cuspal flexure by

one-half and double the fracture resistance of teeth when compared to teeth without bands.[12] These bands provide a protective effect by withstanding forces during the treatment procedure. It also provides an external compressive force, thereby causing uniform stress distribution. The most brittle material should have a lower elastic modulus so that the stress is transferred to material with a higher elastic modulus. Stainless steel band material has an elastic modulus higher than tooth, thus, more stress is transferred to band material. While banding care is to be taken to not have any occlusal interference.

In this case, the etiology for the cracked tooth was traumatic bite. The patient gave a history of masticatory trauma. The occlusal load was mainly concentrated on the left side since the contralateral tooth was missing, and age is also a contributing factor to making the teeth brittle. Dentine of older individuals has a higher elastic modulus, thus increasing the stiffness as compared to younger individuals.[13] This can lead to reduced root dentine fracture resistance.

The long-term prognosis for a cracked tooth is better when no crack is visible or the crack does not extend to the pulp chamber floor. Visual examination using magnifying loupe (2.5 ×, Admetec) revealed crack line terminating just above the pulp floor in this case. Pulpal and periapical diagnosis determine the final treatment plan. The affected tooth was tested as non-vital. Thus, it was planned to carry out root canal treatment followed by prosthetic management. Lack of severe symptoms for the patient may be explained by old age resulting in sclerosis of dentine. The treatment procedure was started with a guarded prognosis. Minor cracks are often managed with bonded restorations or a crown, while deep cracks with pulpal involvement require root canal treatment and a crown to protect them. Indirect resin-bonded composite inlays, as well as bonded mesial-occlusal-distal (MOD) ceramic inlays, have the ability to improve the fracture strength of prepared teeth to a level similar to that of healthy teeth.[14] Resin composite inlays release shrinkage stresses at the interface of the tooth structure, thereby promoting the creation and extension of cracks in the enamel. Therefore, ceramic inlays can be more efficient in restoring CTS than resin composite inlays.[15] Likewise, ceramic onlays have the advantage of resistance to wear and friction, outstanding appearance, and biocompatibility. Indirect composite onlays can also be used. However, full crowns can be the first choice of treatment in CTS.

In this case after banding and root canal treatment, the patient was relieved of symptoms. Post endodontic restoration was done by sealing the orifice using glass ionomer cement, replacing dentine with fiber-reinforced composite (EverX posterior, GC Europe), and occlusal laminate layer of nanohybrid composite (Tetric EvoCeram, Ivoclar Vivadent, Inc.). Bonded restorations have the potential to reinforce weakened tooth structures. Fiber-reinforced composite has high flexural strength and a lower percentage of shrinkage strain. It has the ability to arrest crack propagation. This short fiber-reinforced composite can structurally mimic dentin in its behavior under load. In addition, nanohybrid composite materials also have lower volumetric polymerization shrinkage stress. The banding was retained for a period of 1 month. The treatment was proceeded by the placement of full metal crown. A full metal crown was opted because it requires minimal tooth reduction, thus preserving the bulk of tooth structure. Also, full coverage restoration binds the tooth together, providing an external compressive force like the banding and helps in uniform stress distribution. After root canal therapy, the survival rate of cracked teeth restored with a full crown is significantly higher than that restored with others, and the incidence of complications is reduced.[16] Modern endodontic techniques, including microscope-assisted intraorifice barriers placed apically to the level of crack and full coverage restoration with proper occlusal equilibrium, may account for a better outcome.[17]

A review after 8 months showed asymptomatic and functional tooth with intact periapex. Furthermore, the patient was advised to go for prosthetic rehabilitation of contralateral missing tooth-16.

Cracks are permeable pathways allowing caries-producing bacteria access to dentine–enamel junction. They can cause pulpal and periapical diseases. The crack should be considered as a biological problem rather than a mechanical one alone.[8] When managing the mechanical aspect of teeth, care should be taken to manage the inflamed pulp also.

Clinical Significance

Crack tooth syndrome has a wide variety of signs and symptoms, thus making the diagnosis difficult and complicated. Various techniques have been put forth in the management of cracked teeth to preserve, stabilize, and protect the affected tooth. In this case report, combined use of restorative, banding of the tooth, and endodontic and prosthodontic intervention have resulted in a favorable outcome.

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