

Perplexing Cracks: A Case Report on the Management of Cracked Tooth Syndrome

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Abstract

Cracked Tooth Syndrome is a clinical diagnostic enigma, often manifested like phantom pain. The term cracked tooth syndrome is misleading as the cracked teeth show a variety of symptoms and this unpredictability often makes it a perplexing diagnostic and treatment entity. The prognosis of teeth with cracks is often questionable due to varying factors such as the location, direction and extent of the crack. Management of cracked tooth is usually challenging but with proper diagnostic skills and treatment protocol, many teeth with cracks can be saved!

This clinical report describes the diagnostic procedures and management of an incompletely fractured and unrestored mandibular second molar in a 42 year old male patient. The patient was unable to identify the offending tooth and gave a history of numerous dental procedures with unsatisfactory results. Clinical examination revealed a tooth with crack line and associated pulpal inflammation. The tooth was splinted with orthodontic stainless steel band and root canal treatment was carried out. The tooth was then restored with a metal crown. The symptoms were completely eliminated and patient responded well. Thus, the key factor in the management of

cracked tooth is early diagnosis and immediate splinting so as to limit the propagation of the crack.

Keywords Cracked tooth syndrome, Tooth fracture, Transillumination, Bite test, Mandibular molars, Orthodontic band stabilization.

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]. It is also defined 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. The term Cracked Tooth Syndrome was first introduced by Cameron in 1964. Other authors had previously described the incomplete fracture as “cuspal fracture odontalgia” (Gibbs 1954), “fissured fractures” (Thoma 1954) and “green stick fracture of the tooth crown” (Sutton 1962) [2]. The most common cause for cracked tooth is masticatory or accidental trauma i.e. unintentional biting with physiologic masticatory force on a small and very hard object which generates an excessive load causing the tooth to crack. Other co-factors could be heavily restored teeth, unrestored deep carious lesions, endodontically treated teeth, deep grooves, pronounced

radicular grooves or bifurcation which makes the teeth susceptible to fracture. Some of the iatrogenic factors are extensive cavity preparation, overzealous condensation of amalgam, excessive lateral condensation of GP and placement of friction lock or self-threading pins.

[Table 1]

Classification	Factors	Examples
Restorative procedures	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 restorations 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
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 lesions Cyclic forces
Developmental	Parafunction	Bruxism
	Incomplete fusion of areas of calcification	Occurrence of cracked tooth syndrome in unrestored teeth
Miscellaneous	Thermal cycling	Enamel cracks
	Foreign body	Lingual barbell
	Dental instruments	Cracking and crazing associated with high-speed handpieces

Table 1[3]

The prevalence is similar in men and women. It is primarily seen in adulthood over 40yrs of age and mostly associated with intracoronal restorations [2]. It is most prevalent in mandibular molars although higher incidence is seen in mandibular second molars due to their proximity to TMJ. This is based on the principle of “lever” effect which states that the mechanical force on the object is increased at closer distances to the fulcrum [3]. Arnold stated that ratio of forces on molars, premolars and incisors is 4:2:1 with heavier forces on the most posterior teeth close to the muscles producing this force [4]. Also there could be the wedging effect of prominent MP cusp of maxillary 1st molar. However the transverse ridge of maxillary molar may provide structural reinforcement. Maxillary molars and premolars have similar incidence. Mandibular premolars are the least susceptible. DL cusp of mandibular molars are the most susceptible cusp. Non-functional cusps are more susceptible to fractures than functional cusps. This is due to their cuspal dimension as functional cusps are significantly larger in a BL dimension

and covered with a thicker layer of enamel. Also the functional cusps are supported on the inner and outer inclines by the opposing teeth. But the non-functional cusps are more susceptible to fracture from lateral excursive occlusal forces due to lack of support from the outer incline. Most fractures tend to occur in a direction near parallel to the forces on the cuspal inclines. Cracks tend to have MD direction/orientation in most teeth. It may run BL in mandibular molars. Early diagnosis is important to limit the propagation of the crack, subsequent microleakage and involvement of the pulpal and periodontal tissues. When a crack is suspected, the steps to confirm the suspicion:

1. Dental history
2. Subjective examination
3. Objective – visual examination
4. Tactile examination
5. Bite tests
6. Vitality testing
7. Periodontal probing
8. Staining
9. Transillumination
10. Wedging forces
11. Restoration removal
12. Radiographic exam

The treatment requirement of a cracked tooth is dependent on the position and extent of the fracture. An assessment of the stimuli, character and duration of the pain are influential guide for treatment. A decision flow chart indicating the treatment options available has been presented

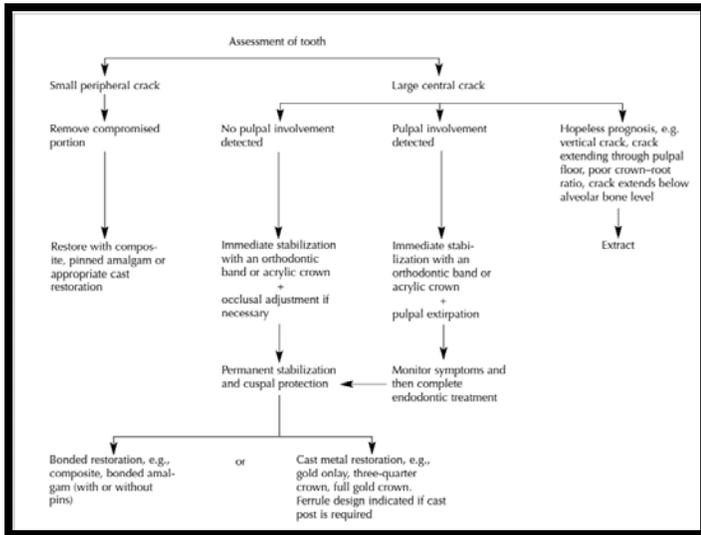


Fig 2: Bite Test

Table 2[5]

Case Report

A 42 year old male patient reported to the Department of Conservative Dentistry and Endodontics with a complaint of sharp pain on biting on hard food and sensitivity on taking cold and hot water on right lower back tooth since two weeks. The pain started after accidentally biting on some hard food substance. On oral examination there was a crack line seen on 47. Pre-OP radiograph revealed that tooth number 47 was intact with no periodontal or endodontic disease on radiographic examination (Fig 1). No other significant radiographic findings were present.

Other investigations were performed as the above findings were inconclusive. Bite test using wooden stick initiated pain on releasing bite pressure (Fig 2). Electric pulp testing revealed vital pulp. Methylene blue dye was used for staining which revealed a crack line on occlusal surface of 47 extending mesiodistally (Fig 3). Transillumination using LED curing light from buccal aspect revealed crack line that did not transmit light to the lingual aspect. Based on the above findings, the diagnosis was irreversible pulpitis due to cracked tooth.



Fig 1: Pre-op Radiograph



Fig 3: Methylene Blue Dye Test Placement

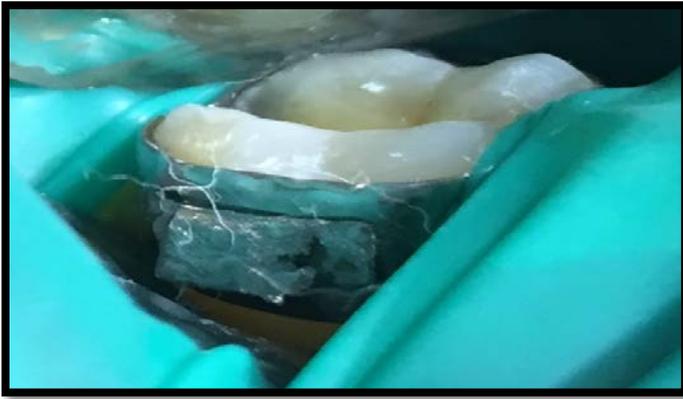


Fig 4: Orthodontic Band

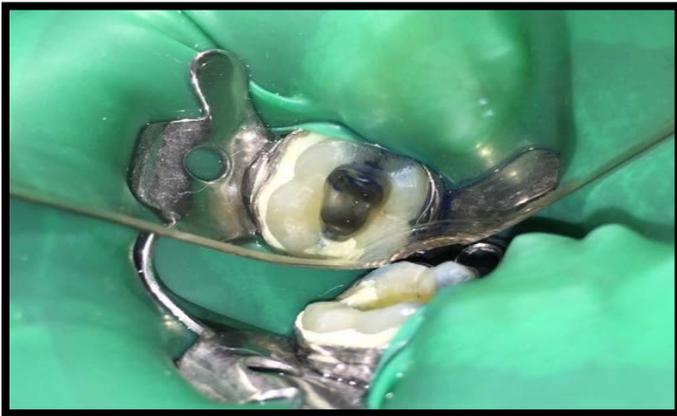


Fig 5: Access Cavity Preparation

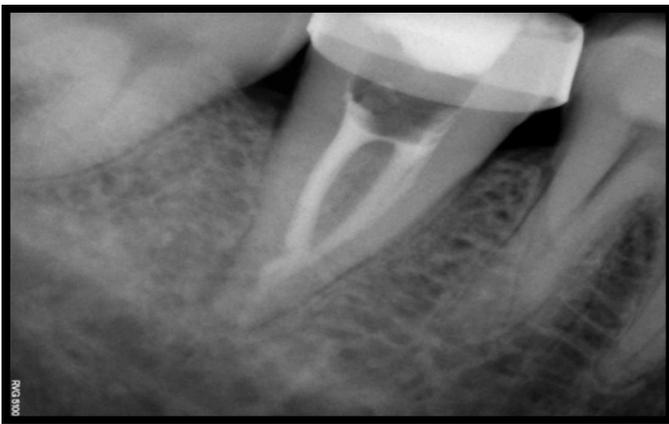


Fig 6: Post-Obturation Radiograph

The first line of treatment was placement of orthodontic band to stabilize the tooth and prevent further propagation of crack (Fig 4). This also helps to reinforce the tooth during endodontic treatment. On the first visit, access cavity was prepared on 47 which revealed a crack line extending upto the pulpal floor (Fig 5). This was confirmed with methylene blue dye staining. On the next

visit, root canal treatment was completed (Fig 6) and the orthodontic band was removed (Fig 7).

This was followed by full coverage metal crown (Fig 8,9). The patient remained asymptomatic during the 3 month follow up visit (Fig 10).



Fig 7: Orthodontic Band Removed Cementation Done



Fig 8: Metal Crown



Fig 9: Post-op Picture Radiograph

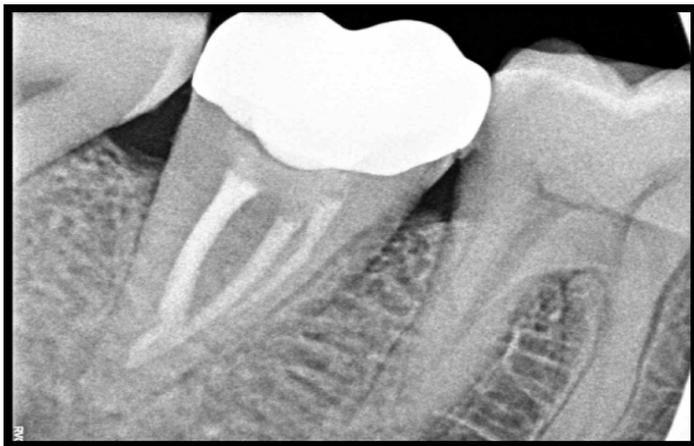


Fig10: Three Month Recall

Discussion

In a recent clinical investigation of 154 cracked teeth, most of the affected teeth (89.6%) were intact or minimally restored [6]. Similarly in another study, 40% of the incomplete fracture were seen in healthy teeth or in teeth with a single occlusal restoration. Therefore the possibility of an unrestored cracked tooth should be considered regardless of the location of the tooth or the presence and size of a restoration. An unintentional bite on a very hard and small object like a seed is the most common cause for CTS [7]. This event can immediately cause an excessive masticatory load due to the small contact area. As a result, the tooth may crack or fracture as seen in this case as derived from the history given by the patient. Teeth with deep cusps and steep fossae are more vulnerable to fracture due to the wedge effect from antagonist cusps, resulting in compressive forces in the cusps and tension forces in the pits.

The crack in an unrestored tooth is frequently hard to see during a common clinical examination. Bite test is the most reliable for reproducing the symptoms of CTS as pain on biting is present in more than 80% of the cases [7].

Several therapies have been proposed to treat painful cracked teeth, however specific therapy depends on the

severity of symptoms and location of the crack. Primary splinting helps prevent further extension of the crack. Erhmann and Tyas suggested the use of orthodontic steel bands for this purpose. Diagnosis can be verified directly after splinting since the diagnostic bite test will no longer provoke the typical rebound pain. In early clinical studies, placement of a complete crown restoration has been suggested for the treatment of CTS. Conversely, full crowns are less effective in preserving pulpal vitality. In a one year clinical investigation, 84.4% of cracked teeth were treated with crowns but half of those teeth needed root canal treatment, considering 60% of the cases were initially intact teeth [6]. In another short-term clinical evaluation of cracked teeth, approximately 20% needed endodontic treatment after crown placement within six months of service [8].

If endodontics is indicated, orthodontic band should be used to reinforce the tooth during endodontic treatment. A multi-disciplinary approach involving endodontic, periodontic, orthodontic, prosthodontic and surgical intervention may be required. In this case, an orthodontic band was cemented to the tooth for stabilization. Root canal therapy was performed and the tooth was bonded with composite restoration. Finally, it was restored with a full coverage crown. However, in cases of cracked teeth, the patient should be fully informed that the prognosis is questionable [9]. A 2006 study evaluated root-filled cracked teeth with a diagnosis of irreversible pulpitis and determined a two year survival rate of 85.5% [10].

Clark and Coughman categorised prognosis as:

1. Excellent: a) cuspal fracture confined within dentin. b) horizontal fracture of a cusp not involving the pulp.
2. Good: A coronal vertical fracture that runs MD into the dentin but not into the pulp.
3. Poor: A coronal vertical fracture that runs MD into the dentin and pulp but is confined to the crown.

4. Hopeless: A coronal fracture that runs MD through the pulp and extends into the root.

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. Hence, a cracked tooth is a compromised tooth even with proper treatment. The prevention and early recognition of cracked tooth syndrome is essential for avoiding more injuries and preventing the progression of cracks into the pulp or root.

Awareness of the existence and etiology of CTS is an essential component of its prevention.

- Cavities should be prepared as conservatively as possible.
- Roughened internal line angles should be rounded-preferred instead of sharp line angles to reduce stress concentration.
- Adequate cuspal protection should be incorporated in the design of cast restoration.
- Cast restoration should fit passively to prevent generation of excess hydraulic pressure during placement.
- Pins should be placed in sound dentin, at an appropriate distance from the enamel to avoid unnecessary stress concentration.
- Prophylactic removal of eccentric contacts -suggested for patients with history of CTS to reduce risk of crack formation
- Because causes of VRF are well known, prevention is not difficult. The cardinal rules for safety are to:
 - a) Avoid excessive removal of intraradicular dentin.
 - b) Minimize internal wedging forces.
- Compaction/condensation of root filling materials should be carefully controlled.
- Posts weaken roots and should not be used unless they are necessary to retain a foundation.

Conclusion

In the above reported case, the key factors in the management of cracked tooth was its early diagnosis and immediate splinting so as to limit the propagation of the crack. Careful clinical examination and investigation using specialized tests will be conclusive. Management of cracked tooth is usually challenging but with the necessary awareness, many teeth with cracks can be saved.

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