Clinical management of cracked teeth

A staged approach from Singaporean practice.

Key points

- 'Cracked tooth' describes a type of longitudinal crack extending into dentine, of unknown depth or size, that may extend subcrestally into the root. There may be pulpal involvement.
- Management and prognosis of cracked teeth vary depending on the location, direction, size and extent of the crack, as well as the presence of pulpal, periapical and periodontal involvement.
- The staged approach used to manage cracked teeth with normal pulp or reversible pulpitis involves an initial stabilisation phase with preformed molar bands, followed by a definitive phase with full-coverage crowns. This protocol may improve diagnostic clarity and treatment planning, while potentially reducing the incidence of root canal treatment required through the definitive cuspal coverage restorations.

Introduction

There is a global shift towards an ageing population. This trend is evident in Ireland, where projections indicate that by 2057, one in three people will be aged 60 years or over.[1] With increasing life expectancy and dental awareness, people are keeping their teeth for much longer. However, those teeth are exposed to a higher probability of cracked tooth syndrome, given the cumulative and progressive nature of dental disease.

Cracked teeth are most frequently seen in routine general dental practice affecting middle-aged patients over 40 years of age.[2,3] There is no clear gender predisposition. Cracked teeth most commonly affect molars, particularly mandibular molars, maxillary premolars and maxillary molars.[2,3]

Early diagnosis and timely management of cracked teeth are important to limit crack propagation and/or pulpal involvement. This may prevent tooth loss. A number of restorative techniques have been described in the literature to manage cracked teeth. However, the management of cracked teeth remains largely clinician dependent. The purpose of this article is to discuss the contemporary management of cracked teeth in the Singaporean healthcare system.

Classification of crack types

In 2008, the American Association of Endodontists (AAE) categorised cracked teeth as one of the five types of longitudinal cracks and fractures of teeth. The term 'longitudinal' cracks and fractures implies vertical extensions over time.[4] More recently, the 2025 European Society of Endodontology (ESE) Position Statement proposed a contemporary classification comprising six longitudinal cracks in teeth.[3] The six recognised longitudinal cracks in teeth (**Figures 1A–1F**) are presented in **Table 1**.

Table 1: Longitudinal cracks and fractures of teeth, as described by the European Society of Endodontology.[3]

Craze line	"Superficial, coronal crack line confined to the enamel with no compromise of the integrity of the tooth." Craze lines generally do not require treatment unless they present an aesthetic concern, i.e., stained craze lines.
Fractured cusp	"Molars – (in)complete fracture extending down a bucco/lingual groove and mesio-distal direction of the affected cusp. Premolars – usually involve marginal ridges. +/- pulpal involvement."
Cracked tooth	"A crack extending into the dentine, of unknown depth or size, may extend subcrestally into the root. There may be pulpal involvement."
Split tooth	"Complete, visible separation of the entire tooth into two parts, usually in a mesio-distal direction." This is a continuation of a cracked tooth and has an unfavourable prognosis.
Vertical root fracture (VRF)	"An incomplete longitudinal (axial) root fracture, involving the cementum, dentine, and root canal space." This has an unfavourable prognosis and extraction is usually recommended.
Split root	"A complete VRF with visible separation of the root into distinct segments."

Aetiology

Classically, large restorations with marginal ridge involvement have been associated with an increased risk of crack formation.[2] Other proposed causes of cracked teeth include: the use of non-bonded restorative materials such as amalgam, which require macromechanical tooth preparation to create cavity retention and resistance form; differential thermal expansion between the restorative material and tooth structure; and, the use of pin-retained restorations.[3,5] However, contemporary literature suggests that cracked teeth are observed most frequently in teeth with no restorations (60.4%) and with class I restorations (29.2%), suggesting a multifactorial aetiology.[5] Other factors

Yong Tong Wong
BA BDentSc Dip PCD RCSI
General Dental Practitioner
Singapore
ORCID: https://orcid.org/0009-0004-3165-5664

David McReynolds
BA BDentSc MFDS RCSEd DChDent (Pros) FFD RCSI (Pros)
Academic Prosthodontist
Dublin Dental University Hospital
Trinity College Dublin
ORCID: https://orcid.org/0000-0003-4427-1788

Corresponding author:
David McReynolds, Department of Restorative Dentistry and Periodontology, Division II, Dublin Dental University Hospital, Lincoln Place, Dublin 2
E: david.mcreynolds@dental.tcd.ie



FIGURE 1: (A) craze lines (UR1 and UL1); (B) fractured cusp (LR6); (C) cracked tooth exhibiting a distal marginal ridge crack (LL6); (D) split tooth (UL6); (E) vertical root fracture associated with palatal swelling (UL6); (F) split root (LL2).

Table 2: Techniques proposed in the management of cracked teeth.

	Strategy	Description
Immediate/interim	Occlusal adjustment	Alleviates symptoms by reducing or controlling occlusal load.
	Preformed metal bands	Serves as an interim circumferential extra-coronal splint to minimise cuspal flexion and reduce risk of crack propagation.
	Direct composite splint (DCS)	Novel technique that is not fully supported by clinical trials. This involves bonding 1–1.5mm of composite resin over the occlusal surface of the affected tooth to immobilise the crack and allow for supra-eruption of the dentition to redistribute occlusal load following the Dahl concept.
	Provisional crowns	Serves as an interim splint, similar to metal bands.
Long term	Direct resin restoration	May be used to manage cracked teeth with reversible pulpitis by sealing the crack interface and dentinal tubules, although the sealing effect is unlikely to be durable.
	Indirect cuspal-coverage restoration	Eliminates cuspal flexure, reduces risk of crack propagation, and seals tooth from bacterial ingress.
	Root canal treatment (RCT)	Performing RCT is contingent on the pulpal and apical diagnosis of the tooth. Not all cracks lead to pulpal and apical disease. Pulpal disease only occurs with bacterial presence within the crack and its ingress towards the pulp chamber.
	Extraction	Indicated when a cracked tooth is deemed to be of hopeless prognosis and unrestorable.

responsible for cracked teeth include: parafunctional habits (i.e., bruxism, pen biting); dietary preferences for hard foods (i.e., nuts, bones, shells, ice); excessive contact of posterior teeth during eccentric jaw movements; malocclusion; steep cusp inclines; and/or deep grooves in occlusal tooth morphology.[3,5]

Prognosis

Where cracked teeth affect pulpal and apical health, the Iowa Staging Index identifies three key variables predictive of the success of root canal treatment in cracked teeth. Success, identified as clinical-centred outcomes, refers to the resolution of existing radiographic pathology and the absence of clinical signs or symptoms.[6]

1. A periodontal probing depth of <5mm associated with the crack has a better prognosis.
2. Location of crack: distal marginal ridge cracks are associated with a poorer prognosis.
3. Pre-operative apical diagnosis: acute apical abscess, acute apical periodontitis, chronic apical periodontitis, and chronic apical abscess are associated with a poorer prognosis.

Management

The treatment of cracked teeth is guided by the patient's signs, symptoms, wishes, and expectations of treatment. Cracks that are asymptomatic may not require intervention. Symptomatic management of cracked teeth depends on the location, direction, size and extent of the crack.[3,4] Techniques that researchers suggest to manage cracked teeth are presented in **Table 2**.

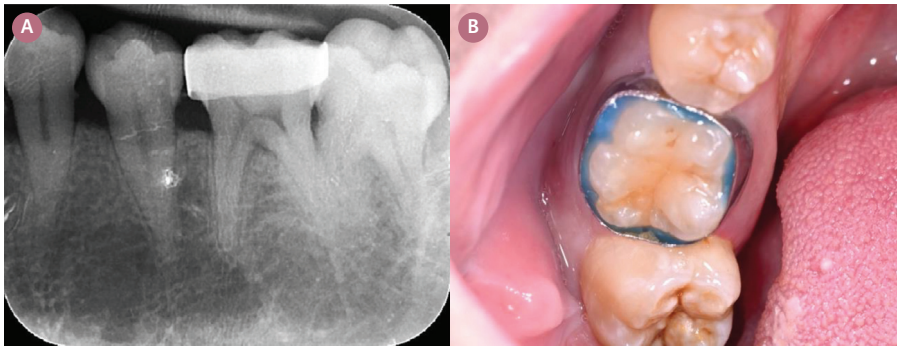


FIGURE 2A-B: Pre-operative intra-oral periapical radiograph (IOPA) showing no periapical radiolucency associated with the lower left first molar with a well-fitting preformed metal band.



FIGURE 2C: Updated IOPA taken at eight-week review.

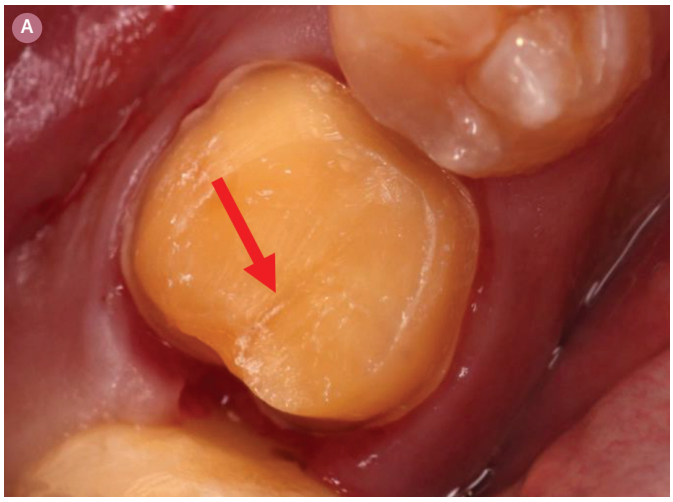


FIGURE 3A: The distal crack line within the lower left first molar becomes more apparent upon crown preparation.

Clinical cases

In Singapore there is a developed service for managing cracked teeth. In this jurisdiction, cracked teeth are managed according to the following protocols.

Case 1

A 41-year-old male with parafunctional bruxism presented with pain on biting and sensitivity to hot stimuli. Intra-oral examination under magnification revealed a distal marginal ridge crack on an unrestored, non-carious lower left first molar. The tooth was not tender to percussion, had a non-lingering cold response and a positive bite test. A 4mm periodontal probing depth was detected at the distal crack line.

'Pain on release' is a characteristic feature of cracked teeth when a Tooth Slooth is applied in a bite test. This can be explained by the hydrodynamic theory, whereby microscopic cusp flexure results in sudden dentinal fluid movement, stimulating myelinated A-delta nerve fibres in the dental pulp and producing acute dental pain.[7] Most cracks are not visible radiographically.[3] However, radicular extension of a crack may result in crestal vertical bone loss associated with an isolated, narrow periodontal probing depth.[6] Nevertheless, radiographs are essential to exclude other pathology and to corroborate clinical findings (**Figure 2A**). Other key clinical investigations include circumferential periodontal probing, restoration removal, dye staining and transillumination, where applicable.[3,6] In this case, the diagnosis was reversible pulpitis with normal apical tissues, with parafunctional bruxism considered a potential contributing factor associated with the cracked tooth.

Initial stabilisation phase

The tooth was first temporarily stabilised with a tight-fitting preformed stainless steel band (3M™ Unitek™ General Purpose Molar Bands, 3M Unitek Corporation, Monrovia, CA, USA). When placing a metal band, local anaesthesia may be administered for patient comfort. Interproximal enamel reduction was performed using a thin flame-shaped diamond bur to provide sufficient clearance for the placement of a preformed band. This approach was considered appropriate as the tooth was intended to subsequently receive a full-coverage crown, which would require proximal reduction. A disadvantage of this approach would be the iatrogenic damage to the tooth if the initial diagnosis was incorrect, highlighting the importance of careful preliminary assessment before undertaking this procedure. An appropriately sized band was selected to encompass the height of contour, with the occlusal margin of the band positioned near the height of both marginal ridges and adjusted where necessary to avoid occlusal interferences. The tooth was then cleaned and air dried, and the band was cemented with Transbond Plus (Transbond™ Plus Light Cure Band Adhesive, 3M Unitek Corporation, Monrovia, CA, USA) (**Figure 2B**).

An *in-vitro* study found that preformed metal bands reduced cuspal flexure by half, and doubled fracture resistance of teeth compared to teeth without bands.[8] In cracked teeth with reversible pulpitis, this approach may limit colonisation of bacteria within the crack and dentinal tubules, promoting pulpal repair. This approach for pulp stabilisation also allows clinicians to monitor reversible pulp conditions, and perform RCT when necessary before cementation of a definitive crown.[9] However, such bands may be plaque retentive and cause gingival inflammation, especially if left in situ long term.

Definitive phase

Following an eight-week monitoring period, the lower left first molar was carefully reassessed and demonstrated resolution of the previously positive bite test with no tenderness to percussion and a non-lingering cold response (**Figure 2C**). Given resolution of symptoms, the tooth was definitively restored with a full metal crown. This material was selected due to its minimal tooth preparation requirements and superior strength (**Figures 3** and **4**). Additionally, a hard, flat occlusal splint was fabricated to manage the patient's parafunctional bruxism and reduce risk of future cracked teeth.

A prospective study showed that 92.6% of cracked teeth had pre-operatively diagnosed reversible pulpitis resolved within two months with orthodontic band



FIGURE 3B-D: The lower left first molar was restored with a full-coverage white gold type IV alloy crown. A bitewing radiograph was made to assess satisfactory marginal fit before crown cementation.

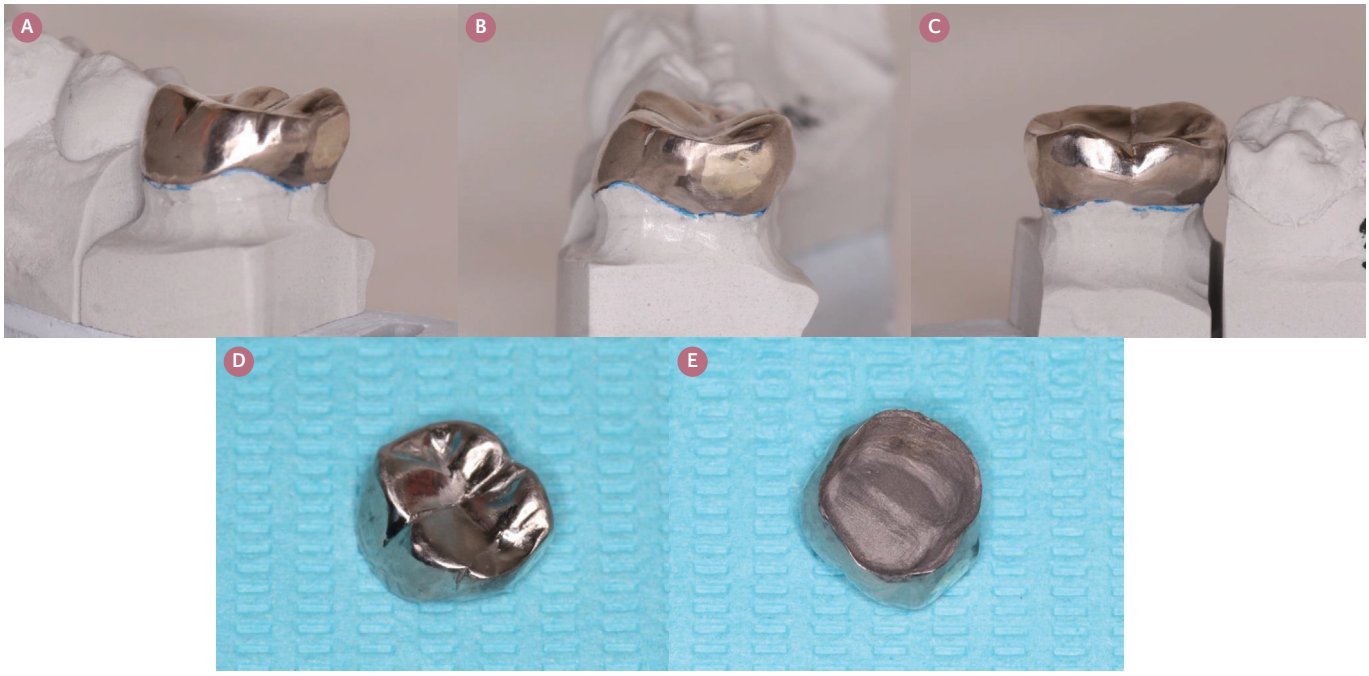


FIGURE 4A-E: Lab work of a full-coverage white gold type III alloy crown of the lower left first molar.

application.[9] This is consistent with another study that found pulp survival to be highest among teeth that required a one- or two-month period to achieve definitive pulp diagnoses (69.6%-78.7%), while teeth that required three months prior to a definitive pulp diagnosis only had total pulp survival of 37.5%.[10] Two months appears to be an appropriate interval to review the pulpal status of cracked teeth in the interim molar band stage, as most teeth achieve pulpal stabilisation within this period. Persistence of symptoms beyond this period warrants careful reassessment of pulpal and periapical status, with RCT considered where clinically indicated.[10]

Prognosis

As cracks can propagate over time, it is best practice to inform patients that the long-term prognosis of a cracked tooth is guarded – to psychologically prepare patients for the potential need for RCT or to anticipate future tooth loss. While cuspal coverage restorations improve the structural integrity of cracked teeth, they do not guarantee success.[4] A retrospective cohort study found that cracked teeth with reversible pulpitis have a pulp survival rate of 71% three years after crown cementation. A total of 29.1% of such teeth eventually developed pulpal complications within one to two years, requiring RCT or extraction.[11] This result is similar to a prospective study that found a one-year pulp survival rate of 76.4% after a stepwise banding approach. Pulpal failures occurred at different stages of treatment, including during the banding stages, during the restorative process, or after coronal coverage restorations.[10]

Case 2

In certain situations, RCT is indicated prior to restoring a cracked tooth with a cuspal coverage restoration:

- if pre-operative clinical and/or radiographic findings suggest irreversible pulpitis or pulpal necrosis; or,
- if symptoms persist after the monitoring stage, this should prompt careful reassessment and establishment of a pulpal and periapical diagnosis.

A 61-year-old female with a documented history of cracked teeth and habit of eating nuts presented with sensitivity to cold stimuli. Intra-oral examination under magnification revealed a crack line across the distopalatal cusp of the upper

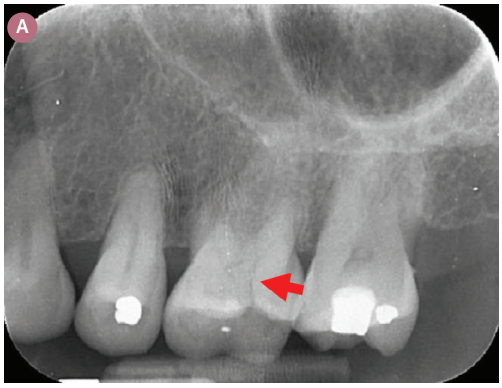


FIGURE 5A: A pre-operative IOPA radiograph showing a vertical radiolucent line suggestive of a crack and a periapical radiolucency associated with the palatal root of the upper left first molar.



FIGURE 5B-D: The patient presented with history of multiple cracked teeth, managed with full-coverage crowns. A molar band was cemented on the upper left first molar and root canal treatment was completed.

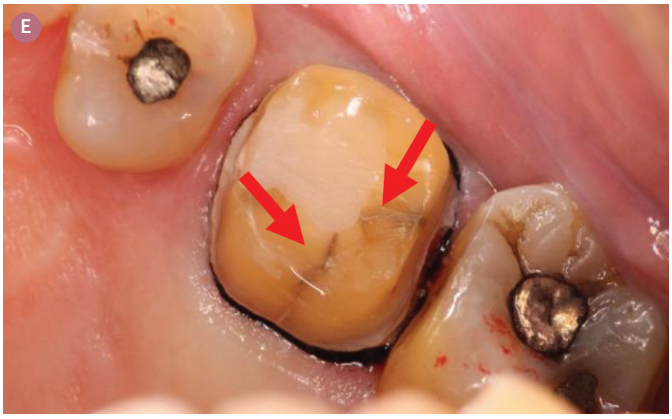


FIGURE 5E: The disto-palatal crack line within the upper left first molar becomes more apparent.

left first molar. The tooth displayed a positive bite test, was slightly tender to percussion, and had a delayed response to cold test. Periodontal probing depths were within normal limits. Radiographic examination revealed a radiolucent vertical line initiated from the crown, suggestive of a crack, and a periapical radiolucency associated with the palatal root of the upper left first molar (**Figure 5A**). The diagnosis was partial pulpal necrosis with symptomatic apical periodontitis, with dietary habits considered a potential contributing factor to cracked tooth in this case.

A molar band was placed on the tooth and root canal treatment was completed by an endodontist (**Figures 5B-D**). Following completion of endodontic therapy, the upper left first molar demonstrated resolution of the previously positive bite test and was no longer tender to percussion. The tooth was definitively restored with a full metal crown (**Figures 5E** and **6**).

At the six-month review, the patient remained asymptomatic and the tooth was functional. The upper left first molar continued to demonstrate a negative bite test and probing depths within normal limits, and was not tender to percussion. A periapical radiograph was taken, showing resolution of the periapical radiolucency associated with the palatal root of the upper left first molar (**Figure 7**).

Prognosis

During endodontic access, the extent of the crack should be determined. Studies have suggested that cracks that extend past the pulpal floor or below the alveolar bone crest generally have poorer prognosis.[4] One study has reported that 95.2% of endodontically treated cracked teeth with coronal cracks had survived at five years, compared to 81.8% of teeth with radicular extensions.[12] Contemporary literature has found that placement of an intra-orifice barrier apical to the level of the crack increased success to 90.6% and survival to 96.4% for cracked teeth with radicular extensions up to a four-year period.[13]

Conclusion

This case series illustrates the management of cracked teeth in the Singaporean healthcare system. Symptomatic cracked teeth with normal pulp or reversible pulpitis are managed with a diagnostic phase using molar bands before a definitive phase with full-coverage crowns. This staged approach promotes pulpal healing and confirms initial diagnosis prior to a definitive restoration. However, the availability of this service may vary across various healthcare settings and is dependent on local resources. With appropriate management, studies have shown that cracked teeth can remain functional and survive for a reasonable



FIGURE 6A-C: Lab work of a full-coverage white gold type III alloy crown of the upper left first molar.



FIGURE 6D-F: Intra-oral photos and bitewing post cementation of the upper left first molar.



FIGURE 7: IOPA of the upper left first molar at six-month review, showing resolution of the periapical radiolucency associated with the palatal root.

period of five years or more. Nevertheless, prevention remains superior to treatment in the management of cracked teeth. Advising patients on diet modification such as limiting consumption of hard foods, and the use of occlusal devices, can help to mitigate the risk of crack formation.

CRediT author statement:

Yong Tong Wong: writing – original draft preparation, clinical procedures, visualisation, conceptualisation.

David McReynolds: writing – review and editing, visualisation, conceptualisation, supervision.

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