Cracked tooth: The Progressive Cut Matrix for preparation

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The cracked tooth syndrome of a vital tooth from the posterior segment might come as a result from a wide range of etiological factors, such as: chewing accidents, para-functional activity, iatrogenic events or extensive inlays, these factors do not provoke a immediate fracture of the dental structure. The term “cracked tooth syndrome” (CTS) was introduced by Cameron in 1964, who noticed a correlation between the size of the restoration and the occurrence of a cracked tooth syndrome. It is defined as a plane fracture line, of unknown depth and with a course that covers considerable tooth structure, without complete involvement, but its progression can create a communication with the pulp chamber and/or the periodontal ligament.

There are two main patterns to form a tooth crack, the first one is described when the crack is centrally located and follows the direction of dentine tubules reaching the pulp. The second patter is more peripheral and could originate cuspid fractures. The pressure applied to the crown of a “cracked syndrome” affected tooth can lead to the separation of the components divided by the crack line, each separation in the dentine resulted in a dynamic flow of the tubules fluid, stimulation of odontoblasts, producing the narrowing and posterior breakage of the odontoblastic processes found in the tubules, in that way the pulp nociceptors are stimulated. The entry of saliva along the crack line could increase the sensitivity at the dentin level.

The wedge effect from the antagonist cusps; specially the mesio-palatal cusps of the upper first molars, are responsible for the over-loading generally affecting the lower first molars, and the first upper bicuspids receive this over-load from the buccal cusps from the lower first bicuspids.

The treatment plan depends of the position and extension of the crack line, as the assessment of the stimuli, type and duration of the pain are also important factors to take into consideration during the decision-making process. The early diagnosis is the most important tool for the treatment of the “cracked tooth syndrome” and in that way, confines the propagation of the fracture and posterior microleakage to pulp and periodontal tissues.

The following case report describes an asymptomatic vital 46, with cracked tooth syndrome. In the present case, an occlusal indirect composite restoration was placed with cuspid coverage; the tooth was prepared using the technique “Progressive cut matrix” over absolute isolation. Through this method a total control of the preparation and dentine protection can be obtained.
Day 1, initial appearance, tooth 46 with presence of a class II deteriorated restoration, needs a replacement. The initial treatment plan was a class II occluso-distal direct restoration with composite resin; at the clinical examination the tooth did not present symptoms, nor spontaneous or mechanically stimulated or thermal stimuli.

Remnant dental structure after the removal of the defective restoration and decayed tooth structure. By the photography, seeing the fracture line with a mesio-distal trajectory involving the mesial marginal crest, due to the reduction of fracture resistance and increase of cusp deflexion from the deteriorated cusps by a severe cavitation. Based on the described findings the restorative strategy was redefined to an indirect approach with cuspid
To preserve the remnant structure and avoid the propagation of the crack, minimizing the possibility of a complete fracture, is imperative to change the restorative approach for an indirect restoration with cuspid support. Therefore a reconstruction of the cavity is needed. The figure illustrate the usage of an etch and rinse adhesive system (3 steps) to perform an immediate dentin sealing (IDS), protecting the dentine-pulp compound.
A layer of flowable composite under 0.5mm width covers the cavity floor and internal angles; aiming to improve the sealing, protect the hybrid layer, and due to its low elasticity module reduce the stress and tension during the reconstruction process.

Filling the cavity with the build-up technique to provide the compression resistance and proper support for the future restoration. Reducing the need of extending the pulp floor and also reduces the need of opening the cavity making it narrower.

Removal of the excess of build-up material using different anatomical references from the treated and
neighbouring teeth. Removal of the rubber dam making an occlusion adjustment to avoid premature contacts in maximal intercuspidation.

Fig. 7  Day 2, absolute isolation with a long ring clamp (clamp 27; Hu-Friedy) positioned on the lower second molar allowing to work on a greater operatory field and comfortable access to the tooth preparation.

Fig. 8  With the use of a condensation silicon of high strength (Hard 80), we obtained the “Progressive Cut Matrix”, for the occlusal preparation protocol, this matrix was trimmed to the tooth equator for a proper setting of the guide and in a triangular shape on distal to avoid the clamp and maintain some references, support and stability of the
matrix over the occlusal surface of the second molar.

"Progressive Cut Matrix"; It's called like that because while we are moving backwards from mesial to distal, the matrix is progressively cut following the sequence (using a scalpel #11 cutting the matrix from buccal to lingual), this strategy ensures the full stability of the guide and control during the preparation. This approach varies from the conventional matrix protocol making easier the stability of the matrix instead of trying to set each previously prepared pieces that sometimes are difficult to stabilize.
To start the preparation with absolute isolation, the first matrix cut is made on the mesial third of the occlusal surface, moving backwards progressively to the distal third. This progressive cut techniques allows maintaining the stability of the guide.
Based on the first cut of the matrix, the preparation started only working in the mesial third of the occlusal surface; the preparation depth was achieved using a calibrated cylindrical bur of 1.2 mm of diameter.
The second cut of the matrix in the mid-third on the occlusal surface, also in buccal-lingual direction. In that way, the preparation is moving back progressively.
Based on the second cut of the matrix, we proceed with the progressive preparation on the mid-occlusal third, the depth of the preparation is controlled due to the stability of the matrix supported by the second molar, we can appreciate the preparation progressively advancing from mesial to distal on the occlusal surface.
Fig. 14  Third and last progressive cut of the matrix, in the distal third of the occlusal surface.
Based on the third cut of the matrix, we continue progressively with the preparation of the distal-occlusal third, the guide is stable supported by the second molar.
Fig. 16 The preparation is finished, protecting the neighbouring teeth with a metallic matrix and creation of the peripheral bevel increasing the area of peripheral enamel, obtaining a bigger adhesive area, stability of the restoration and resistance of tangential forces.
Fig. 17

Occlusal view of the preparation, the peripheral enamel and the freshly cut of dentine is observed, supra-gingival and conservative preparation with a small portion of core resin. The preparation design for the restoration demands the simplest approach with a basic geometry and supra-gingival finishing line to avoid marginal microleakage, periodontal problems, it also makes isolation and removal of cement excess easier. The ferrule effect, the peripheral enamel and the adhesive technology, allows a substantial preservation of the tooth structure.
Immediate Dentin Sealing (IDS), using an etch and rinse adhesive system of three steps with fillers.

Elimination and inactivation of the oxygen inhibited layer with water soluble glycerine gel and light-curing during 40 s.
Prophylactic brush with pumice to remove and complement the action of the glycerine.
Fig. 21  Occlusal view of the surface after IDS treatment and elimination of the oxygen inhibited layer, ready for the removal of the rubber dam and proceed with the definitive impression.
Fig. 22  Lateral view of the preparation after the IDS.

Fig. 23  Work model, occlusal view.

Fig. 24  Work model, buccal view.
Fig. 25  Work model, lingual view.

Fig. 26  Work model from a mesio-buccal view.
Fig. 27  Work model from a mesio-lingual view.

Fig. 28  Composite indirect restoration following the stratification technique; dentine A3, enamel A2, and high value achromatic composites were used.
With of the occlusal veneer of approximately 1.2mm
The cases of cracked tooth syndrome are detected in patients from the 3rd and 5th decade of life, affecting both men and women, the most affected teeth are lower second molars, followed by the lower first molars and first upper bicuspids. The crack line is generally located from mesial to distal, but a buccal-lingual direction was also reported in mandibular molars. A reduction on the tooth stability, reduction of the fracture resistance and increment on the flexure of the weakened cusps follow the restorative procedures, including the caries lesion excavation, cavity preparation or root canal treatment. The selection of a direct or indirect technique, on posterior teeth can represent a real challenge, implying biomimetic, anatomical, aesthetic and functional considerations.

To improve the longevity of the restoration some considerations must be taken into account, a preparation keeping peripheral enamel and supra-gingival will prevent: future microleakage, periodontal problems, makes easy the fitting of the indirect restoration, makes the isolation process and the removal of excess cement easier; provides an ideal occlusal width improving the compressive strength; the implementation of the "Progressive Cut Matrix" allowed us to have control and predictability during the preparation, the substrate should maintain the elasticity module as high as possible (rigidity) optimizing the cavity using adhesive systems plus core composite, in that way disregarding planimetry and mechanical retentions on the preparation, an adhesive cementation and the creation of an interphase tooth-luting agent, developing punctual occlusal contacts and a proper polishing of the restoration.