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Case Report

Indirect Pulp Capping and Occlusal Matrix: A Minimally Invasive Approach for Restoring Young Permanent Molars with Deep Carious Lesions

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Abstract

The term "hidden caries" designates a dentinal lesion beneath the dentinoenamel junction with intact or minimally cavitated enamel, therefore the radiographic exam is fundamental for the diagnosis. One possible treatment for these lesions is the indirect pulp capping with partial removal of the carious dentin to preserve the tooth vitality and to avoid a more invasive treatment such as endodontics. Therefore, this study aimed to describe a clinical case of indirect pulp capping in a first permanent molar with a deep carious lesion of a teenager patient. The final restoration was carried out with composite resin using the occlusal matrix technique, restoring aesthetics and function. Long-term follow up was accomplished through digital radiographic subtraction technique, which allowed the observation that mineral density of the affected dentin continue to increase over time, showing positive results after 12 months regarding dentin remineralization.

Keywords: Hidden Caries; Indirect Pulp Capping; Remineralization

Introduction

Dental caries is the result of an unbalance in the oral environment, that results in a slow and progressive destruction of the mineralized dental tissues. It is caused by interactions between acidogenic bacteria, substrate and environmental factors along with the host's individual characteristics [1]. Despite improvement of the diagnostic methods and greater availability of resources for caries control, carious lesions at advanced stages are still found and result in significant loss of dental structure and possible pulp involvement [2].

However, in some cases, the carious lesion might present an unusual development pattern [3,4]. This type of lesion – known as hidden caries – is a carious lesion in which the proximal or occlusal surfaces present sound enamel or very little demineralization, however, the dentin shows extensive loss of mineral. These characteristics, along with the complementary radiographic examination, lead to the diagnosis of hidden caries (Baratieri; Monteiro-Junior, 2016). Nowadays, it can be classified as the International Caries Detection and Assessment System as a code 4 lesion.

This lesion is characterized by the conservation of the external structure of the enamel with the development of a carious lesion in the subjacent dentin in a larger or smaller extension [5,6].

The traditional restorative treatment of carious lesions with dentin involvement consists in the total removal of the carious dentin and the unsupported enamel [7]. However, this results in unnecessary loss of dental structure or pulp exposure, which may require more invasive procedures that increase treatment costs and complexity [8].

Currently, a more conservative restorative protocol is the first choice for the treatment of such clinical condition: the indirect pulp capping [9,10]. This procedure consists in the removal of the infected dentin, as well as the carious tissue of the surrounding walls of the carious cavity, and keeps a demineralized dentin layer (affected dentin) on the cavity floor [10-12]. Dentin remineralization of the affected layer is achieved over time, with the placement of the lining material into the cavity followed by adequate restoration of the tooth [13].

The dental restoration after partial removal of the carious tissue is usually carried out with composite resin or glass ionomer cement. But when restoring "hidden caries", that present no cavity formation or loss of dental anatomy, the use of a matrix can facilitate this process [14,15]. Such matrix is manufactured prior to the cavity preparation and duplicate the dental enamel anatomy. Therefore, it provides an occlusal anatomy with a very natural ap-

pearance, in addition to re-establishing the function and reducing clinical hours. This restoring technique can be called occlusal matrix or occlusal replica [14-16].

Therefore, the objective of this study was to describe a clinical case of indirect pulp capping with composite restoration using the occlusal matrix technique in a teenager's permanent molar, as well as to present the 12-month clinical/radiographic follow up.

Case Report

A 14-year-old female patient attended the dental clinic of the State University of Ponta Grossa, accompanied by a caregiver for a routine examination. During the anamnesis, the patient reported the absence of tooth pain or systemic alterations. In the intra-oral clinical examination, it was observed that the upper left first permanent molar exhibit a more opaque area at the occlusal surface and a small cavity on the palatal surface (Figure 1). The complementary examination included periapical radiograph of the region (Figure 2), which revealed the existence of a deep dentin carious lesion, confirming the hidden caries diagnosis.

Figure 1: Baseline clinical situation of the left first permanent molar.

Figure 2: Baseline radiographic exam of the left first permanent molar.

Since the occlusal surface of the tooth did not present morphological alteration, the treatment plan consisted of partial removal of the carious dentin (indirect pulp capping) associated to dental restoration with hybrid composite resin with the occlusal matrix technique. This plan was presented to the patient and the caregiver, who consented with the treatment and signed an informed consent form.

The restorative phase started with the dental prophylaxis using pumice and water to remove the dental biofilm on the tooth surface. Before the tooth dehydration, the shade of the composite resin was selected (shade A1; Master Fill/Biodinâmica/Ibiporã, PR, Brazil), followed by local infiltrative anesthesia and placement of rubber dam for isolation of the operative field (Figure 3).

Figure 3: Baseline clinical situation after rubber dam placement.

Prior to cavity preparation, an occlusal-palatal matrix of the tooth to be restored was manufactured. This matrix manufacturing phases were: (1) lubrication of the tooth with petroleum jelly (Rioquímica/São José do Rio Preto, SP, Brazil); (2) manipulation of self-cured acrylic resin (Vipi/Vipi Flash/Pirassununga, SP, Brazil); (3) adaptation of the acrylic resin on the occlusal-palatal surfaces to replicate the tooth anatomy; (4) manufacture of the a matrix handle; (5) matrix finishing with maxicut burs (Figure 4).

Figure 4: Aspect of the occlusal-palatal matrix after the finishing procedures.

After manufacturing the matrix, the cavity preparation was accomplished. The occlusal/palatal surfaces were opened with high-speed carbide burs to gain access to the damaged dentin structure below the enamel. The carious tissue was removed with dentin excavators and slow speed carbide burs in a size compatible with the cavity. The infected dentin presented a soft consistency and yellowish color. It was easily removed with dentin excavators (Figure 5). The carious dentin was totally removed from the cavosurface margin and surrounding walls of the cavity. The affected dentin, which showed harder consistency and darker shade, was kept on

the cavity floor in order to prevent possible pulp exposure (Figure 6).

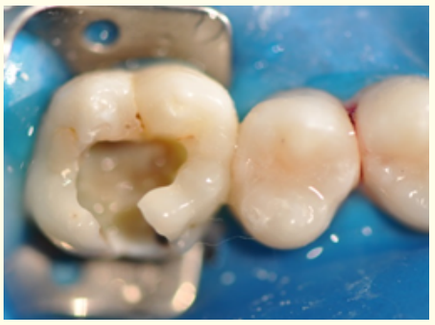

Figure 5: Appearance of the infected dentin after initial cavity preparation.

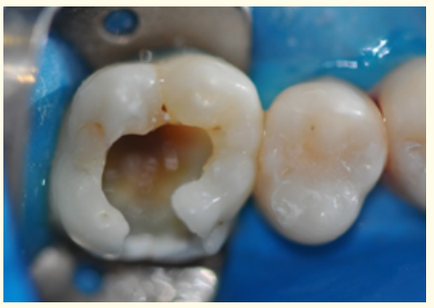

Figure 6: Affected dentin appearance after removal of the infected dentin.

The indirect pulp capping was done by applying a layer of glass ionomer cement (Gold Label/GC America/Alsip, IL, EUA) on the cavity floor (Figure 7).

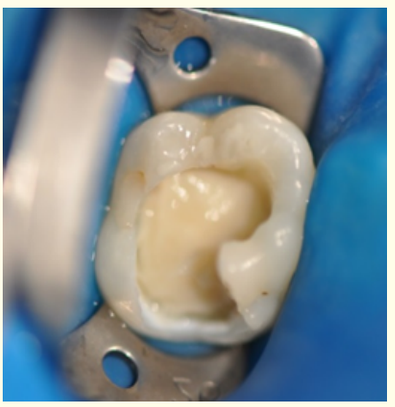

Figure 7: Indirect pulp capping with glass ionomer cement.

In sequence, the cavity was conditioned with 37% phosphoric acid gel (Dentsply/Rio de Janeiro, RJ, Brazil) for 15 seconds on dentin and 30 seconds on enamel. The area was washed for 60 seconds, dried without desiccation and the adhesive system was applied (Ambar/FGM/Joinville, SC, Brasil) followed by photopolymerization for 60 seconds. The composite resin was placed in layers of 2mm thickness and light cured individually for 60 seconds.

The last layer of composite resin was adapted in the cavity without polymerization to allow the adaptation of the previously prepared acrylic resin occlusal-palatal matrix. On the matrix inside surface, a very thin layer of petroleum jelly was applied to isolate the matrix from the composite resin. The matrix was adapted on the tooth surface with a gentle digital pressure. After the adaptation, light curing of the composite resin was carried out (Figure 8) for 60 seconds on each surface.

Figure 8: Occlusal matrix positioned and composite resin photopolymerization.

After the removal of the acrylic matrix, the restoration was finishing with diamond burs, disks and diamond pastes, obtaining favorable aesthetics (Figure 9). A periapical radiograph was carried out after the procedures had been finished (Figure 10). The patient's occlusion was checked with carbon paper after removal of the rubber dam isolation; there was no need for adjustments.

Figure 9: Clinical appearance immediately after rubber dam removal.

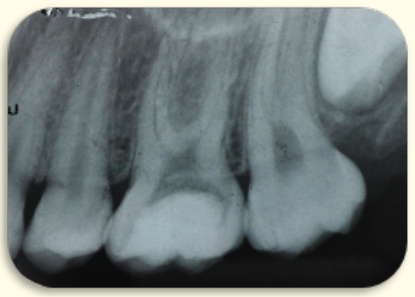

Figure 10: Radiographic exam after restoration.

Follow-up appointments occurred three, nine and twelve months after the restoration for clinical and radiographic follow up (Figures 11 and 12, respectively). The final restoration was judged as a successful procedure, since it restored aesthetic and function and enabled the remineralization of the affected dentin. As seen on the radiograph after 12 months of follow-up (Figure 13), a more radiopaque area on the cavity floor can be observed when compared to the same area just after placement of the restoration (Figure 12).

Figure 11: Clinical appearance after 12 months.

Figure 12: Radiographic exam after 12 months; the arrow points out a more radiopaque layer on the cavity floor.

In order to confirm this finding, digital subtraction radiography (DSR) protocol was done. DSR enables the detection of differences between sequential radiographs that may be difficult to detect by human eyes. The process creates a new image by subtracting the value of the corresponding pixels of two images. Changes in the final image will appear as brighter (when the mineral content enhances) or darker (when the mineral content decreases) areas (Chibinski., *et al.* 2013). Therefore, it was possible to visualize clearly the changes in the mineral content of affected dentin after 12 months, which is consistent with dentin remineralization

Figure 13: Radiographic subtraction after 12 months; the lighter area bellow restoration is consistent with affected dentin remineralization (arrow).

Discussion

Carious lesion patterns have changed throughout the years. A diagnosis based only on the visual clinical exam may not be enough since carious lesions might progress in the dentin under the healthy or demineralized enamel [17,18]. This clinical situation is reported in this paper, showing a very deep carious lesion which extension could only be confirmed after periapical radiograph (Figure 2).

The etiology of this type of carious lesion has been widely discussed, but it is still very controversial. However, the literature lists some hypotheses, like the presence of irregularities below the dentin-enamel junction, intense exposure to fluoride, deep occlusal cracks with a complex morphology which enable greater biofilm retention, specific microbiota and thin enamel layer on the crack base. These are all different factors that might start the carious process [15]. The proposed treatment must aim the restoration of the tooth and the maintenance of pulp vitality, combining a minimum invasive and aesthetic restorative approach (Vieira 2016).

The case reported in this study associated all these factors, following a conservative treatment protocol: indirect pulp capping and aesthetic restoration using the occlusal matrix technique.

Dental literature showed the benefits of the carious tissue selective removal when compared to the complete removal, especially for deep lesions in teeth that do not present periapical diseases or irreversible pulp damage [12,19,20]. Researchers have reported that indirect pulp capping reduces the risk of exposure and post-operative pulp symptoms, enabling the preservation of a

larger tooth structure when compared to more invasive treatments and the maintenance of tooth vitality [10,21-23].

One of the greatest challenges of indirect pulp therapy is to determine clinically the necessary amount of carious tissue to be removed [24,25]. Carious dentin can be theoretically divided into infected and affected dentin with differences in the morphological, physiological, biochemical and bacteriological aspects. Only the most external and superficial portion, which is called infected dentin, should be removed because it is irreversibly denaturized. The affected dentin can be remineralized, due to the presence of collagen fibrils and apatite crystals, therefore, it should be preserved [26,27]. However, the whole process can only occur if the cavity is accurately sealed and properly restored so that the lesion cannot develop further [13,28]. After some time, the remaining dentin becomes darker and harder and the carious lesion paralyzation is achieved [22,28,29].

The confirm that the treatment was successful, clinical-radiographic follow up is necessary, so that the radiographic alterations occurred immediately after intervention and the long-term changes can be compared [22,27-30]. In this clinical case, a process called digital radiographic subtraction was carried out. This is a non-invasive diagnosis tool [19,22] which uses x-ray images of two different moments during the treatment to identify mineral alterations in a tooth [19,31]. Anatomical structures that appear in a neutral grey shade demonstrate the absence of alterations, while lighter shades of grey represent an increase in the mineral density [19,22,27]. After 12 months follow-up, the digital radiographic subtraction, process showed lighter grey shades in the carious dentin region kept under GIC, confirming the dentin remineralization (Figure 14). Moreover, there was no report of post-operative pain, presence of fistula or abscess and no signs of pulp pathologies were observed, thus confirming the successful treatment..

When performing indirect pulp capping, biocompatibility is a vital factor to obtain good results and long-term success. The most frequently employed material is the glass ionomer cement (GIC) [13]. GIC presents another very important advantage over other materials that is bonding to moist tissue and fluoride releasing, which may aid in the remineralization of carious lesions. Indeed, the biocompatibility and bonding property are more important than the fluoride release, since it has been proved that dentin remineralization occurs even when an inert material is used for pulp capping (Kuhn., *et al.* 2014) if an adequate cavity sealing is obtained [27]. Therefore, the restorative procedure not only recovers tooth anatomy but also guarantee the continuity of dentin remineralization.

Several materials and techniques have been developed to restore teeth with occlusal carious lesions; the replica or occlusal matrix is among them [32]. This technique aims to obtain a negative copy of the tooth surface that will be used to transfer the tooth natural anatomy when applied to the restoration before the polymerization of the last layer of composite resin [33]. Such procedure is only indicated to restore carious lesions in which the occlusal surface does not present cavity [34,35].

The occlusal matrix technique is simple, safe, easy to execute and not expensive [35]. Its use enables the restoration of the shape, function and aesthetics, eliminating the sculpture phase and reducing the clinic hours required by the procedure [36]. Other advantages already reported in the literature are: better marginal adaptation [37,38], the absence of premature contact and very little need of finishing and polishing, which reduces the occurrence of cracks and excessive wearing [33,39]. All these benefits were observed during the restorative procedure described.

The occlusal matrix can be made from different types of material like photopolymerizable surgical cement [40], photopolymerizable temporary cement [4,34,41,42], polyvinyl siloxane [37,43], composite resin [40], prefabricated transparent silicone molds [38,44] and colorless autopolymerizable acrylic resin [45]. In this case, the material of choice was the auto-cured acrylic resin, since it provides an exact replica of the tooth anatomy and its transparency allows some light passage [45]. Due to the lack of contact with oxygen during polymerization of the composite resin, its superficial surface layer is totally photopolymerized, which improves the superficial hardness of the resin [38].

Finally, it should be stated that the overall treatment was successful since it kept the pulp vitality, preserved tooth structure and restored shape, function and aesthetics of the tooth, with a relatively simple and effective technique. Also, it must be pointed out the main achievement of the employed treatment: the continuous remineralization of the affected dentin, which guaranteed the long-term success of the procedure [46-48].

Conclusion

The association of indirect pulp capping and occlusal matrix technique was efficient to restore young permanent molar with a deep carious lesion and guaranteed tooth vitality and induced dentin remineralization. The positive results were confirmed throughout the 12-month follow-up period.

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