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CASE STUDY

Treatment of deep carious lesions with mineral trioxide aggregate: clinical case report

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ABSTRACT

Introduction. Deep carious lesions are a dental disease widely spread among population of all ages. From clinical point of view, they have little symptoms and go unnoticed by the patients a long time, until they provoke dental pulp inflammations. If diagnosed and treated properly, the tooth can be treated conservatively with certain techniques of pulp vitality preservation. An important role in this process plays the innate capacity of regeneration of the pulp-dentine complex and the enhanced stimulating properties of new biomaterials used in dentistry. The aim of this clinical case report is to describe the clinical manifestations and the diagnostic algorithm used in deep caries and to establish a clinical guideline of treatment of deep carious lesion with a calcium silicate hydraulic cement.

Material and methods. Description of clinical case of a permanent tooth with a deep carious lesion, treated by indirect pulp capping with mineral trioxide aggregate cement. Clinical and paraclinical methods of investigations were used, the patient was evaluated after 6 and 12 months after the received treatment.

Results. The sensitivity to cold stimuli presented by the patient before the treatment attenuated shortly after he received dental care. After 6 and 12 months, the tooth is asymptomatic, the clinical findings and paraclinical parameters show no evidence of pulp inflammation.

Conclusions. Mineral trioxide aggregate showed long term successful results when used as a biomaterial for vital pulp therapy.

Keywords: deep carious lesion, vital pulp therapy, direct pulp capping, mineral trioxide aggregate.

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Key messages

What is not yet known on the issue addressed in the submitted manuscript

Vital pulp therapy in carious teeth is still a controversial topic regarding in conservative dentistry. It has shown very high rates of success in non-carious dental pulp exposures. However, it remains to be established what the long-term success rates are for cases of deep carious lesions.

The research hypothesis

The cariously exposed dental pulp requires an enhanced treatment protocol in order to ensure the preservation of pulp vitality.

The novelty added by manuscript to the already published scientific literature

A case of a deep carious lesion in a permanent tooth is presented, along with its clinical and paraclinical manifestations, as well as the enhanced treatment algorithm with mineral trioxide aggregate.

Introduction

Vital pulp therapy (VPT) is defined as an ultra-conservative treatment that aims to preserve and maintain pulp tissue in a healthy state that has been compromised but not destroyed by caries, trauma, or restorative procedures [1]. Based on the level of pulp preservation, VPT includes stepwise excavation, indirect pulp capping, direct pulp capping, miniature pulpotomy, partial pulpotomy (Cvek) and complete coronal pulpotomy [2]. In our case report, we used the technique of direct pulp capping, a method that involves placing a bioactive dental material directly on an exposed pulp with the aim of stimulating the reparative function of the pulp-dentine complex.

In deep carious lesions, the bacteria present in the infected dentine initiate a reversible inflammatory process in the pulp. However, if the aggression is removed and proper conditions are established, the vital pulp-dentine complex has a high potential for self-repair [3]. This is due to the complex mechanisms that are initiated once the removal of the infected dentine occurs, a process known as tertiary dentine formation. Tertiary dentine is divided into two different categories based on the events that precede its formation and the mechanism of formation. Reactionary dentine is a form of tertiary dentine secreted by odontoblast cells that have survived a mild stimulus. Reparative dentine, on the other hand, is tertiary dentine secreted by a new generation of odontoblast-like cells in response to a strong stimulus (traumatic or carious pulp exposure), after the death of the original odontoblasts responsible for the primary and physiological secondary dentine secretion [4].

According to scientific research, hydraulic calcium silicate cements have a substantial positive influence on pulp-dentine complex regeneration [5]. The mineral trioxide aggregate (MTA) used in our case report (ProRoot MTA, Denstply) is categorized as a type 1 hydraulic calcium silicate cement [6]. MTA has the following positive properties: radiopacity, low solubility, and long-term stability; high biocompatibility; forms an excellent seal to prevent the ingress of bacteria; and promotes the formation of tertiary dentine by stimulating the production of growth factors and mediators in the injured pulp. However, MTA also has some drawbacks, such as a difficult handling technique, prolonged setting time, high cost, and tooth discoloration over time [7].

To achieve long-term success in the treatment of deep caries, the clinician needs to correctly assess the pulpal status at the beginning of the treatment and employ an enhanced treatment protocol. The proper diagnostic of the pulpal health status is crucial for the treatment's outcome [8].

Clinically, there are two available methods of assessing pulp vitality, based on the presence or absence of sensitivity to cold or electrical stimuli, with their combination leading to better precision. Parameters indicating pulp health or reversible inflammation are mild to strong sensitivity or pain to cold stimuli that disappears once the stimulus is removed. Additionally, values of electrical tests are as follows: for the incisors and canines group - from 2 to 9 μA, for the premolars group - from 6 to 15 μA, and for the molars group - from 8 to 18 μA. In the case of deep carious lesions in the molar group, values of electrical tests can increase to as much as 25-27 μA [9].

For paraclinical assessment of the dental caries, X-ray diagnostic methods are most commonly used, especially periapical, bitewing, and orthopantomography [10]. The radiological signs for deep carious lesions are:

- the presence of extensive radiolucency in the tooth of interest that has no communication with the pulp chamber;
- a preexisting faulty filling with underlying radiolucency, indicating the presence of secondary caries;
- no pathological periapical findings.

Once the diagnosis of a deep carious lesion with a vital pulp is established, the treatment requires an enhanced protocol because severe microbial contamination is expected when the necrotic tissue is removed. The enhanced protocol includes: selective carious tissue removal guided by optical magnification, disinfection of the resulted cavity with 5.25% sodium hypochlorite, and application of a hydraulic calcium silicate cement to the bottom of the cavity [11].

Materials and methods

This article reports a clinical case study of a 30-year-old male who sought dental care with the chief complaint of mild sensitivity to cold and sweet stimuli in the upper right quadrant. The patient was evaluated from clinical and paraclinical perspectives. The following tests were conducted: dental probing, axial percussion, cold and electrical sensitivity tests to assess pulp vitality, and orthopantomography.

Results

Clinical examination revealed a deep carious cavity in tooth 17 with a displaced preexisting filling. Dental probing did not elicit any pain; the dentine had a soft consistency, and axial percussion was negative. For cold testing, a cotton pellet soaked in Endo-Frost spray was used, and the response indicated a vital pulp. Additionally, electrical pulp testing was performed with a DigiTest device, recording a value of 18 μA. On the orthopantomography, an extended radiolucency without communication with the pulp chamber was detected in tooth 17, along with a displaced radiopaque filling. No pathological periapical findings were observed. The diagnosis of a deep carious lesion, classified as class I cavity by Black, was established.

Following the principles of minimal invasive dentistry, a direct pulp capping procedure was performed on tooth 17 in a single visit, which involved the following steps:

1. Local anesthesia with Septanest 1:100.00;
2. Isolation of the working field using a rubber dam;
3. Selective carious cavity preparation, resulting in a small pulp exposure;
4. Cavity disinfection and hemostasis achieved with 5.25% sodium hypochlorite 5.25% for 10 sec.;
5. Application of a thin layer of mineral trioxide aggregate on the bottom of the cavity;

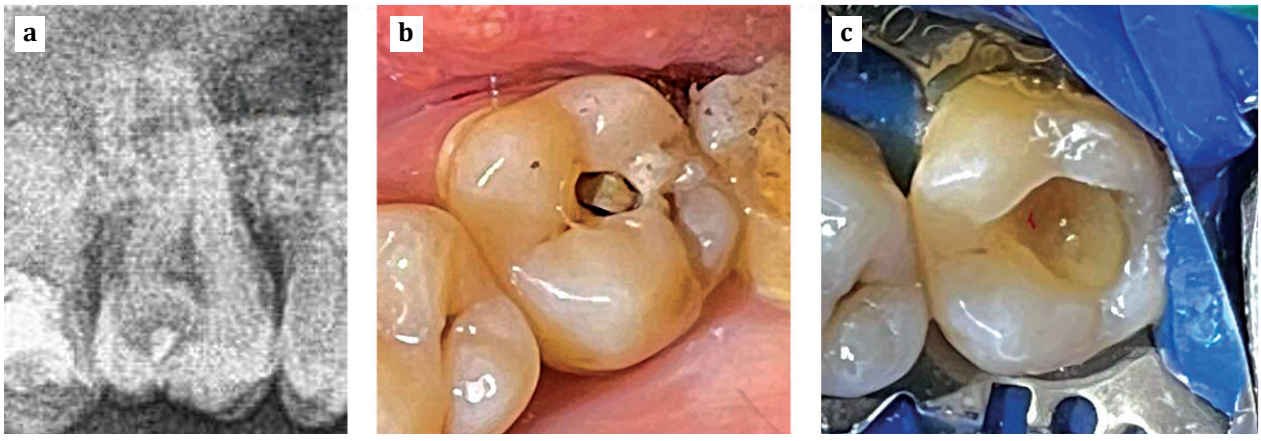

Fig. 1 Deep carious lesion in tooth 17, classified as a class I cavity by Black.
(a) - radiological image of the tooth; (b) - intraoral initial status; (c) - final preparation of the cavity.

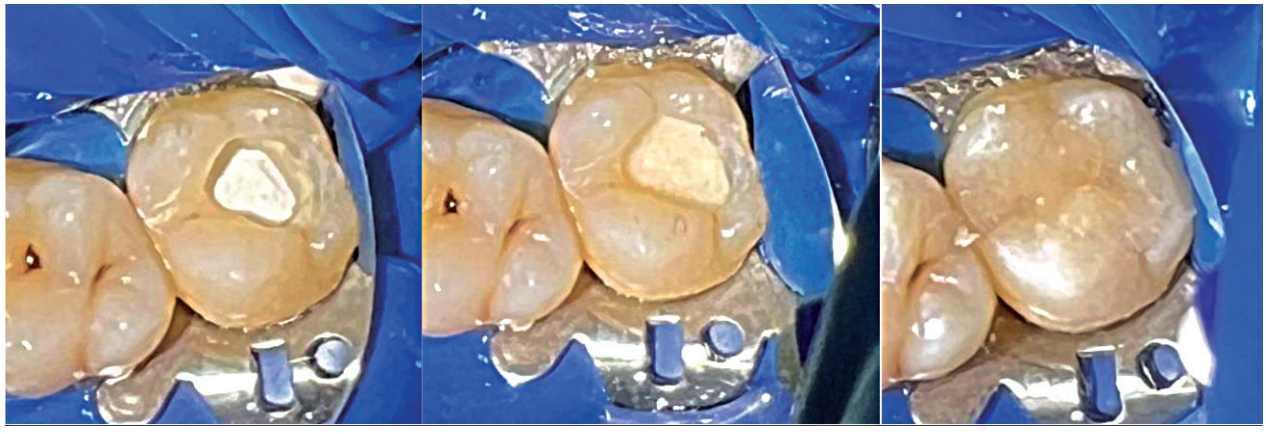

Fig. 2 Direct pulp capping of tooth 17 with MTA.
(a) - a thin layer of MTA covering the bottom of the cavity; (b) - the isolating layer made from glass ionomer cement; (c) - the final permanent restoration using light-curing composite.

6. Application of an isolating layer of glass ionomer cement;
7. Utilization of the total etch technique and V-th generation bonding;
8. Application of a permanent restoration using light-curing composite.

Discussions

This clinical case study describes the procedure of direct pulp capping, which involves the application of a thin layer of bioactive dental material over an exposed pulp. The exposure can occur due to traumatic injury or the removal of carious dentine. The procedure aims to maintain pulp vitality and stimulate the apposition of tertiary dentine. Studies have shown high success rates (92-97%) for MTA when used as a direct pulp capping agent [5]. This success is attributed to MTA's physical and bioactive properties, which result in the formation of a tertiary dentine bridge: high sealing capacity, low solubility, alkaline pH, slow release of calcium ions, and stimulation of TGF-α and BMP growth factors.

Direct pulp capping in cariously exposed dental pulps remains one of the most controversial areas in dentistry because the exposure is considered to occur through an infected layer of dentine, and in some cases, the pulp can show initial signs of inflammation. According to Bjørndal, these cases require an enhanced protocol that includes the removal of only the infected carious tissue, the use of optical magnification, disinfection and hemostasis with 5.25% sodium hypochlorite, as well as the use of a hydraulic calcium silicate cement as a pulp capping agent [11]. This is precisely the protocol we employed in our clinical case study.

The patient was recalled at 6 and 12 months after the applied treatment in order to perform vitality tests and radiographically assess potential changes. Electrical and cold tests confirmed the vitality of the pulp, and on the radiograph, a uniform and continuous layer of newly created tertiary dentine was observed, with no periapical pathologies depicted. Our findings correlate with the study results of Smith et al. [4]. Direct pulp capping can be done if the patient is of the proper age (under 35 years) and good general

health; in this case, the dental pulp still has a good ability to regenerate. After an enhanced protocol treatment, it can maintain its vitality and function, extending the shelf life of the tooth.

Conclusions

The direct pulp capping with MTA was considered successful as the chief complaint, which was sensitivity to cold and sweet stimuli, disappeared after the received treatment. Also, at the follow-up visits at 6 and 12 months, the cold tests indicated a vital pulp, the electrical pulp testing recorded values of 15 μA and 12 μA, respectively, indicating a positive dynamic, and no pathological periapical radiological modifications were depicted. In conclusion, we can say that MTA is an excellent pulp capping agent with a wide range of clinical uses, especially in VPT.

Competing interests

None declared.

Patient consent

Obtained.

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Authors' contributions

Both authors have equally contributed to the results presented in the paper and have approved the „ready for print" version of the manuscript.

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