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Reviving Pulp Vitality Using Strategies For Preserving Pulp Vitality: A Case Series

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Abstract:
This case series explores various pulp capping methods, focusing on direct and indirect approaches using tricalcium silicate-based cement. The goal is to maintain pulp vitality while promoting reparative dentin formation. The efficacy of MTA over traditional calcium hydroxide is discussed, emphasizing its superior properties in terms of biocompatibility, sealing ability, and dentin bridge formation. Proper diagnosis, isolation, and follow-up are crucial for successful pulp capping. Clinicians should weigh the benefits of MTA when preserving pulp health.

Key Word: *Biocompatibility, Calcium silicate cement, Dentin, Reparative dentin, Vital pulp therapy*

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I. Introduction

Dental caries is a chronic, multifactorial disease that shares risk factors with other chronic conditions. It leads to mineral loss in the tooth's hard tissues due to acids produced by bacteria in the biofilm on the dental surface, which metabolize dietary carbohydrates. Carious lesions begin with subsurface demineralization of enamel. If this process continues, the lesions progress, causing the enamel surface to collapse and cavitation to appear. Over time, the dentinal layer, cementum, and pulp are also affected. The development of these lesions is dynamic, with alternating periods of progression, arrest, and regression.[1]

Preserving pulp vitality is crucial for the long-term survival of a tooth. Deep carious lesions and their management can compromise dental pulp vitality, so treatments aimed at preserving pulp vitality are recommended. Various treatment options for carious exposure range from conservative, minimally invasive vital pulp treatments (VPT) like direct pulp capping (DPC), partial and complete pulpotomy, to more invasive procedures such as pulpectomy and root canal treatment. Although root canal treatment is traditionally preferred for cariously exposed pulps, it is a destructive and technically demanding procedure.[2]

Direct and indirect pulp capping procedures aim to maintain the health and vitality of the pulp complex by controlling bacteria, halting caries progression, stimulating pulp cells to produce new dentin, and ensuring a durable seal. Direct pulp capping is applied when the pulp is visibly exposed due to caries or trauma, whereas indirect pulp capping is used in deep cavity preparations close to the pulp but without visible exposure.[3]

The success of both direct and indirect pulp capping procedures largely depends on the initial health and vitality of the pulp complex. Teeth with a history of unprovoked spontaneous pain, necrotic or partially necrotic pulps, radiographic pathology, or excessive hyperemia upon direct pulp exposure due to irreversible pulpitis typically have a poor prognosis and often require endodontic intervention or extraction. In contrast, vital and healthy pulps are suitable candidates for pulp capping procedures.[3]

Although calcium hydroxide has long been used as a direct pulp capping material, long-term studies have shown its results to be unpredictable. One major disadvantage of calcium hydroxide is the formation of tunnel defects within the newly formed dentin bridge, which can create pathways for microbial invasion. In contrast, mineral trioxide aggregate (MTA), a bioactive silicate cement, has demonstrated effective hard tissue formation by recruiting growth factors and exerting an organizing influence over odontoblasts.[4]

II. Case Report

Case 1: Direct Pulp Capping Procedure Using Tricalcium Silicate Based Cement

A 30 year old male patient presented to the department of conservative dentistry and endodontics with a chief complaint of sensitivity on consumption of cold beverages in the lower right back region of the mouth since 3 weeks. On clinical examination, extensive carious lesion involving the distal, occlusal and lingual walls of the tooth irt 46 was noted. The tooth was not tender on percussion but was sensitive upon cold stimulation. Inflammatory status of the pulp was confirmed using investigatory procedures. Digital radiography revealed radiolucency involving enamel, dentin and approaching the mesial and distal pulpal horns. No signs of periapical pathology was observed, thus indicating that the tooth was vital, leading to the diagnosis of reversible pulpitis irt 46. Medical history of the patient was noncontributory.

Since there was no pulp involvement, caries excavation followed by vital pulp therapy was indicated irt 46. Patient was informed regarding the procedure and caries excavation was done using #4 tungsten carbide bur and a high-speed handpiece with water coolant. After achieving isolation using rubber dam, the remaining soft infected dentin was carefully removed using a spoon excavator. Upon excavation a pin point pulpal exposure was observed. Cavity was cleaned with saline and dried with sterile cotton pellets, after which hemostasis was achieved with aluminum chloride. A digital radiograph was taken to confirm the same.

On the site of pulpal exposure, a 1.5mm-2 mm thick layer of MTA (Angelus Industria de Produtos) was placed which was manipulated according to manufacturer's instructions. This was confirmed by a digital radiograph. A moist cotton pellet saturated with saline was placed on top of the MTA layer to enable the setting process. Temporization was achieved using glass ionomer cement. The patient was recalled after one week from the first appointment date and was asked to report to the department in case of any pain or discomfort.

In the second appointment, any signs for clinical and radiographical changes were assessed. Since no changes were noted radiographically and the patient was asymptomatic a permanent restoration was recommended. Upon isolating the tooth using rubber dam, a resin based restoration was placed after removal of the temporary and cotton pellet placed in the former appointment. The patient was recalled for a follow up for 1,3,6, months respectively.

Case 2: Two Step Indirect Pulp Capping Procedure Using Tricalcium Silicate Based Cement

A 21 year old female patient reported to department of conservative dentistry and endodontics with a chief complaint of decay and hypersensitivity on consumption of cold beverages in the lower right back region of the mouth since 2 weeks. On clinical examination dislodged amalgam restoration with secondary caries was

noted. The tooth was not tender on percussion and responded positively for the pulp sensibility test. Digital radiograph showed radiolucency involving enamel, dentin and approaching the pulp chamber. No periapical changes were noted. Since the tooth was vital, all findings lead to the diagnosis indicating reversible pulpitis irt 46. Medical history of the patient was noncontributory. Hence, indirect pulp capping was planned for the same.

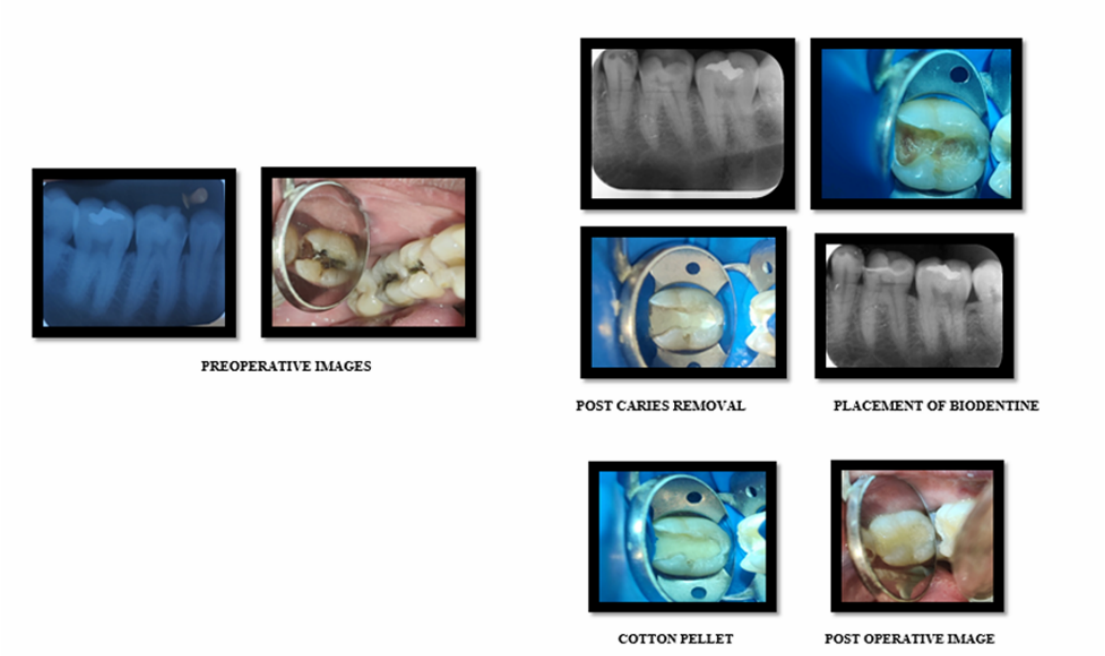
The patient was explained regarding the procedure and caries excavation was done using #4 tungsten carbide bur and a high speed handpiece with water coolant. After achieving isolation with rubber dam, the remaining soft infected dentin was removed carefully using a spoon excavator which was later confirmed using a digital radiograph. MTA (Angelus Industria de Produtos) was manipulated according to manufacturer's instructions. A 1.5mm-2mm thick layer of MTA was placed and confirmed using digital radiograph. A moist cotton pellet saturated in saline was placed on top of the MTA layer to enable setting process. Temporization was achieved using glass ionomer cement. The patient was recalled after one week from the first appointment date and was asked to report to the department in case of any pain or discomfort.

In the second appointment, any signs for clinical and radiographical changes were assessed. Since no changes were noted radiographically and the patient was asymptomatic a permanent restoration was recommended. Upon isolating the tooth using rubber dam, a resin based restoration was placed after removal of the temporary and cotton pellet placed in the former appointment. The patient was recalled for a follow up for 1,3,6, months respectively.

Case 3: One Step Indirect Pulp Capping Procedure Using Tricalcium Silicate Cement

A 28 year old male patient reported to department of conservative dentistry and endodontics with chief complaint of decay accompanied with sensitivity upon consumption of cold beverages in the lower left back region of the mouth since 3 weeks. On clinical examination, extensive caries lesion involving occlusal, distal aspects of the tooth irt 36. The tooth tested negative for percussion tests and reacted positively for pulp sensitivity tests indicating vital state of the pulp. On radiographic examination, radiolucency involving enamel ,dentin and approaching the pulpal horns distally with no periapical changes was observed. All the findings indicated reversible pulpitis as final diagnosis irt 36. Medical history of the patient is non contributory. Hence, indirect pulp capping was recommended for the same.

The patient was educated about the procedure and caries excavation was done using #4 tungsten carbide bur . Isolation was achieved using rubber dam following which the smooth infected dentin was excavated carefully using a spoon excavator. A confirmatory radiograph was taken to evaluate the remaining dentin thickness. 1.5-2mm thick layer of MTA was placed after manipulating it according to the manufacturer's instructions. A moist cotton pellet saturated with saline was placed on the existing material to enable the setting process of biodentine after which a resin based permanent restoration was placed.



III. Discussion

The present case series evaluates treatment success in patients with deep carious lesion using criteria for minimally invasive management or selective caries removal.[1] Vital pulp therapy involves isolating the treatment area with a rubber dam to minimize bacterial contamination and promote the formation of reparative dentin in the lesion. This approach includes clinical and radiological follow-up and monitoring of pulp vitality. These minimally invasive procedures should be prioritized in routine dental practice as they help avoid more invasive treatments and are more biologically favorable.[1] The conservative management techniques for deep carious lesions, aimed at preserving pulp vitality, include indirect pulp capping (IPC), direct pulp capping (DPC), and partial pulpotomy.[1]

Direct pulp capping (DPC) is the most conservative and straightforward method for preserving pulp vitality, as it does not require the removal of pulp tissue, unlike pulpotomy procedures.[2]

DPC is recommended when there is exposure of clinically vital and asymptomatic pulp, either mechanically or during dental dam isolation. It is suitable if bleeding at the exposure site is controlled and an adequate coronal seal can be maintained. However, DPC is not recommended in cases of spontaneous or nocturnal toothaches, excessive tooth mobility, thickening of the periodontal ligament, radiographic signs of furcal or peri-radicular degeneration, uncontrollable hemorrhage at the exposure site, or the presence of purulent or serous exudate.[5]

For successful Indirect Pulp Capping, accurate pulpal diagnosis, effective cavity sealing, and control of caries activity are crucial. Clinicians typically define a deep carious lesion as one where pulp exposure is likely after caries removal; for example, deep caries is often identified as penetrating three-quarters of the dentin thickness on a radiograph.[4]

Therefore, experience and clinical judgment are vital for devising an appropriate and successful treatment strategy. A thorough clinical interview, clinical examination, and radiographic assessment are essential for accurate case selection.[4]

When MTA is mixed with water, the chemical reactions are quite complex. The primary reactants, tricalcium silicate, dicalcium silicate, and tricalcium aluminate, break down into various reaction products, including calcium silicate and calcium hydroxide. The calcium hydroxide dissociates into hydroxyl ions (-OH), creating a high pH environment. Unlike regular calcium hydroxide, which tends to have solubility issues over time, this mixture of reaction products has very low solubility and retains its physical integrity long after placement.[3]

MTA itself does not contain calcium hydroxide; however, once it hardens, calcium oxide is produced, which then reacts with tissue fluids to form calcium hydroxide. This reaction stimulates pulp cells near the necrotic layer under the capping material to secrete fibronectin. The fibronectin layer subsequently forms collagen fibrils that reorganize into reparative dentin tissue. Therefore, MTA can promote the formation of reparative dentin.[4]

Besides its low solubility, MTA boasts several other beneficial properties, such as high biocompatibility, bioactivity, hydrophilicity, radiopacity, lower toxicity compared to calcium hydroxide, and

excellent sealing ability. MTA has also been demonstrated to support the regeneration of the periodontal ligament, dental pulp, and peri-radicular tissues.[3]

A study found that the outcomes for pulp capping with calcium hydroxide were similar to those using hydraulic calcium silicate cements, such as MTA and Biodentine, at the six-month follow-up. However, at the 12-month and longer follow-ups, MTA showed better performance compared to calcium hydroxide-silicate cements.[2] Applying MTA or calcium silicate cement at a thickness of 1.5mm or more enhances bacterial neutralization and minimizes further microbial challenges. After decontamination and the use of a hemostatic agent, the next step involves placing a biocompatible material to seal the pulp and prepare it for the formation of reparative dentin.[5]

IV. Conclusion

Based on the findings of this case series, Mineral Trioxide Aggregate (MTA) demonstrates promising potential as a material for vital pulp therapy. MTA, or Mineral Trioxide Aggregate, is a versatile dental material that has gained significant recognition in the field of endodontics, particularly in vital pulp therapy. It is composed of a mixture of fine hydrophilic particles, primarily tricalcium and dicalcium silicate, along with other minerals such as bismuth oxide. One of the primary uses of MTA is in vital pulp therapy, a treatment approach that aims to preserve the vitality of the dental pulp in cases of deep caries, trauma, or other injuries.

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