

Clinical evaluation of mineral trioxide aggregate (MTA) in direct pulp capping in adults.

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Abstract

Introduction: The main aim during any dental treatment is to maintain vital pulp as long as possible.

Objective: The aim of this study was to assess clinically the use of MTA in direct pulp capping in adult patient.

Method: MTA was performed in two visits treatment protocol on direct pulp capping in adult.

Results: Clinical and radiological examination conducted after 7 months post treatment of direct pulp capping in adult resulted in proper pulp vitality and normal radiographic image of the tooth.

Conclusions: MTA can be a reliable pulp-capping material on direct pulp exposures in permanent teeth in adults.

Key words: adults, direct pulp capping, MTA

Introduction

The main goal during any dental treatment is to maintain vital pulp as long as possible. Sound dental pulp performs many functions, including a defensive barrier to protect against invasion of microorganisms into the body. As a result of its activity, it may produce protective dentine - the secondary pathological, appearing at the projection of the stimulus, the transparent dentine - sclerotic, after the close of the primary dentin tubules^{1,2}. However, in the case of pulpal exposure, the use of odontotropic preparation may stimulate a formation of a reparative dentin also called a dentin bridge^{3,4}. Pulp capping is recommended first of all to permanent teeth with incompletely formed apices, because after a period of odontogenesis, pulp regenerative capacity declines due to poorer blood supply and the gradual replacement of cells by collagen fibers. However, clinical practice shows that you can also obtain positive therapeutic effect in young healthy adults.

Ideal preparation for biological treatment of a pulp should full fill the following tasks: maintain the necessary odontotropic action, act bactericidal and if possible bacteriostatic or should not dissolve in tissue fluids. Moreover, it is recommended to obtain good contrast on radiographs needed for recall tests. From a practical point of view it is important to use this material in a simple procedure. Preparations used for this purpose such as calcium hydroxide, tricalcium phosphate, hydroxyapatite and other bioceramic materials, despite the many advantages, do not meet all the requirements posed to them. Their main disadvantages are associated with poor marginal adhesion to dentin, solubility in dentin liquid and acids, the ability to resorption, lack of resistance to mechanical forces triggered during chewing^{5,6}. Complications that can appear after use of above mentioned preparations could be irreversible pulpitis, internal root resorption or canal calcification resulting at the end in the need for endodontic treatment.

The most modern formulation now widely recommended for treating severe endodontic cases is Mineral Trioxide Aggregate (MTA). Mineral Trioxide Aggregate (Dentsply Maillefer, USA) is a modern dental material, which is characterized by the many possibilities of clinical applications. This is an odontotropic material based on Portland cement. The powder consists of calcium silicate, bismuth oxide, magnesium phosphate, calcium phosphate and calcium magnesium aluminium. The product must be stored in tightly sealed containers, and when mixing with water should be used immediately to avoid dehydration of the material. When combined with water MTA forms a highly alkaline colloidal gel which, hardens, provides an impermeable barrier to fluid, which is of particular importance for the processes of reparation of the pulp. Mineral Trioxide Aggregate immediately after the addition of water gives a colloidal gel with a pH of 10.2, after 3 hours reaches a pH of 12.5, this strong alkaline stimulates pulp to the processes of reparation⁷. The ratio of powder and water affects three characteristic features: porosity of the material, size of crystals formed and the solubility of cement. Manufacturer recommends a ratio of 0.33 g water per 1 g of powder. The product is resistant to compression of 40 MPa immediately after application 70 MPa after 3 weeks. The initial setting time of cement is 4 hours, and bond strength increase within 72 hours after insertion. Compression resistance after 3 weeks is comparable to the 68% ethoxy benzoic acid EBA cement⁸.

Mineral Trioxide Aggregate is available commercially as ProRoot MTA (Dentsply DeTrey GmbH, Konstanz, Germany) in two forms: Regular ProRoot (Grey MTA, GMTA, gray MTA) and ProRoot White (WMTA, white MTA) and MTA Angelus (gray) and White MTA (white) (Angelus, Londrina, Brazilia). The difference between gray and white MTA applies to the content of iron oxide, which can cause discoloration of the tooth hard tissues, in white MTA reduction in the content of this compound is tenfold⁹.

Application of Aggregate Mineral Trioxide in the biological treatment of the pulp has been well documented in experimental studies on cell cultures and animals¹⁰. In the literature there are papers on clinical observations in deciduous teeth, but the number of reports on the success of direct pulp capping in adults are limited.

The aim of this study is to describe our own clinical experience in application of MTA in direct pulp capping in adult patient.

Case description

The patient, aged 23, was admitted to the Department of Conservative Dentistry, Medical University of Bialystok, Poland to carry out the treatment of deep caries in the upper right central incisor. The correct response of pulp was found while using cold testing and drilling. After removing of all carious dentin pulp expose was observed (Figure 1). Promptly dental tools were changed for the sterile one, the cavity was cleaned with 0.9% saline, dried with sterile cotton

pellets, and on the spot of exposure biological dressing was placed with the ProRoot MTA White (Dentsply DeTrey GmbH, Konstanz, Germany), which was covered with compomer material Dyract flow (Dentsply DeTrey GmbH, Konstanz, Germany) and microhybrid composite Herculite XRV (Kerr Italia S.p.A, Scafati, Italy). The patient was commissioned to report to any case of tooth pain. At recall appointment the patient did not report any tooth pain or sensitivity to any external stimuli and the reaction of pulp to cold test was correct. 7 months after pulp capping procedure a control x-ray examination was conducted. An x-ray was assessed with respect for reparative dentin formation, improper pulpal calcification and evidence of pathology at apical part of root. We observed reparative dentin formation in the form of slight shading in the area where MTA was placed and the correct radiographic image of the root and periapical tissues (Figure 2). The outcome was assessed as positive (Figure 3).

Discussion

Before the introduction of Mineral Trioxide Aggregate preparation the first choice for direct pulp capping was calcium hydroxide. Today it is known that its use in the biological treatment of the pulp gives rise to reparative dentine. It may change its structure to the tubular dentin only after resolution of inflammation as a result of the creation of new odontoblasts. Although many studies have established that the action of calcium hydroxide in the process of creating dental bridge is the most important, opinions what plays a major role are divided. Torneck considers that the intensity of cell proliferation of odontoblasts depends on the number of calcium ions, which results in increasing their levels in young fibroblasts-like cells and stimulating their reproduction¹¹. According to some authors, cell proliferation is the result of increased pH, and thus the hydroxyl groups⁶. According to data from the literature both types of ions are involved in the formation of dentin bridge. Odontotropic action of OH groups is that they create favourable conditions for alkaline phosphatase activity (optimum pH 7.2-7.4), an enzyme essential in the processes of reparative dentine formation. Under the influence of this enzyme collagen bridges, forming an organic matrix of dentine, changing their structures and become capable of incorporation of mineral salts. Alkaline phosphatase releases from the circulating blood inorganic mineral salts, of which the collagen matrix precipitates calcium phosphate. The role of released from calcium hydroxide ions is that they act by sealing the capillary endothelium, reduce their permeability, and thus reduce the amount of transudate passing to the extravascular space. In addition, increased levels of calcium ions causes in the pulp increased levels of alkaline phosphatase isoenzyme, whose activity is dependent on the presence of calcium^{1,12}.

According to the available literature Mineral Trioxide Aggregate is a gold standard during a biological treatment of a pulp. MTA has a higher ability to stimulate dentin bridge formation in comparison with hydroxide calcium preparations^{12,13}. It is because of its odontotropic, bactericidal and sealing properties and biocompatibility. Andelin et al., and Chacko and Kurikose^{5,6} observed greater effectiveness in preventing the penetration of bacteria, toxic substances and irritants to the pulp in comparison with other materials used for direct pulp capping. It is important that contact with the blood does not affect the binding of MTA, does not cause the resorption of the material and does not reduce its sealing properties. It is possible to provide a radiological control of the position of MTA in relation to the tooth cavity due to the presence of bismuth. Dentin bridge formation is also accompanied by the addition of lithium and sodium chloride favourably influencing the formation of calcium complexes in the reaction of binding material^{6,7,8}. Andelin⁵ found that the dentine bridge formed after direct pulp capping

after the use of MTA preparation has a very regular, homogeneous, tubular structure without fibrous components, difficult to distinguish from primary dentine. This may explain the fact that on our control radiograph (Fig.2) the reparative dentine is difficult to distinguish. Moreover, compared with calcium hydroxide preparations, MTA induced no inflammatory reactions in the pulp, and new dentine bridge was much thicker¹². It was also observed activation of resembling bone cells and formation of hydroxyapatite layer near the MTA material^{6,14}.

The number of papers describing clinical outcomes in direct pulp capping in adults is limited. According to Bogen et al.¹⁵ the pulp capping in carious teeth has been considered unpredictable and even contraindicated. However, they observed 49 teeth with direct pulp capping with placed MTA during period of nine years and noticed that 97.96% of cases had favourable outcomes on the basis of cold testing and radiographic appearance, subjective symptoms and cold testing. Our observations, presented above, confirm the efficacy of biological treatment using MTA in permanent teeth in adults. Chueh and Chiang¹⁶ described a case of direct pulp capping with mineral trioxide aggregate performed in a 19-year-old patient with a premolar with irreversible pulpitis and symptomatic apical periodontitis. Follow-up using electric pulp tests showed viability of the tooth after three and 10 months, then a tooth was extracted due to orthodontic reasons and processed for histological examination. They found that the pulpal wound was free from inflammation and covered with a thin layer of reparative dentin. As a matter of fact direct pulp capping is not a method of choice for treatment of irreversible pulpitis, but this case demonstrates a very good odontotropic activity of MTA.

Treatment procedures of direct pulp capping with the use of MTA can be performed during one or two visits.^{2,3} In the presented case we decided to performed the treatment in one visit. However, Bogen et al.¹⁵ performed two visit treatment: first they removed caries and placed MTA over the exposures and all surrounding dentin, then restored the teeth with bonded composite. Particularly important in the two visit treatment is prevention of infections, which are possible in the presence of leakage of temporary filling and in the course of subsequent treatment-related procedures. Undoubtedly, an important factor in the sterility of the surgical site is isolation of a tooth from the oral cavity from bacterial infection that can occur during surgery, for example through contact with saliva or microleakage after the permanent restoration of the crown tissues. However, mineral trioxide aggregate (MTA) resists bacterial leakage and may provide protection for the pulp, allowing repair and continued pulp vitality in teeth when used in combination with a sealed restoration. It was found that the MTA is a powerful inhibitor of the growth of bacteria such as *Staphylococcus aureus*, *Enterococcus faecalis* and *Pseudomonas aeruginosa*, which are considered among the main causes of diseases of the pulp¹⁴.

Teeth treated with pulp capping require at least a 12-month observation period. During this time, recall visits should be carried out three times: after 3, 6 and 12 months. In each of the follow up examinations pulp vitality tests and radiographic examination must be done to control the process of dentin bridge formation as a positive result of the biological treatment of pulp, and also assessment and observation of periapical tissues. The presence of foci of pathological internal or external resorption and periapical tissue inflammation will testify to the failure of the treatment, and the lack of any pathological changes, despite the apparent lack of dentin bridge, testifies to the positive effect of treatment. Clinical course of healing after the application of biological therapy may vary depending on the used preparation. Sometimes, however, there are signs of pulp hypersensitivity to low and high temperatures. This increased sensitivity is associated with the local action of drugs contained in the biological dressings of calcium hydroxide, which in the first period of their actions give rise to inflammation, associated with healing of the pulp tissue^{6,17}. The systematic decrease in the hypersensitivity to abolish it completely in the period up to 2 weeks can be seen as successful treatment outcome. If, however, hypersensitivity lasts longer, then it should be regarded as a forecast of negative outcome. In teeth where MTA was used, there was no observed pulp hypersensitivity to various external

stimuli or inflammatory reactions in the pulp in vivo examinations.^{18, 19, 20} In described case the healing process was asymptomatic, and the pulp showed a normal response to vitality tests.

Biocompatibility and stimulating properties caused the extensive use of Mineral trioxide Aggregate in different endodontic situations. This is the material of choice for retrograde filling of root canals after resection of the root apex, closing the perforations of a chamber floor or of a root canals and filling cavities caused by internal resorption.

Conclusion

Our case demonstrates the effectiveness of MTA in the biological treatment of pulp in permanent teeth in adults. MTA can be an excellent alternative to previously used preparations in the treatment of pulp capping

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Conflict of Interest: None declared.

Fig 1. Direct pulp capping in tooth 11, arrow shows injured pulp.



Fig 2. MTA placed on injured pulp.

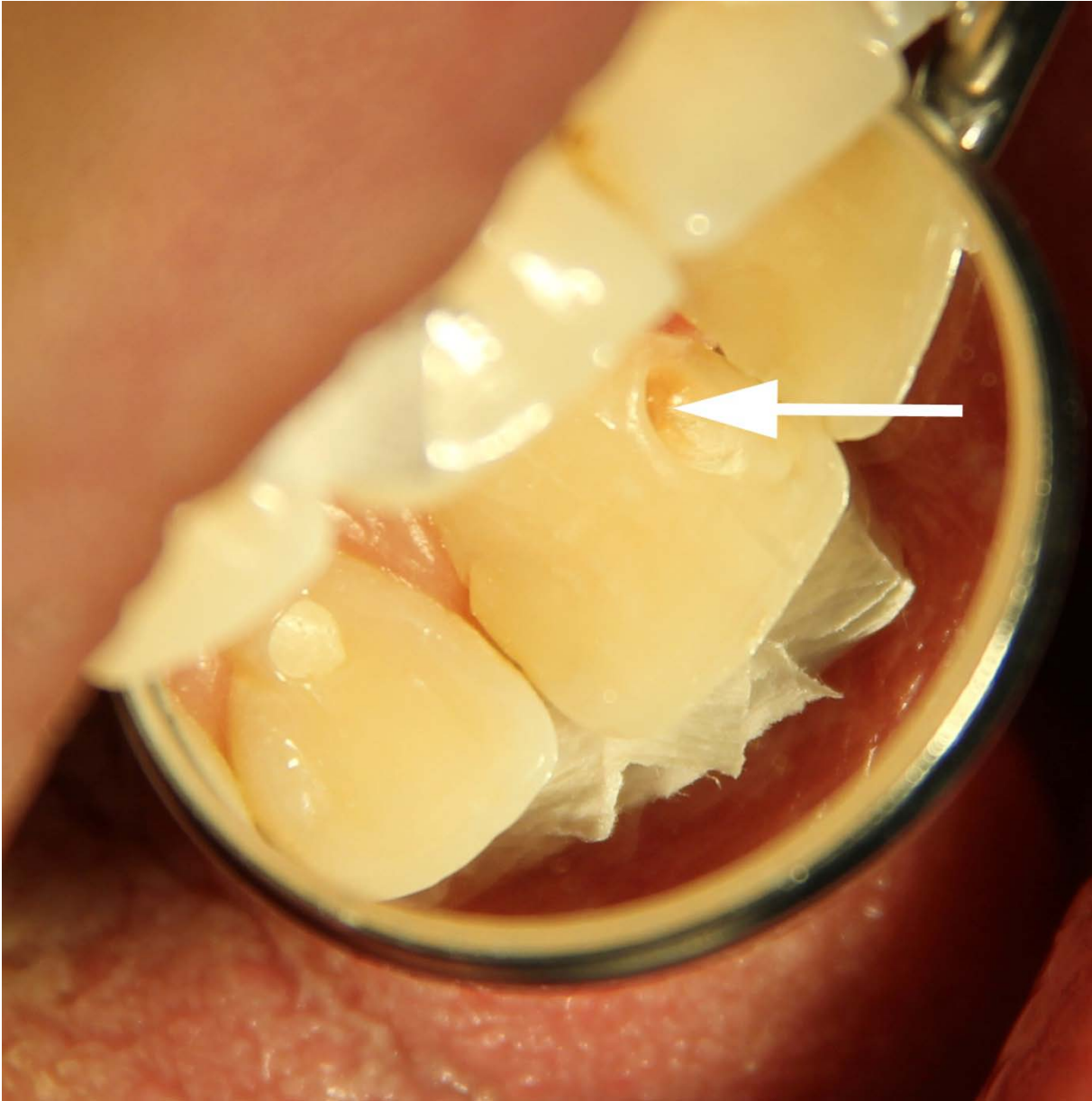


Fig 3. Tooth 11 after seven months after treatment.

