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Usage Areas of Mineral Trioxide Aggregate in Endodontic Treatments

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Abstract

Mineral Trioxide Aggregate (MTA) is a material developed from Portland cement. MTA, possessing an alkaline pH and exhibiting antibacterial and antifungal properties, is well-tolerated by tissues and simultaneously capable of inducing hard tissue formation. This study aimed to retrospectively evaluate the treatment methods implemented using MTA in our clinic.

Patients presenting at the who required apexification, internal resorption, external resorption, iatrogenic perforation repair, vital pulp capping treatment, and regenerative endodontic therapies and who met the necessary indications for MTA application, were identified. Following the preparation of teeth in accordance with the appropriate treatment modalities for the relevant indications, endodontic treatments were administered using MTA.

Patients were summoned for follow-up examinations at specified intervals. Teeth treated with MTA were evaluated clinically and radiologically. No symptoms such as dental pain, percussion sensitivity, or mobility were observed, and improvements were noted in periapical lesions. Radiographic examination revealed an increase in root length in teeth with incomplete root development following regenerative endodontic treatment procedures.

It has been determined that MTA is a well-tolerated material by tissues in vital pulp therapies where it comes into contact with the periapical region and vital dental tissues, and simultaneously induces hard tissue formation.

Case Report (HRU Int J Dent Oral Res: 2025;5(1):30-35)

Key words: MTA, MTA Plug, regeneration, vital pulp therapy, resorption.

Introduction

An optimal orthograde or retrograde filling material should effectively seal the communication pathways between the root canal system and the surrounding tissues. Moreover, the material should exhibit non-toxic, non-carcinogenic, and non-genotoxic properties, demonstrate biocompatibility with host tissues, remain insoluble in tissue fluids, and maintain dimensional stability (1).

Mineral trioxide aggregate (MTA), has gained significant application in dentistry in recent years due to its possession of the aforementioned properties. MTA is a hydrophilic and biocompatible endodontic cement that exhibits the capacity to stimulate healing and osteogenesis. Upon hydration, dust forms a colloidal gel characterized by a pH of 12.5, which subsequently solidifies over a period of approximately 3 to 4 hours (2).

Upon direct interaction with human tissues, MTA exhibits the capacity to liberate calcium ions, which subsequently facilitate cellular proliferation. Consequently, MTA facilitates the migration and differentiation of cells responsible for hard tissue formation, which results in the development of hydroxyapatite on its surface and establishes a biological seal (2) (Figure 1).

The application of MTA as a root-end filling material resulted in the formation of fibrous connective tissue and thin hard tissue layers in immediate contact with the material. MTA elicits a biological response in osteoblasts and furthermore provides a biocompatible surface for cell adhesion. Moreover, it has been effectively employed for repairing external root resorption, as well as furcation and root perforations (3).

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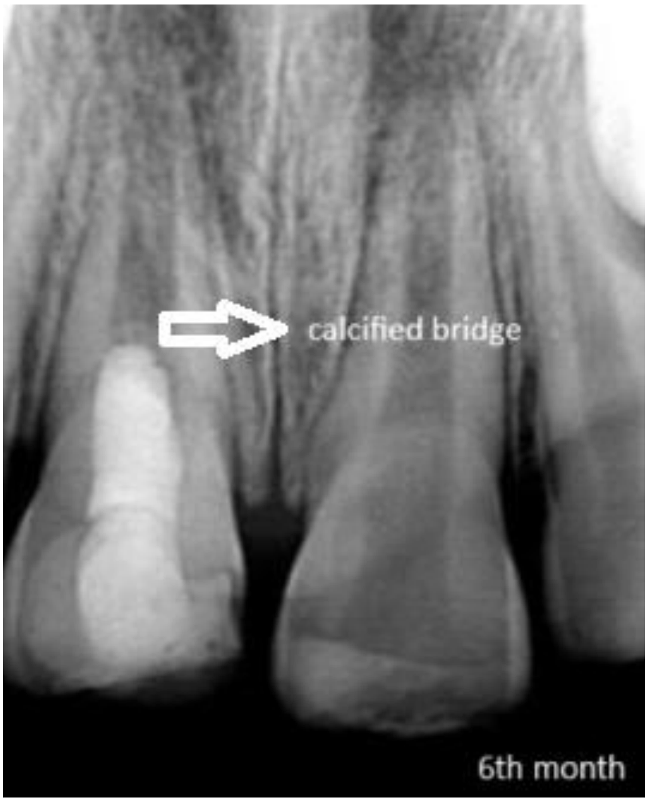

Figure 1: Formation of a calcified bridge following the coverage of the coagulation area with MTA in regenerative endodontics.

Over the past decade, MTA has been successfully used in the field of dentistry for the implementation of numerous specific treatment procedures within conservative and endodontic therapies (2). MTA is successfully utilized in the endodontic clinic as a capping material in vital pulp therapy, for creating an apical barrier during apexification, in the repair of iatrogenic perforations, in the treatment of internal and external resorption, as a root-end filling material, and in the treatment of complicated crown fractures and partial pulpotomy in traumatized teeth.

The objective of this study is to evaluate treatments performed using MTA in cases with diverse indications. This study's results constitute a substantial contribution to validating the safety and reliability of oral rehabilitations performed using these biomaterials, while also paving the way for future enhancements of their properties.

Use of MTA in the Treatment of Internal Resorptions

Case 1:

A female patient presented to our clinic with a complaint of pain in tooth number 37. Clinical examination revealed a fallen filling cavity and caries in the tooth. Severe percussion pain was present. Radiographic examination revealed lesions at the root apices and internal resorption in the middle third of the mesial root near the apex.

Cone-beam computed tomography (CBCT) was obtained to precisely determine the localization and boundaries of the resorption area. Imaging revealed that the resorption occurred within the mesiolingual canal without affecting the external root boundaries.

The tooth was isolated utilizing a rubber dam, and the previous root canal treatment was removed. Reshaping was subsequently performed. 2.5% NaOCl was used with sonic activation. Calcium hydroxide dressing was applied until the tooth became asymptomatic. The distal canal and mesiobuccal canal were obturated with gutta-percha. MTA was applied using MTA pluggers, and the access canal, including the resorption area, was filled with MTA (Figure 2).

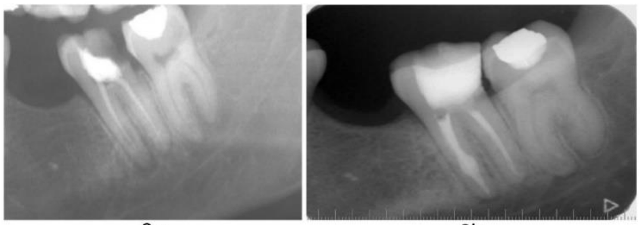

Figure 2: Treatment of internal resorption in tooth 37.
*2a: Symptomatic tooth 37 requiring retreatment. Internal resorption area observed in the apical portion of the middle third of the mesial root. Periapical lesion visible at the root apices.
2b: Post-treatment radiograph of tooth 37 following obturation of the resorption area with MTA

Case 2:

The patient presented with a complaint of pain in tooth number 21. Upon examination, a fistulous tract was observed in the buccal gingiva, and the tooth exhibited pain upon percussion. Radiographic examination revealed an area of internal resorption in the middle third of the root, with calcification of the root canal observed apical to this region. CBCT analysis confirmed that the external root boundaries remained intact without perforation. EDTA (Etilen diamin tetra asetik asit) and a 0.2 mm diameter K-type manual steel file (size 15) were used to access the calcified area apically. Following four visits of calcium hydroxide dressing, the tooth became asymptomatic,

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and the access canal, including the resorption area, was subsequently filled with MTA (Figure 3).

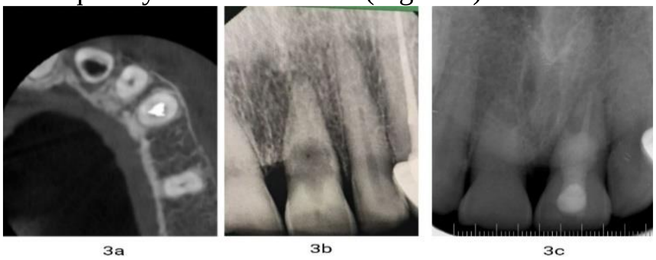

Figure 3: Treatment of internal resorption in tooth number 21
*3a: CBCT image demonstrating the absence of perforation in the external walls of the tooth.
3b: Periapical radiograph showing the internal resorption area and the calcified root canal apical to this region.
3c: Periapical radiograph illustrating that the apical portion of the calcified canal has been reached and the root canal, including the resorption area, has been filled with MTA.

Use of MTA in the Management of External Root Resorption

Case 3:

A patient sought medical attention due to discomfort in tooth #11. Upon clinical assessment, the tooth was found to be free of decay but exhibited grade I mobility. External root resorption was identified in the mesial portion of the root through CBCT imaging. The resorption area was surgically exposed and, following curettage of the resorptive tissue, sealed with MTA. Following the surgical procedure and subsequent wound healing, the canal treatment was completed. In ongoing follow-up examinations, it was observed that mobility had ceased and the tooth had become asymptomatic (Figure 4).

Use of MTA in Apical Closure Treatment for Permanent Teeth with Open Apices

Case 4:

A male patient who had experienced trauma to tooth number 12 during childhood presented to our clinic with complaints of gingival dehiscence and inflammation. Clinical examination revealed no carious lesions on the tooth, and there was no percussion pain or mobility. The tooth was asymptomatic, and the root was visible through a large fenestration area in the buccal gingiva.

Due to the thinness of the canal dentin walls, minimal shaping was performed, and disinfection was achieved through copious irrigation with activated 2.5% NaOCl solution. CaOH was applied in three visits. After ensuring complete cleaning of the canals, the apical portion of the root was sealed with MTA. The coronal portion of the root was subsequently obturated with gutta-percha using the warm vertical compaction technique. Following the completion of endodontic therapy, the fenestration area in the buccal mucosa was surgically closed. One-year post-treatment revealed the tooth to be asymptomatic, with periapical tissues exhibiting normal health (Figure 5).

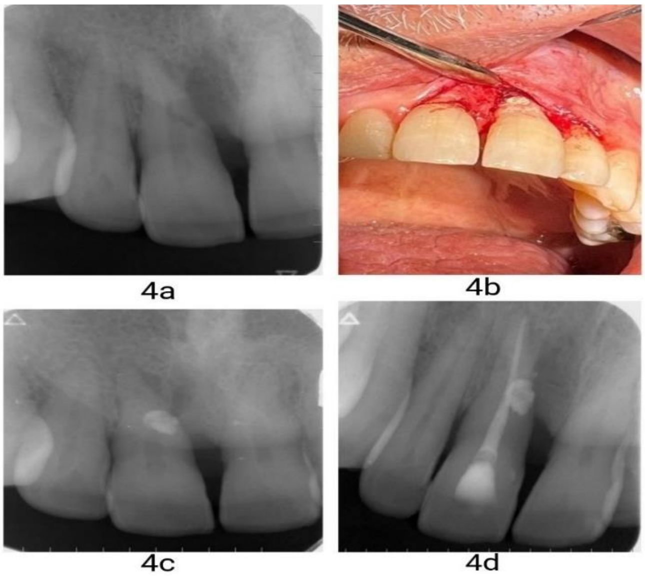

Figure 4: Tooth with external resorption repaired using MTA
*4a: Periapical radiograph showing the area of external resorption on the mesial aspect of the root.
4b: Surgical exposure of the resorption area and repair of the defect using MTA.
4c: Post-surgical radiographic image.
4d: Periapical radiograph taken after repair of the external resorption area and completion of root canal treatment.

Use of MTA as Pulp Capping Material in Vital Teeth

Case 5:

Clinical examination of the patient who presented for treatment of tooth number 26 revealed no percussion pain and healthy periapical tissues. The tooth exhibited no symptoms and demonstrated a positive response to vitality testing.

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A periapical radiograph revealed a deep carious lesion in close proximity to the pulp. During the removal of carious tissue, pulpal perforation occurred.

The hemorrhage in the perforation area was controlled with NaOCl, and the cavity was irrigated with saline solution. Following the drying procedure, MTA was placed in the perforation area. A base was constructed using conventional glass ionomer cement. The permanent restoration was completed using composite filling material (Figure 6).

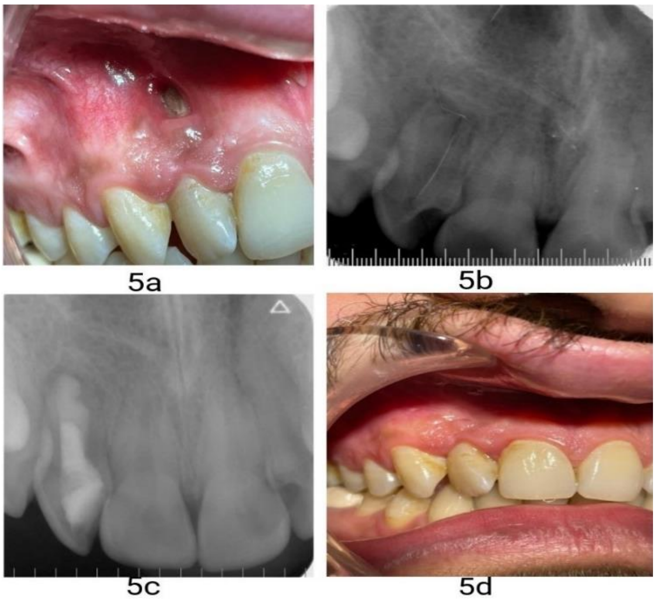

Figure 5: Treatment stages of tooth number 12 with fenestration area.
*5a: Photograph depicting the fenestration area in the buccal mucosa.
5b: Periapical radiograph of the same case.
5c: Periapical radiograph demonstrating the apical portion of the root sealed with MTA and the coronal portion filled with warm gutta-percha.
5d: Follow-up photograph one year after the surgical procedure

Use of MTA in the Repair of Iatrogenic Errors

Case 6:

A patient who developed a furcal perforation during root canal treatment of tooth number 46 was referred to our clinic with accompanying radiographs. The perforation area was sealed with Teflon tape. The canal orifices were obturated with gutta-percha to preserve canal locations, and the perforation area was subsequently sealed with MTA.

The patient was recalled 24 hours after MTA application, and the root canals were disinfected with 2.5% NaOCl irrigation, completing the canal shaping process. The tooth was restored with composite resin (Figure 7).

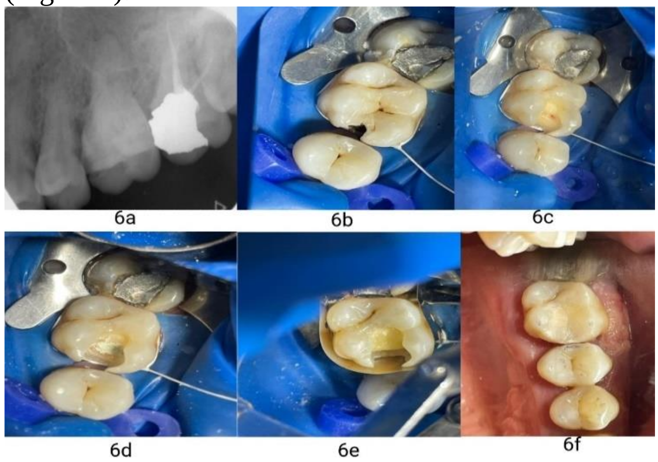

Figure 6: Vital pulp therapy application on tooth number 26
*6a: Periapical radiograph depicting the carious lesion on tooth number 26.
6b: Tooth with carious cavity under rubber dam isolation.
6c: Exposed pulp tissue following caries removal.
6d: Sealing of the perforation area with MTA.
6e: Placement of conventional glass ionomer base material and application of bonding agent.
6f: Completion.

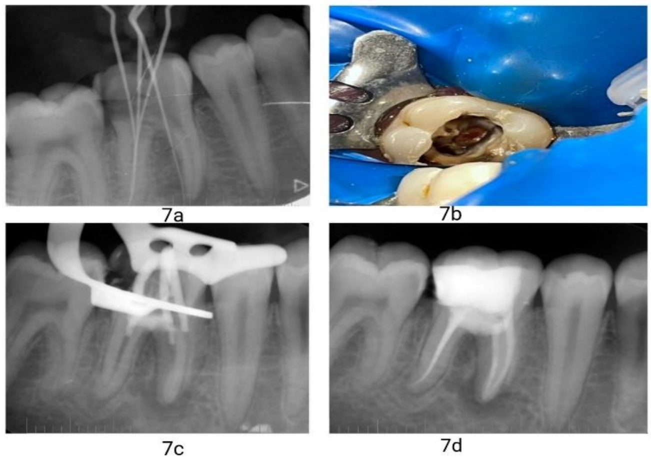

Figure 7: Perforation repair in tooth 46
*7a: Periapical radiograph of tooth 46 with furcal perforation. 7b: Perforation site observed in the furcation area. 7c: Sealing of canal orifices with gutta-percha and repair of the perforation area with MTA. 7d: Periapical radiograph demonstrating the completion of root canal treatment along with the repair of the perforation area.

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Use of MTA in Regenerative Endodontic Treatments

Case 7:

A 9-year-old patient presented with complaints of pain and discoloration in an anterior tooth. Clinical examination revealed the presence of a pre-existing fracture on the incisal edge due to trauma and discoloration of the tooth. Considering the patient's age and evaluating the regenerative potential, it was decided to perform regenerative endodontic treatment to promote root development.

Informed consent was obtained from the patient's guardian. Irrigation with 1% NaOCl. A triple antibiotic paste was applied, and a follow-up appointment was scheduled for three weeks later. The triple paste was removed, and irrigation was performed using 1% NaOCl and 17% EDTA. Bleeding was induced by extending a K-type steel manual file (size 25, 0.2 mm diameter) 2-3 mm beyond the apex. Following coagulation, a collagen barrier was placed, and a plug was created by applying MTA to a thickness of 4-5 mm. A base was constructed on the MTA using traditional glass ionomer cement, and the restoration was completed (Figure 8).


8a


8b

Figure 8: Application of regenerative endodontic treatment in tooth #21
*8a: Necrotic immature tooth #21 with open apex.
8b: Tooth #21 after regenerative treatment, with the coronal portion of the root sealed with MTA.

Discussion

The prevalence of MTA-based materials is attributed to their hydraulic properties, which confer the capacity for setting in a moist environment such as root canals. MTA serves multiple clinical functions, encompassing vital pulp capping, perforation repair, apexification, apexogenesis, root canal obturation, and application as an endodontic filling material (4).

Although numerous aspects of internal root resorption have been investigated, the precise mechanism of its development remains elusive. It is characterized as a destructive process that occurs within root canals or the pulp cavity (5). Clinically, the condition is asymptomatic; consequently, the presence of resorption may be incidentally detected through radiographic examination. External root resorption originates from the root surface and primarily affects cementum and occasionally dentin, manifesting radiographically only in atypical widespread lesions (5).

In a case report, the treatment of a tooth with internal resorption were filled with MTA (6). Follow-up radiographic examinations conducted 5- and 10-years post-treatment revealed that the tooth remained asymptomatic and the pathology had resolved. In our cases, we aimed to achieve similar success through the utilization of MTA.

In our case, similar to the external resorption procedure we applied, the surgical treatment of the lesion involved raising a flap and repairing the external resorption area with MTA. During the two-year follow-up of this case, it was observed that the tooth remained asymptomatic and the periapical region had completely healed (7).

Endodontic treatment of immature teeth presents significant clinical challenges. In such instances, appropriate preparation and obturation are rendered complex due to the interruption of root formation, thin and fragile dentin walls, and the challenge of achieving apical retention of root fillings against a widely patent apex (8). MTA is a material with a pH value of 12.5, low cytotoxicity, and effective bacterial sealing properties. Recent studies have reported that the MTA plug facilitates enhanced root development (9). MTA, when used in the treatment of open apex, promotes the formation of new cementum and PDL. A study presenting three cases of apexification treatment with MTA following trauma demonstrated MTA's excellent compatibility with periapical tissues and its success in apical closure therapy. This was evidenced by the asymptomatic nature of the teeth and the resolution of periapical pathology during a 12-month follow-up period (10).

Vital pulp therapy(VPT) is a restorative dental procedure (11). The efficacy of VPT is dependent upon multiple factors, including the volume of infected tissue, sufficient vascular supply to the tooth, a healthy periodontal structure, and the capacity to establish an appropriate coronal seal. In these cases, MTA demonstrates highly successful outcomes due to its

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biocompatibility, moisture resistance, and excellent sealing properties. Furthermore, its bioinductive characteristics stimulate the formation of dentin bridges (11).

Furcal perforation is characterized as a pathological or mechanical communication between the root canal system in the interradicular region of multi-rooted teeth and the external tooth surface. In the context of root canal procedures, inadvertent perforations have been documented to account for as much as 29% of all treatment-related iatrogenic errors (12).

To mitigate environmental contamination, the repair material should exhibit appropriate physicochemical properties and facilitate periradicular tissue regeneration (12). MTA exhibits the most predictable biological behavior (12).

Similar to our case, a perforation area in the furcal region of tooth number 36 in a 24-year-old patient was repaired with MTA, and an indirect onlay composite restoration was subsequently placed (13). In our case, as in this case, MTA perforation was observed to have good closure capability for repair.

Regenerative endodontic therapy (RET) is a biologically-based procedure that functions as an alternative to apexification. Several studies implementing RET in patients have reported successful outcomes (9). A case report of regenerative endodontic treatment using MTA demonstrated successful outcomes at five-year follow-up (14). In the regenerative therapy protocol, MTA is applied to create a coronal plug due to its excellent sealing properties, biocompatibility, bioactivity, and structural stability in the presence of moisture. In our case study, we successfully used MTA.

Conclusion

Our study has demonstrated that MTA is a viable material for application in numerous endodontic cases. Future advancements are likely to further expand the scope and efficacy of this material.

Conflict of Interest: There is no conflict of interest the authors.

Our study titled "MTA Applications in Endodontics" was evaluated by the scientific committee and accepted and presented as an oral presentation at the Gaziantep University 1st International Dentistry Congress held at Gaziantep Mavera Congress and Art Center between 25-27 October 2024.

AUTHOR CONTRIBUTIONS

The author contributions are listed as follows: **Concept/Idea:** EÜT, AK, EB **Design:** EÜT, AK, EB. **Revision/Consultation:** EB, AK **Resources:** EÜT **Materials:** EÜT **Data collection or processing:** EÜT, AK, EB **Analysis and interpretation:** AK, EÜT, EB **Literature review:** EÜT **Manuscript writing:** EÜT, EB **Critical review:** AK, EB

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