

MTA –MIRACLE IN DENTISTRY

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Abstract –

MTA, is a new material developed for endodontics that appears to be a significant improvement over other materials for various procedures . It is the first restorative material that consistently allows for the overgrowth of cementum, and it may facilitate the regeneration of the periodontal ligament. This material has a wide range of applications like root end filling, pulp capping agent, apexification, etc.

Key words: Mineral Trioxide Aggregate, Composition, Mechanism of action, Physical and Chemical properties, clinical applications.

INTRODUCTION

The field of endodontics is undergoing a continual evolution in terms of materials and techniques, as well as growth in the number of patients who can benefit from endodontic treatment. Endodontics is a specialty which is very receptive to new ideas and concepts and has travelled and untravelled multiple paths in their quest for excellence.

Most endodontic failures occur as a result of leakage of irritants from pathologically involved root canals into the periradicular tissue and procedural errors. Therefore, a repair material providing a good seal is desirable.

An ideal endodontic repair material should adhere to tooth structure, maintain a sufficient seal, be insoluble in tissue fluids, dimensionally stable, non-resorbable, radiopaque, and exhibit biocompatibility if not bioactive.¹ A number of materials have historically been used for retrograde fillings and perforation repair, such as amalgam, zinc-oxide-eugenol cements, composite resin, and glass-ionomer cements. Unfortunately, none of these materials have

been able to satisfy the total requirements of an ideal material.^{2,3}

One such material that is **Mineral Trioxide Aggregate**, was investigated by the research pioneer and Endodontist, **Dr.Mahmoud Torabinejad**, at Loma Linda university, along with his patient Dean White in 1993. Since its approval by US food and drug administration in 1998, its use in clinical practice is increasing steadily.

This review discusses the composition, advantages, disadvantages, mechanism of action, physical, chemical, biological, histological properties and clinical applications of MTA in endodontics.

What is MTA?

MTA is a powder consisting of fine hydrophilic particles of tricalcium silicate, tricalcium aluminate, tricalcium oxide and silicate oxide. It also contains small amounts of other mineral oxides, which modify its chemical and physical properties. Hydration of the powder results in formation of colloidal gel with a pH value equal to 12.5 that solidifies to form a strong impermeable hard solid barrier in approximately three to

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four hours. Bismuth oxide powder is added to make the aggregate radio-opaque.

MTA Angelus is a recent material & contains 80% Portland cement & 20% bismuth oxide with no addition of calcium

sulfate in an attempt to reduce setting time (2 hours for ProRoot MTA & 10 min. for MTA Angelus).²

Two commercial forms of MTA have been available ProRoot MTA is available in either the gray or white form.³

Components of MTA	
<u>Tricalcium silicate</u>	(CaO) ₃ .SiO ₂
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<u>Tricalcium aluminate</u>	(CaO) ₃ .Al ₂ O ₃
<u>Tetracalcium aluminoferrite</u>	(CaO) ₄ .Al ₂ O ₃ .Fe ₂ O ₃
<u>Gypsum</u>	(CaSO ₄ · 2 H ₂ O)
<u>Bismuth oxide</u>	(Bi ₂ O ₃)

DIFFERENCES BETWEEN – GMTA & WMTA

GRAY MTA (GMTA)	WHITE MTA (WMTA)
Consists of dicalcium & tricalcium silicate, bismuth oxide. Also significant amount of ferrous oxide .	It contains tricalcium silicate & bismuth oxide & lower amounts of iron, aluminium & magnesium.
Crystal size is approximate 8 times larger than WMTA.	Crystal size is smaller as compared to GMTA.
Higher initial & final setting time.	Has longer setting time in comparison with Portland cement. This is due to the lower levels of sulfur & tricalcium aluminate. ⁷
Shows low solubility.	It has high solubility, exhibits greater hardness & is more radio opaque.
GMTA particles are not as fine & homogenous.	WMTA has finer particles & are more homogenous, increase surface contact with the mixing liquid and lead to greater early strength as well as ease of handling.

MTA has shown potential as an endodontic material in several in vitro and in vivo studies. It was first recommended as a material for repair of root perforations. It was then widely used as a root-end filling material and for vital pulp therapy, including direct pulp capping and pulpotomy of immature teeth with vital pulps (apexogenesis). In addition, because of its sealing ability, it was also suggested as an apical barrier in the treatment of teeth with opened apices and necrotic pulps (apexification).⁴

Masuda et al.³ in 2005, examined MTA in vivo and concluded that MTA is biocompatible and does not produce any

adverse effects on microcirculation in the connective tissue. Witherspoon et al. in 2006, stated that MTA may be useful as a substitute for calcium hydroxide in pulpotomy procedures.

Advantages of MTA

- High biocompatibility (regenerates osseous and cemental tissue)
- Hydrophilic
- Radio-opaque
- Highly alkaline pH (Bacteriostatic)
- Excellent sealing ability (Low marginal leakage)
- Low solubility

Disadvantages of MTA

- Difficult manipulation
- Discolouration potential (GMTA)
- Presence of toxic elements in the material composition (arsenic)
- Long setting time
- An absence of a known solvent for set MTA.
- Difficulty in removal after curing
- High cost

What's so Unique About MTA?

Materials used to repair perforations, sealing the retro-preparation in surgical

endodontics, to close open apices or to protect the pulp in direct pulp capping, are inevitably in contact with blood and other tissue fluids. This moisturizing effect may be an important factor that has major effects on the physical properties and sealing abilities of the restorative materials. MTA is however not affected by moisture or blood contamination. The presence or absence of blood seems not to affect the sealing ability of the mineral trioxide aggregate.

MANIPULATION:

MTA is supplied as a powder. Each pack of Pro root MTA powder comes with a pre-measured unit dose of water for convenience in mixing.

MIXING TIME:

MTA is prepared by mixing 3 parts of powder with one part aqueous solution by weight to obtain a putty consistency which is achieved after 30 seconds of mixing.

Carriers for MTA placement

- ✓ MTA Endo Manual Carrier
- ✓ MTA Surgical Manual Carrier
- ✓ Messing gun – They come with detachable tips
- Straight
- Present
- Bendable
- ✓ Small plastic amalgam type carrier
- ✓ Back side of spoon – excavator
- ✓ Small K-G carrier
- ✓ A Messing Gun or specially designed Dovgan Carriers are best.

MECHANISM OF ACTION: From the time that MTA is placed in direct contact

with human tissues, its mechanism of action is as follows-

- (1) Forms calcium hydroxide that releases calcium ions for cell attachment and proliferation.
- (2) Creates an antibacterial environment by its alkaline pH.
- (3) Modulates cytokine production.
- (4) Encourages differentiation and migration of hard tissue-producing cells.
- (5) Forms hydroxy apatite (or carbonated apatite) on the MTA surface and provides a biologic seal.

PHYSICAL, CHEMICAL, BIOLOGICAL AND HISTOLOGICAL PROPERTIES:²

1. pH: 10.2 initially and it rises to 12.5 after 3 hours, and thereafter, it remains constant.

2. Radiopacity: radiopacity for MTA is 7 - 17 mm of equivalent thickness of aluminium. Since it is more radiopaque than conventional gutta - percha and dentin, it is easily distinguishable on radiographs when used as a root filling material.

3. Setting time: Advantages of its longer setting time are that, the quicker a material sets the more it shrinks. This explains why MTA in previous experiments had significantly less dye and bacterial leakage than other materials tested as root filling materials.

4. Compressive strength: In 24 hours MTA had the lowest compressive strength (40 Mpa) among the materials (Amalgam, Super EBA & IRM) tested, but it increases after 21 days to 67 MPa. The increase in compressive strength of MTA requires the presence of moisture.

5. Solubility: MTA shows no signs of solubility in water and this is a major factor in assessing the suitability of potential substances to be used as restorative

materials in dentistry. Lack of solubility has been stated as an ideal characteristic for root end filling material.

7. The **push-out strength** of perforation repair materials is an important factor because shortly after perforation repair, tooth function might dislodge the material. MTA has lower push-out strength in comparison with IRM or Super EBA after immersion in walking bleach materials (sodium perborate mixed with saline, Superoxol, sodium perborate mixed with Superoxol).

6. Biocompatibility: Application of MTA as a root end filling material promotes regeneration of dental and osseous tissues, and may induce cementoblasts to produce matrix for cementum formation over MTA.

7. Sealing ability MTA has enhanced sealing ability which could be due to the setting expansion when it is used in moist oral environment.

8. MTA has an **antibacterial effect** on some of the facultative bacteria and no effect on any of the strict anaerobic bacteria. The antibacterial effect of MTA against these organisms could be because of its alkaline pH or release of diffusible substances into the growth medium.

9. **Vasoconstriction** MTA induces vasoconstriction when used at clinical doses and may allow proper hemostasis which is critical for success of any pulp capping treatment. In a study conducted by Bodem et al on rat thoracic aorta it was found that vascular contractions induced by MTA are dependent on calcium influx.

9. MTA is an effective **pulp capping material** able to stimulate hard tissue bridge formation during the early wound healing process. The stereotypic pulp defence mechanism by which primitive matrix (fibro

dentine) triggers expression of the odontoblastic potential of pulpal cells seems to be related to the dentinogenic activity of MTA.

Pulp capping with MTA induces cytological and functional changes in pulpal cells resulting in formation of fibrodentine and reparative dentine at the surface of mechanically exposed dental pulps.

10. **In-vitro study** of human osteoblasts revealed that MTA stimulated the release of cytokines and the production of interleukine.⁶

CLINICAL APPLICATIONS ⁵

1. Pulp capping
2. Pulpotomy
3. Root canal filling
4. Perforation repair - apical, lateral, furcation
5. Resorption repair - external & internal
6. Root end filling
7. Apical barrier for tooth with necrotic pulps & Open apex
8. Sealer
9. Horizontal root fractures,
10. Obturation
11. Dens invaginatus.

CONCLUSION

MTA is a promising material with an expanding foundation of research. The use of MTA has changed dramatically the treatment plan and increased the success rate of many previously thought of as hopeless cases. MTA is an efficient and promising dental material that should be used routinely in the practice of endodontics.

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