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# Mineral Trioxide Aggregate (MTA) – an overview

*Running Title: Mineral Trioxide Aggregate*


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***Abstract: Mineral trioxide aggregate(MTA) seems to be an all-rounder material which is used invarious field of dentistry such as endodontic treatment.Here is an overview of the composition, properties, biocompatibility, setting, clinical uses, indication, contraindicationof MTA, conclusion***

***Keywords: Mineral Trioxide Aggregate, Endodontic treatment.***

## 1. Introduction:

In 1993MohmoudTaorabinejad introducedMineral Trioxide Aggregate[MTA] at Loma Linda University, California, USA [1]and the approvalwas given by the U.S food and drug administrationin 1998[2]. The MTA is composed of a hydraulically active powder that mixes fluxing lime Calcium oxide (CaO), aluminum oxide (alumina, Al2O3) and Silicone dioxide (Silica, $Sio_2$) into hydraulically active ceramic compound.

**Supplied as:**

- Powder and liquidform
- base and catalyst in tubes– paste forms

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- In plunger tubes as static mixing system

2. **Composition:**

Table 1-Composition of MTA[3]

| **Ingredient** | **Function** |
|---|---|
| Tricalcium silicate | Main ingredient |
| Dicalcium silicate | main ingredient |
| Tricalcium aluminate | Initial hydration |
| Bismuth or tantalum oxide | Radio-opacity |
| Calcium sulphate dihydrate (gypsum) | Retarder |
| Tetracalciumaluminoferrite | Present in gray MTA.<br>Absent in White MTA. |

They are

Grey and White MTA

Asgaryet al claimsthatiron, aluminium and magnesium oxides are present in less quantity in white MTA[4]while others claim total absence of thoseoxides in white MTA[5,6].

**Liquid:**

Water-solublepolymer - workability is increased.

**Settingreaction**:

MTA+ watercalcium silicate hydrate ⟶ ends up in 0.1% of setting expansion ⟶ sealing ability.

When MTA is mixedinwater a highly alkaline(pH12) cement matrix comprising of calcium hydroxide and calcium silicate hydrate is created.

An acidic environmentdoesn’tinterfere with the setting of the MTA[7] .

According toTorabinejad et al setting time ofMTA is 2 hours and 45 minutes with +/- 5minutes [3], Islam et al [8]states2hours and 55 minutesfor grey MTA and for whiteis 2 hours and 20 minutes, which could be a major drawback.

New formulations are being introduced to shorten the setting time likesalts, water, polymerscalcium chloride,and reducing agent[9].Such products will expand the indication and utility of thosecalcium-silicate powder.

Hydration reactions of MTA continues for about 28 days, while the strength increases over this era to about 50 MPa.

**Manipulation:**

Powder liquid ratio=4:1&2:1 [2]

To mix MTA, Powder should be dispensed onto a glass slab, a drop of the liquid placed next to thepowder.A metal spatula should be used to incorporate the powder gradually into the liquiduntil a putty-like consistency is reached,the mixed materialare often formed and rolled in toa “log’’with gloved fingers;using spatula small sections are made for insertion.Asmall amalgam carrier, or a condenser is commonly used to transport the MTA delicately into the desiredlocation.

If mixed MTA isn't used immediately, a moist gauze "tent"is placed over themixed MTAto prevent dehydration.MTA -pH is10.2 immediately after mixing and increases to 12.5 after 3 hours of setting [3]. Sluyk et al in their study reported that the mixing time should be less than 4 minutes[10].

**Indication:**

For restorative endodontic, and regenerative dental procedures.

1. Vital pulp therapy (pulp capping and pulpotomy)[11]
2. Apexification
3. Perforation repair(lateral and furcation)
4. Root-end filling
5. Internal bleaching
6. Resorption repair
7. As sealer and as obturating material (partial or complete).

**Contraindications:**

1. MTA is an hydrophilicmaterial, so it requires moisture to set, making absolute dryness [12]
2. Potential for discoloration, especially when used in the anterior esthetic zone
3. MTA not used for post retention.
4. **Properties:**

1. **Compressive strength-**within 24 hours of mixing - 40.0MPa
   -greater in gray MTA than WMTA[13]
2. **Setting Expansion-** Set MTA exhibit<0.1%.
3. **Radiopacity-** 7.17 mm[3].
4. **Solubility-**set cement has no signs of solubility,but increase whenexcess H2O is addedwhilemixing.The event of cementogenesisis due to calcium hydroxideby reaction ofSet MTA with water[14].
5. **Marginal adaptation and sealingability -**excellent[15].
6. **Antibacterial and antifungal property-**Torabinejad et al reported that MTA has no antimicrobial effect against any anaerobes but has some effect on S.mitis,S.mutans,S.salivarius, Lactobacillus andS.epidermidis [16].
7. **Reaction with other dental material-**MTAdoes not react or interfere with any other restorativeCements[17]. While remainingcalcium hydroxide reacts with the MTA to dentin thereby reducing its sealing.Cements like GIC, composite resins, doesn't affect the setting of MTA. Several intracanalirrigantor oxidizing agents have been found to affect the push-out strength of GMTA as it is susceptible to sodium hypochlorite, sodium perborate mixed with saline, so 30% hydrogen peroxide,sodium perbonate mixed with 30%hydrogen peroxide and saline fora era of 7 days[18].GMTA is susceptible to oxidizingagents[18]. $H_2O_2$-based canal preparatory agent showed reduced push-out strength of GMTA to dentin whereas 2% and 5.25%of chlorhexidine and NaOClrespectivelydid not affect[19].
8. **Biocompatibility-** MTA is not mutagenic[20], less cytotoxic compared to IRM. Superior to formocresol aspulpotomymedicament.
9. **Tissue regeneration-** MTA capable of activation ofcementoblasts and production ofcementoblast[21].

10. **Mineralization-**MTA inducesdentin bridge formation which is faster, thicker with good structural integrity[22]. MTA also proves tobe better at stimulating reparative dentin formation and maintaining the integrity of the pulp[23,24].

**Mechanism of action:**

In vivo the ability of MTA to induce reparative dentin bridge formation has been consistently demonstrated in animal studies. These studies have also shown that MTA causes limited pulp tissue necrosis shortly after its application. Thus, MTA seems less causative than calcium hydroxide, which is known to cause the formation of a necrotic layer along the material-pulp interface[25].

Exposed site ⟶ MTA is placed ⟶ MTA induces pulp tissue necrosis ⟶ which in turn stimulate odontoblast ⟶ which leads to stimulation of reparative dentin.

GMTA initially induced the formation of a zone of crystalline structure and an arrangement of pulp cells with the morphological features of increased biosynthetic activity leading to deposition of fibrodentin,and then reparative dentin formation[the presence of polarized odontoblast-like cells and a tubular dentin-like matrix].Thus stereotypic pulp defense mechanism by which fibrodentin triggersodontoblastic potential of pulp cells may be involved in MTA-induced reparative dentinogenesis[26].

In another study, the reparative process of mechanically exposed rat molar pulps capped with WMTA, investigated using immunohistochemistry. The reparative process involved initial deposition of osteopontin in the superficial layer of the pulpal matrix followed by increased cell proliferation and the appearance of nestin-immunoreactive newly differentiated odontoblast-like cells.

**Clinical application of MTA:**

**In primary teeth:**

1. Pulp capping[2]
2. Pulpotomy[27]
3. Root canal filling
4. Furcation perforation repair[2]
5. Resorption .

**In permanent teeth:**

1. Pulp capping[2]
2. Partial pulpotomy[27]
3. Perforation repair-Apical,lateral,furcation[2]
4. Resorption repair-External and internal[2]
5. Repair of fracture-Horizontal and vertical
6. Root end filling
7. Apical barrier for tooth with necrotic pulps and open apex
8. Coronal barrier for regenerative endodontics
9. Root canal sealer

**Comparing MTAwith Calcium hydroxide:**

MTA induces reparative dentin formation at a greater rate and a superior structural integrity[28].MTA provideshigher frequenciesofdentinbridge formation, and a mild degree of pulpal inflammation in comparison with calcium hydroxide-based materials [28].In study they found that Stronger dentin sialoprotein expression was observed in MTA-capped teeth than inDycal-capped teeth, resulting in superior dentinogenic effect of MTA. The compressive strength of MTA gradually increases after initial setting[3]. Thus, MTA Possesses sufficient physical strength for endodontic use and is stronger than calcium hydroxide-based material[29].

## 6. Conclusion:

Considering the literature an over view, MTA is an excellentbiocompatible material with innumerable qualities required foran ideal material.MTA is also successfulin the formation of a dentin bridge that is thicker with lesser defects and side effects.

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