

Mineral Trioxide Aggregate an Introduction : Review

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Abstract

MTA (Mineral Trioxide Aggregate) has emerged as a reliable bioactive material with extended application in endodontics that includes the obturation of root canal space. It is the most versatile material in the field of dentistry. Good physical properties, ability to enhance tissue regeneration as well as good pulp response adds to its usage.

Introduction

Quest for newer materials are never ending in our field of dental sciences. A number of materials have been formulated, tested and standardized to obtain maximum benefit for good clinical performance. One such new material was introduced by Mahmoud Torabinejad at Loma Linda University, California, USA and the first literature about material appeared in 1993⁽¹⁾. MTA (Mineral Trioxide Aggregate) was originally formulated to provide the physical properties⁽²⁾, setting requirements⁽³⁾ and characteristics necessary for an ideal repair and medicament material⁽¹⁾⁽⁴⁾⁽⁵⁾.

MTA (Mineral Trioxide Aggregate) promises to be one of the most versatile materials of this century in the field of dentistry. Some good properties of MTA (Mineral Trioxide Aggregate) include its good physical properties and its ability to stimulate tissue regeneration as well as good pulp response.

Availability

MTA (Mineral Trioxide Aggregate) is fine hydrophilic powder available in single use sachets of 1 gram

Commercially available MTA (Mineral Trioxide Aggregate) are

- ProRoot MTA (Dentsply)
- White ProRoot MTA (Dentsply)
- MTA Angelus (Solucos Odontologicas)
- MTA Angelus Blanco (Solucos Odontologicas)
- MTA Bio (Solucos Odontologicas)⁽⁶⁾

Composition

MTA (Mineral Trioxide Aggregate) consists of tricalcium silicate, tricalcium aluminate, tricalcium oxide, silicate oxide and bismuth oxide⁽²⁾. Bismuth oxide is added (17-18 wt%) to improve the properties and the radio-opacity⁽²⁾. The MTA (Mineral Trioxide Aggregate) particles are smaller and uniform in size⁽⁷⁾.

Types

MTA (Mineral Trioxide Aggregate) of two types Grey & White. The grey and white MTA (Mineral Trioxide Aggregate) differs mainly in their content of iron, aluminium and magnesium oxides. Asgary et al claim that these oxides are present in less quantity in White MTA (Mineral Trioxide Aggregate)⁽⁸⁾

While others⁽⁹⁾ claim total absence of these oxides in white MTA (Mineral Trioxide Aggregate).

White MTA (Mineral Trioxide Aggregate) contains smaller particles with a narrower range of size distribution than grey MTA (Mineral Trioxide Aggregate)⁽¹⁰⁾.

Manipulation and setting reaction of MTA (Mineral Trioxide Aggregate)

MTA (Mineral Trioxide Aggregate) paste is obtained by mixing 3 parts of powder with 1 part of water to obtain putty like consistency. Mixing can be done on paper or on a glass slab using plastic or metal spatula. Mix is placed in the desired location and condensed lightly with moistened cotton pellet⁽³⁾⁽⁴⁾⁽¹¹⁾.

pH 10.2 immediately after mixing and increases to 12.5 after 3 hrs. of setting. Mixing of MTA (Mineral Trioxide Aggregate) is very crucial. If mixing is prolonged it results in dehydration of mix. Sluyk et al⁽³⁾ in their study reported that mixing time should be less than 4 minutes. MTA (Mineral Trioxide Aggregate) takes longer time to set as compared to other materials.

Presence of moisture during setting improves the flexural strength of the set cement. Therefore it is advised to place a wet cotton over the MTA (Mineral Trioxide Aggregate) in the first visit followed by replacement by a permanent restoration at the second visit. Though moisture is needed for MTA (Mineral Trioxide Aggregate) to set, excess moisture results in a mix that is soupy and difficult to use⁽¹²⁾.

After mixing, the mix should not be left open as it undergoes dehydration and dries into sandy mixture, so should be used immediately⁽¹¹⁾.

MTA (Mineral Trioxide Aggregate) may be placed into desired location using hand instruments or ultrasonic condensation. Hand condensation is done with plugger, paper point or messing gun⁽¹¹⁾. Ultrasonic condensation is done by first placing a hand instrument such as condenser in direct contact with MTA (Mineral Trioxide Aggregate) then an ultrasonic instrument is placed touching the shaft of the hand instrument and activated for several seconds⁽¹³⁾.

Properties of MTA (Mineral Trioxide Aggregate)

- **Compressive Strength-** It takes an average of three to four hrs. for the MTA (Mineral Trioxide Aggregate) to completely solidify. It is shown that once it is set, it has compressive strength equal to IRM and super EBA but less than amalgam⁽¹⁴⁾.

- **Radio-opacity** - MTA (Mineral Trioxide Aggregate) is less radio-opaque than IRM, super EBA, amalgam or gutta percha and has similar radiodensity as zinc oxide Eugenol⁽¹⁵⁾⁽¹⁶⁾. The mean radio-opacity of MTA (Mineral Trioxide Aggregate) is 7.17 mm of equivalent thickness of aluminium, which is sufficient to make it easy to visualize radiographically⁽²⁾.

- **Solubility** : Set MTA (Mineral Trioxide Aggregate) shows no signs of solubility, the solubility might increase if more water is used.

The set MTA (Mineral Trioxide Aggregate) when exposed to water releases calcium hydroxide which might be responsible for its cementogenesis inducing property⁽¹⁷⁾.

- **Marginal adaptability & sealing ability-** This property is most vital for any restorative material when it is to be for root end filling, repair of perforations, pulpcapping or pulpotomy procedures.

Bates et al⁽¹⁸⁾ found MTA (Mineral Trioxide Aggregate) superior to the other root and filling materials. MTA (Mineral Trioxide Aggregate) has excellent sealing ability due to its property to expand⁽¹⁹⁾.

MTA (Mineral Trioxide Aggregate) also proved itself to be superior in the bacterial leakage test by not allowing the entry of bacteria at the interface.

MTA (Mineral Trioxide Aggregate) of thickness of about 4 mm is sufficient to provide a good seal⁽²¹⁾.

- **Antibacterial and antifungal properties-** Due to the property of MTA (Mineral Trioxide Aggregate) to provide good seal and preventing microleakage it can be proclaimed anti bacterial agent against *Enterococcus faecalis* and *Streptococcus sanguis* in vitro⁽²²⁾.

MTA (Mineral Trioxide Aggregate) does not show anti microbial activity against anaerobes but shows some against 5 (*S. mitis*, *S. mutans*, *S. salivarius*, *S. epidermidis* and *Lactobacillus*) of the nine facultative bacteria.

- **Tissue Regeneration-** MTA (Mineral Trioxide Aggregate) is capable of activation of cementoblasts and production of cementum⁽¹⁴⁾.

It allows for overgrowth of cementum and also facilitates regeneration of PDL. Also allows bone healing and eliminates clinical symptoms in many cases⁽¹²⁾.

- **Mineralization-** MTA (Mineral Trioxide Aggregate) just as calcium hydroxide induces dentine bridge formation⁽⁵⁾.

Holland et al⁽²⁵⁾ found calcite crystals nearest to the opening of the dental

tubules close to MTA (Mineral Trioxide Aggregate). They theorized that the tricalcium oxide in MTA (Mineral Trioxide Aggregate) reacts with tissue fluids to form calcium hydroxide resulting in hard tissue formation in a manner similar to that of calcium hydroxide.

But the dentine bridge formed with MTA (Mineral Trioxide Aggregate) is faster, with good structural integrity and more complete than that with calcium hydroxide⁽²⁶⁾.

- **Reaction with Other Dental Materials-** MTA (Mineral Trioxide Aggregate) does not react or interfere with any other restorative material.

- **Biocompatibility-** Kettering and Torabinejad studied MTA (Mineral Trioxide Aggregate) in detail and found that it is not mutagenic and is much less cytotoxic as compared to super EBA and IRM⁽²⁷⁾.

Genotoxicity tests of cells after treatment of peripheral lymphocytes with MTA (Mineral Trioxide Aggregate) showed no DNA damage⁽²⁸⁾.

Arens and Torabinejad⁽²⁹⁾ reported osseous repair of furcation, perforations treated with MTA (Mineral Trioxide Aggregate).

MTA (Mineral Trioxide Aggregate) showed good interaction with bone forming cells, cells remained viable and released collagen even after 72 hours with good adherence⁽³⁰⁾.

Conclusion

MTA (Mineral Trioxide Aggregate) having the ability to enhance tissue regeneration along with good pulpal response and almost no tissue reaction or damage proves itself as the most versatile material in our field of dentistry. Its of very importance in the obturation of root canal system in endodontics and also in the field of pediatric dentistry in management of non vital immature teeth, apexification. Also proves itself in dentine bridge formation. So MTA (Mineral Trioxide Aggregate) needs to the

explored more and more by clinicians so as to use it upto its best and its beneficial properties can be extracted.

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