

## Mineral Trioxide Aggregate: A Review.

Litty Varghese\*, Mithra N Hegde, Aditya Shetty, and Chitharanjan Shetty.

Department of Conservative Dentistry and Endodontics, AB Shetty Memorial Institute of Dental Sciences, Deralakatte, Mangalore, Karnataka, India.

### Review Article

Received: 03/12/2013  
Revised: 24/01/2014  
Accepted: 02/02/2014

#### \*For Correspondence

Department of Conservative Dentistry and Endodontics, AB Shetty Memorial Institute of Dental Sciences, Deralakatte, Mangalore, Karnataka, India.

**Keywords:** MTA (mineral trioxide aggregate), HA(hydroxyl apatite) calcium, phosphorus

#### ABSTRACT

The main aim of an ideal retrograde filling material is to seal the pathways of communication between surrounding tissues and the root canal system, hence mineral trioxide aggregate (MTA) which is a biocompatible and a nontoxic material was developed for dentistry. This material allows normal healing response due to the formation of new cementum and bone. Calcium and phosphorus are the main ions detected under the electron probe micro analysis of the MTA powder. A review of literatures will be discussed in this article regarding the history, composition, mechanism of action, and various aspects of its clinical considerations.

#### INTRODUCTION

The main aim of endodontics is to prevent or treat apical periodontitis [1] leakage of irritants through in properly sealed root end fillings into periradicular tissues is the most common endodontic failure [2,3,4,5]. An ideal retrograde root canal filling material must seal the pathways of communication between root canal system and its surrounding tissues [6]. The materials used in root canal therapy, particularly root end filling, are frequently in direct contact with soft and hard periodontal tissues; therefore, a root filling material is necessary to be highly biocompatible and nontoxic [7]. MTA has been found to be fulfilling the above requirements of an ideal retrograde root canal filling material.

MTA has been found to be beneficial as it has microleakage-proof, biocompatible, has an osteoinductive property and has an ability to set in the presence of moisture [8]. MTA is now most widely used in endodontics for pulp capping, pulpotomy, repair of root perforations, root end filling, root canal filling, and apical barrier formation in teeth with necrotic pulps and open apices.

#### History

Mineral trioxide aggregate (MTA), a new root-ending endodontic material, was developed by Torabinejad at the university of Loma Linda, in 1990 [9]

The first study on this material was published by Lee et al in 1993 [10] and It received acceptance by the US Federal Drug Administration and became commercially available as ProRoot MTA (Tulsa Dental Products, Tulsa, OK, USA).

#### Types of MTA

Until recently, two commercial forms of MTA have been available (Pro Root MTA) in either the grey or white forms. Recently MTA-Angelus (Angelus Soluc, o~esOdontolo´gicas, Londrina, Brazil) has become available.

#### Comparison of Grey and White Material

There has been always some comparison data on the biocompatibility of grey and white MTA.

Holland et al. revealed that both types were biocompatible when they were implanted into rat connective tissue but these materials were not conducted in the same experiment.

Perez et al. used a different type of cell and summarised that grey MTA is more biocompatible than the white version and also reported that there is difference in their biocompatibility due to surface morphology of these materials.

Camilleri et al. indicated no successful outcome on the difference between the two variants, but when allowed to set for 28 days both materials exhibited reduced cell growth [11].

### **Vascular Effects of MTA**

The effect of MTA on vascular tissues was evaluated from two different models [12,13]. One investigation evaluated the effect of MTA on microcirculation which was held on rabbit ear chamber [12]. This investigation showed that after placement of MTA for 4 weeks, microcirculation was completely restored, and new vessels were formed. Another investigation carried out was a rat aortic ring model that simulated the pulpal vessels' smooth muscle contraction [13]. These studies concluded that MTA induces vessel contraction in a dose-dependent manner

### **Composition of MTA**

MTA comprises of fine hydrophilic particles like Tricalcium silicate Tricalcium aluminate Tricalcium oxide Silicate oxide, It also contains trace amounts of mineral oxides, which acts and changes its physical and chemical properties [14].

Calcium and phosphorus are the main ions detected under the electron probe micro analysis of the MTA powder [14]. MTA is cement that consists of tricalcium silicate, tricalcium aluminate, tricalcium oxide, silicate oxide and bismuth oxide. 5% calcium sulphate dehydrates and tetracalciumaluminoferrite is also found in the composition of MTA [14].

MTA has an off white appearance and is contributed by the lack of an iron containing compound, tetra calcium aluminoferrite compound. 70% Portland cements, 20% bismuth oxide and 5% gypsum by weight also comprises both this formula [14].

### **Mechanism of Action**

When MTA is placed in direct contact with human tissues, it appears that the material does the following

- Forms the releases of calcium ions for cell attachment and proliferation
- An antibacterial environment is created by its alkaline pH
- Cytokine production is modulated
- Migration and differentiation of hard tissue-producing cells is encouraged
- Provides a biologic seal by the formation of HA (or carbonated apatite) on the MTA surface [14]

### **MTA as a Root Canal Sealer**

Holland et al compared MTA as a sealer with glass ionomer root canal sealer and finalized that MTA leads to the closure of main foramen by the formation of new cementum with the absence of inflammatory cells after several months.

Dentin MTA interfacial layer is formed in the presence of phosphate when MTA is used as a root canal sealer when it is compacted against the dentin.

This dentin MTA interstitial layer has a close resembles with the hydroxylapatite of dentin in its structure and composition when it is seen under x-rays diffraction and analysis [15].

### **Uses of MTA for Direct Pulp Capping**

MTA is a very reliable material for direct pulp capping teeth especially with reversible pulpitis, as analysed by various histological studies. Mente et al recently concluded "MTA appears to be more effective than calcium hydroxide for maintaining long-term pulp vitality after direct pulp capping and shows much promise in the long term health of pulps that have been capped using MTA.

## Uses of MTA for Root Perforation

The antimicrobial properties and high pH (12.5) of MTA leads to its repair capacity and numerous other characteristic of MTA also leads to the growth promotion of the cementum and bone formation [16].

Various reports has been reported the uses of MTA for the repair of furcal perforations. Arens and Torabinejad [18] informed two cases to be successful when MTA was used to repair root perforations. Pace et al [19] indicated a successful outcome for sealing root perforations under clinical and radiographic follow ups at 6 months, 1 year, 2 years, and 5 years, and after 5 years, in 9 out of 10 teeth. Oliveira et al [20] has also done study on primary molars to repair the furcal perforation with MTA and has done follow ups for 20 months. They were successfully observed clinically and radiographically. Silveira et al [21] reported 2 cases in which MTA was successfully used for the repair of root perforation. Adithya et al [22] indicated a successful outcome that Mineral Trioxide Aggregate (MTA) materials demonstrated a biocompatible behavior when used for root-end fillings and perforation repairs from their clinical trials

## Uses of MTA as an Apical Barrier in Open Apices

When the effectiveness of Ca(OH)<sub>2</sub> versus MTA was compared and resulted in showing that MTA has been found effective as Ca(OH)<sub>2</sub> for the treatment an open apex cases.

Considerably lesser period of time with effective and predictable results were shown when MTA was used in performing the same procedure. Various studies reported that the chances for biological calcific bridge formation are highly favourable when the root canal apices were under filled with MTA.

## MTA in Pulpotomy

Pulpotomy procedure involves removing only part of the pulp ,eliminatingtissues that have inflammatory or degenerative changes and leavingintact the underlying healthy pulp [23].

Eghbal et al [24] revealed an outcome of short term clinical and histological study of MTA pulpotomy of 12 mature permanent molars with irreversible pulpitis. Clinically, there was no complaint of discomfort or tenderness in the next day. Later a dentinal bridge was evident in all cases when the teeth were extracted two months post treatment for histological study.

Witherspoon et al [25] also reported successful outcomes on clinically and radio graphically on MTA pulpotomy for 19 symptomatic permanent teeth in 14 patients.

## CONCLUSION

MTA is a new biocompatible material with various exciting clinical applications in dentistry. An ideal root repair material should have the most important quality of being nontoxic and other qualities like resistance to microleakage, non-resorbable and should also have ease of clinical manipulation.MTAhas also have a high ph similar to calcium hydroxide and also induces the hard tissue formation often after the use of this substance. So MTA can be of a great choice in various treatment aspect of dentistry.

## REFERENCES

1. Hargreaves, Cohen. COHEN'S pathways of the pulp. 10th ed. St Louis: Mosby Elsevier; 2011.
2. Parirokh, Torabinejad. Mineral trioxide aggregate: A comprehensive literature review-Part III: Clinical applications, drawbacks, and mechanism of action. J Endod. 2010;36:400-13.
3. Ribeiro, Duarte, Matsumoto, Marques, Salvadori. Biocompatibility in vitro tests of mineral trioxide aggregate and regular and white Portland cements. J Endod. 2005;31:605-7.
4. Torabinejad, Pitt Ford. Root end filling materials: A review. Endod Dent Traumatol.1996;12:161-78.
5. Fernandes, Santos, Reda, Motta. Biocompatibility analysis of MTA, Portland cement and modified Portland cement on cultured fibroblast cells and subcutaneous tissue. Conscientiae Saúde.2010;9:11-6.
6. Torabinejad, Chivian. Clinical applications of mineral trioxide aggregate. J Endod. 1999;25:197-205.
7. Camilleri, Pitt Ford. Mineral trioxide aggregate: A review of the constituents and biological properties of the material. Int Endod J. 2006;39:747-54.
8. Mithra N. Hegde, Ganesh Bhat, Pramith Shetty, Snehal Thatte : Revascularization of non-vital immature tooth : A case report. Indian J Dent 2012;3(1-3).
9. Torabinejad white tooth filling and material use.US Patent No 5 1995 May;769:638
10. Lee Monse. Torabinejad sealing ability of mineral trioxide aggregate for repair of lateral root perforations. J Endod 1993:19.

11. Camilleri, Pitt Ford. Mineral trioxide aggregate: a review of the constituents and biological properties of the material. *Int Endod J* 2006;39:747-754.
12. Masuda, Wang, Hossain, et al. Evaluation of biocompatibility of mineraltrioxide aggregate with an improved rabbit ear chamber. *J Oral Rehabil.* 2005;32:145-50.
13. Tunca, Aydin, et al. The effect of mineral rioxide aggregate on the contractility of the rat thoracic aorta. *J Endod.* 2007;33:823-6.
14. Ravichandra, Jayaprada Reddy S, Harikumar, Kavita. Mineral trioxide aggregate doi: 10.5866/3.3.593
15. Holland Souza. Reaction of dogs teeth to root canal filling with mineral trioxide aggregate or a glass inomer sealer. *J Endod* 1999;25:728-30
16. Holland, Otobonifilho et al. PFE Dean junior Mineral trioxide aggragate repair of lateral root perforation. *J Endod.* 2001;27 281-84
17. Roberts, Toth, et al. Mineral trioxide aggregate material use in endodontic treatment: a review of the literature. *Dent Mater.* 2008;24:149-164.
18. Arens, Torabinejad. Repair of furcal perforations with mineral trioxide aggregate-two case reports. *Oral Surg.* 1996;82:84-88.
19. Pace, Giuliani, Pagavino. Mineral trioxide aggregate as repair material for furcal perforation: case series. *J Endod.* 2008;34:1130-1133.
20. Oliveira, Sakai, et al. Repair of furcal perforation treated with mineral trioxide aggregate in a primarymolar tooth: monthfollow-up. *J Dent Child (Chic).* 2008;75:188-191.
21. Silveira, Sánchez-et al. Repair of furcal perforation with mineral trioxide aggregate: long-term follow-up of 2 cases. *J Can Dent Assoc.* 2008;74:729-733.
22. Aditya Shetty, C Ravi Chandra, Mithra N Hegde, Uday S Mahale & Ganesh Bhat. Mineral Tri-oxide aggregate (MTA) for the repair of periapical tissues in a patient with self-inflicted injuries : Case report. *NUJHS .* 2013;3(1).
23. Armstrong , Patterson , Kafrawy , Feltman :Comparison of Dycal and formocresol pulpotomies in young permanent teeth in monkeys. *Oral Surg.* 1979;48:160.
24. Imad Hassan Barngkgei, Esam Saleh Halboub, and Roula Safouh Alboni. Pulpotomy of Symptomatic Permanent Teeth with Carious Exposure Using Mineral Trioxide Aggregate. *Iranian Endodontic Journal.* 2013;8(2):65-68.
25. Witherspoon DE, Small JC, Harris GZ. Mineral trioxide aggregate pulpotomies: a case series outcomes assessment. *J Am Dent Assoc.* 2006;137(5):610-8.