Mineral trioxide aggregate - a new experimental material for retrograde filling

Sealing ability of amalgam super EBAcement and MTA when used as retrograde filling materials
by J. Aqrabawi 2000;188:266-268

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Mineral trioxide aggregate (MTA) is a remarkable material for use in endodontics. It is basically the material used in the building trade as the basis of cement and mortar. It sets even in wet conditions, the reaction being a hydration and crystallisation. Its use was pioneered by Dr Torabinajad of the University of Loma Linda in California, USA, and he has found it to have exceptional properties of biocompatibility, even when it is expressed from the apex of the tooth. Quite why this should be the case is not clear; the material is very alkaline (pH 12), and might be expected to irritate the tissues. But Nature can be capricious, and in fact the hard tissues of the body seem to positively welcome this material.

The present paper compares the sealing ability of MTA with other accepted endodontic sealers, namely amalgam and zinc oxide-EBA cement. In the study, conventional endodontic preparation was given to 79 freshly extracted human teeth, which were divided into three groups of 25, all of which used gutta percha points in conjunction with one of the sealers. Controls were also prepared, two each of a negative control (fully coated with nail varnish) and a positive control (instrumented and obturated with gutta percha and sealer).

The extent of leakage was determined using methylene blue dye. The results showed that none of the MTA-sealed teeth had any leakage. By contrast, 14 of the amalgam-sealed teeth (56%) and 5 of the EBA-sealed teeth (20%) showed considerable leakage. These results were highly significant statistically.

There was thus clear evidence that MTA provided a hermetic seal when used as a root end filling material. Its potential clinical properties are thus as promising as its other biological ones. Dr Aqrabawi is cautious about extrapolating these results to clinical practice, and there is certainly anecdotal evidence that MTA, being a slow setting paste, is difficult to use in the clinic. Nonetheless, it does have great potential; and these findings once again vindicate Dr Torabinajad's decision to use this particular building material in endodontics.

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MTA was developed by Dr. Torabinejad at Loma Linda University in 1993. It is a compound mixture of hydrophilic tricalcium silicate, tricalcium oxide, and tricalcium aluminate with some other oxides. An independent analysis reveals that MTA is identical to Portland cement with the addition of bismuthoxide. Because MTA has a pH of 12.5, some of its biological and histological properties can be compared to those of Ca(OH)2. The material sets in a moist environment and has low solubility. The compressive strength of MTA is equal to that of IRM and Super EBA but less than that of amalgam (Nahmias and Bery).

There are clinical situations in root canal therapy that would require the use of a product that would provide a reliable clinical outcome and long-term prognosis. Pulp capping, lateral root or furcation perforation, apexification, apicoectomy, and internal and external resorption are some of the cases that would rely on the use of such a product. An ideal root repair material should be non-toxic, bacteriostatic, and non-resorbable. It should also promote healing and provide a good apical seal. Compared to other materials, MTA shows less microleakage, less toxicity, and better bacteriostatic effect. Histologic examination has revealed that it has actually induced cementogenesis, and bone deposition with minimal or absent inflammatory response.

Below is the list of clinical situations that benefit from the use of MTA and the proper treatment for each case.

Pulp Capping

If you happened to cause a mechanical perforation, immediately place a rubber dam over the tooth for proper isolation. Rinse the cavity with sodium hypochlorite to disinfect the area. You do not have to dry the area since MTA sets in a moist environment. Mix the MTA powder with enough sterile water to give it a putty consistency. Apply it over the exposed pulp and remove the excess. Blot the area dry with a cotton pellet and restore the cavity with an amalgam or composite filling material. MTA provides a higher incidence and faster rate of reparative dentin formation without the pulpal inflammation that is seen when Dycal is used.

Internal and External Root Resorption

In the case of internal root resorption, isolate the tooth and perform RCT in the usual manner. Once the canal has been cleaned and shaped, prepare a putty mixture of MTA and fill the canal with it, using a plugger or gutta-percha cone. Next insert a SafeSiders 25/.08 down the canal to spread the cement laterally and create a new canal. Flood the canal with EZ-Fill cement and obturate it with a single gutta-percha cone. The MTA will provide structure and strength to the tooth by replacing the resorbed tooth structure.

In the case of external resorption, complete the root canal therapy for that tooth. Next raise a flap and remove the defect on the root surface with a round bur. Mix the MTA in the same manner as above and apply it to the root surface. Remove the excess cement and condition the surface with tetracycline. Graft the defect with decalcified freeze-dried bone allograft and a calcium sulfate barrier.

Lateral Perforation and Strip Perforation

If you happened to cause a strip or lateral perforation during instrumentation, first finish cleaning and shaping that canal. Irrigate the canal really well with sodium hypochlorite and dry it with a paper point. The paper point will allow you to see where the perforation is located. If the perforation is down at the mid to apical third, then follow the directions for treating an internal resorption, above. The MTA will seal off the perforation as it is spread laterally by the SafeSiders 25/.08 file and the gutta-percha cone. If the perforation is closer to the coronal third, then fill the canal up with EZ-Fill cement and gutta percha as usual. Next, remove the gutta percha about 23 mm below the perforation using the Peeso reamer. (Be careful not to perforate again!) Now mix the MTA and fill the rest of the canal up with a plugger.

Furcation Perforation

If you create a furcal perforation while accessing the tooth, there are two ways to repair it.

If you can finish the root canal in one visit, then do that first. Next remove the excess gutta percha in the chamber and soak it for 5 minutes with sodium hypochlorite. Now mix the MTA and fill the chamber with it. Using a moist cotton pellet, plug the MTA down into the perforation site and remove the excess cement from the chamber. Place a moist cotton pellet in the chamber to help with the setting of the MTA and close the tooth up with a temporary cement of your choice.

If you cannot do a one-visit root canal, then first seal the perforation with the MTA mixture. Make sure that you can locate the canal while the MTA has not set and remove the excess material from the area. Close the tooth as above and do the root canal the next visit.

Apexification

Vital pulp: Isolate the tooth with a rubber dam and perform a pulpotomy procedure. Place the MTA over the pulp stump and close the tooth with a strong temporary cement until the apex of the tooth closes up.

Non-vital pulp: Isolate the tooth with a rubber dam and perform root canal treatment. Once the canal has been cleaned and shaped, irrigate it and dry it with a paper point. Mix the MTA and plug it down to the apex of the tooth, creating a 2 mm thickness of plug. Wait for it to set; then fill in the canal with cement and gutta percha

MTA is a cement composed of tricalcium silicate, dicalcium silicate, tricalcium aluminate, tetracalcium aluminoferrite, calcium sulfate and bismuth oxide (1). An independent analysis we requested from a laboratory reveals that MTA is identical to Portland's cement except for the addition of bismuthoxide, believed to help modifying its setting properties (Fig. #2).

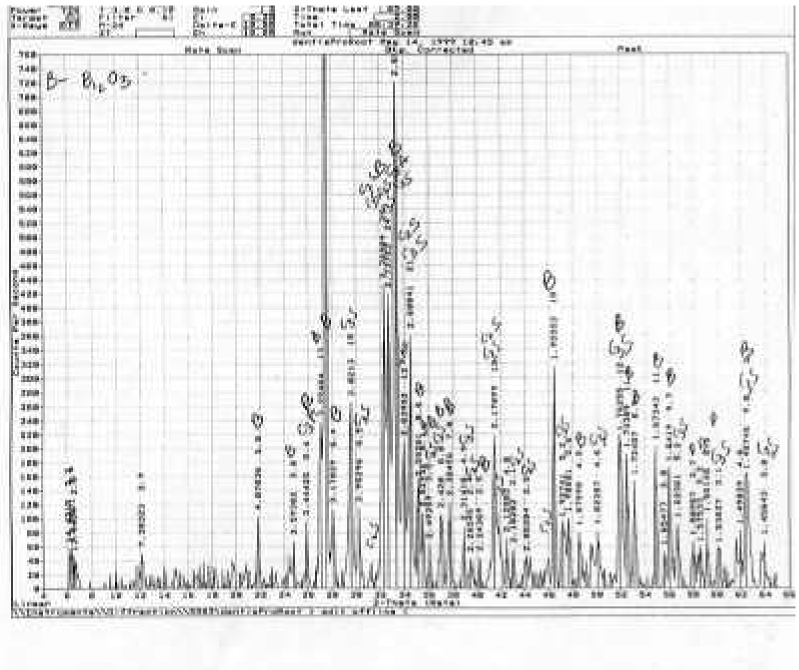

Figure 2 Independent analysis of MTA suggests that the material is very similar to Portland's cement.

MTA is very alkaline, and it can be compared to Calcium Hydroxide when it comes to some of its biological and histological properties. The material is mixed with sterile water to provide a grainy, sandy mixture. Once the material has acquired this consistency it can be applied by using a Messing gun or an instrument supplied with it (Fig. #3).

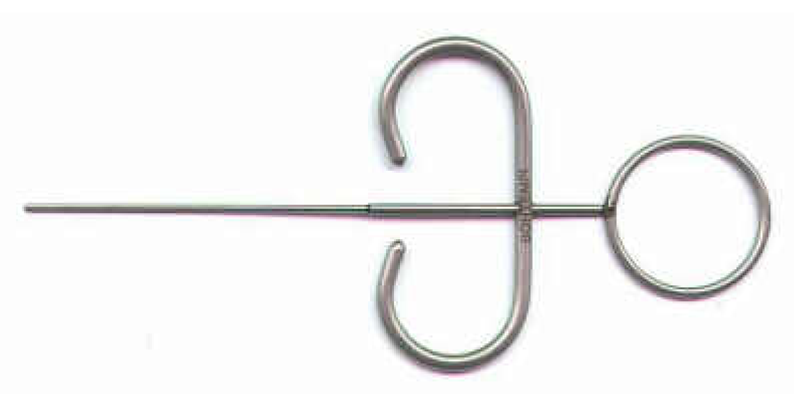

Figure 3 This carrier can be used for the placement of MTA into the desired area

At this point it is gently packed into the desired area. MTA being hydrophilic requires moisture to set, making absolute dryness not only unnecessary but contraindicated. Some techniques require the placement of a moist cotton pellet directly in contact with the MTA in order to allow proper setting. It takes an average of four hours for the material to completely solidify. It has been shown that once its has set, it has a compressive strength equal to IRM and Super EBA but less than amalgam (2). Its consistency is that of a very hard cement, it can be compared to "concrete"!

Torabinejad and others (3,4) have widely and extensively documented the response of connective tissue in contact with MTA. When studied as a root-end filling material, MTA has shown to be better than amalgam (5). Histologic examination revealed that it had actually induced cementogenesis, and bone deposition with minimal or absent inflammatory response (5). Holland showed that the histological responses of MTA were similar to those induced by Calcium Hydroxide after six months (6). Dye and bacterial leakage studies have shown the sealing ability of MTA to be superior to amalgam and equal or better to Super EBA (7-8). It has also been shown to be less cytotoxic than IRM and Super EBA (3).

As a retrofilling material, MTA fulfills many of the requirements of the ideal material such as; biocompatible with periradicular tissues, non-toxic, non-resorbable and minimal or no leakage around the margins.

Given the favorable results of MTA as a root-end filling material, its use has been expanded for procedures such as pulp capping, apexification, and most importantly the sealing of perforations (Fig. #4).

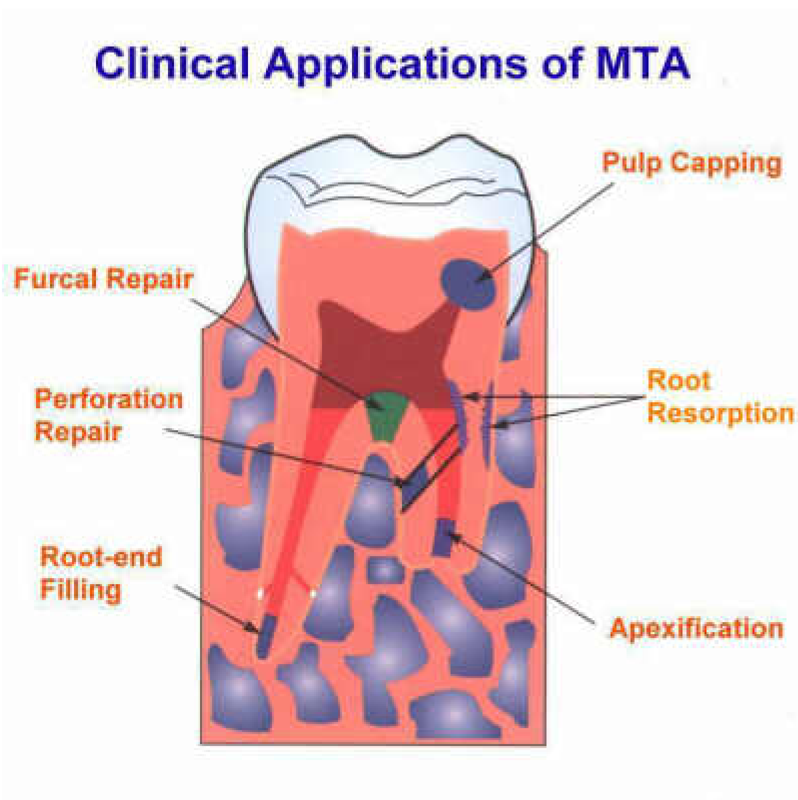

Figure 4 Illustration showing the many uses for MTA.

MTA is now the material of choice in the non-surgical treatment of furcal and radicular strip perforations!

Figure 1