Mineral trioxide aggregate revisited: a cement for all seasons

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MTA is available as gray MTA and white MTA. The crystaline structure and chemical composition of gray and white MTA are similar, except for the presence of iron in gray MTA.

Both contain bismuth oxide and calcium silicate oxide. Portland cement is composed mainly of calcium silicate oxide and does not contain bismuth oxide but does contain potassium. Calcium oxide is added in both Angelus white and gray MTA (Angelus, Londrina, Brazil) to reduce the setting time, which is too long in MTA cements of other brands (Fig. 1).

MTA has a similar mechanism of action to calcium hydroxide in that the main component of the material, calcium oxide, when in contact with a humid environment, is converted into calcium hydroxide. This results in a high pH of 12.5, making its surrounding inhospitable for bacterial growth and producing an antibacterial effect for a long period of time. But unlike calcium hydroxide products, such as Dycal® (DENTSPLY, York, Pa.) and MTA Angelus (Angelus, Londrina, Brazil), it has very low solubility, so it maintains a hard, excellent marginal seal.

Finally, unlike most dental materials, MTA actually needs moisture to set, so it thrives in a moist environment. Of the commercially available MTA products, MTA Angelus is well suited for most of the indicated endodontic procedures due to its setting time of 10 minutes, compared with the four-hour setting time of the other commercially available material. It is also packaged in air-tight bottles, allowing the practitioner to use it only when it is needed, without introducing undue moisture into the remainder and without waste.

MTA was shown to seal off the communication between the root canal system and its surrounding tissues, effectively sealing the pathways of communication between the root canal system and the periodontium, and sealing the irritants of the dental pulp and periradicular tissues. Microorganisms are the main irritants of the dental pulp and periodontium, and sealing the pathways of communication between the root canal system and the periradicular tissues is imperative if bacterial leakage is to be prevented.

An ideal orthograde or retrograde filling material that seals the pathways of communication between the root canal system and its surrounding tissues should be non-toxic, non-carcinogenic, biocompatible, insoluble in tissue fluids and dimensionally stable. Furthermore, the presence of moisture should not affect its sealing ability; it should be easy to use and be radio-opaque for recognition on radiographs.

Because existing restorative materials used in endodontics did not possess these “ideal” characteristics, 4 mineral trioxide aggregate was developed and recommended initially as a root-end filling material. However, it has been used for pulp capping, pulpotomy, apexogenesis, apical barrier formation in teeth with open apices, repair of root perforations and, most recently, in regenerative procedures. MTA has been recognized as a bioactive material.

MTA has been shown to seal off the communication between the root canal system and surrounding tissues, significantly reducing the risk of reinfection. It is made up of fine hydrophilic particles that set in the presence of water, and it is composed of tricalcium silicate, dicalcium silicate, tricalcium aluminate, tetraalcum aluminium, aluminium silicate, calcium sulphate dihydrate (gypsum) and bismuth oxide, which provides it with radiopacity.

Portland cement is the most common type of cement in general use around the world, used as a basic ingredient of concrete, mortar, stucco and most nonspontaneously growing. It usually originates from limestone.

The development of normal, sterile granulation tissue within the root canal is thought to aid in revascularization and stimulation of cementoblasts and the undifferentiated mesenchymal cells at the periapex, leading to the deposition of a calcific material at the apex as well as on the lateral dentinal walls.

Endodontic revascularization

Treatment of the immature, non-vital tooth with apical pathology presents several challenges. The mechanical cleaning and shaping of such a tooth with a blunderbuss canal is difficult, if not impossible, to achieve predictably. The thin, fragile lateral dentinal walls can fracture during mechanical filing, and the large volume of necrotic debris contained in a wide root canal is difficult to completely disinfect.

A new technique is presented to revascularize immature permanent teeth with apical periodontitis. The canal is disinfected with copious irrigation and a combination of three antibiotics. After the disinfection protocol is complete, the apex is mechanically irrigated to initiate bleeding into the canal to produce a blood clot to the level of the cementoenamel junction. A double seal of the coronal access is then made, first with MTA over the blood clot and then a bonded composite. The combination of a disinfected canal, a matrix into which new tissue could grow, and an effective coronal seal appears to have the ability to produce an environment necessary for further revascularization.

Testing, with mild sensitivity to cold and electric pulp testing, was prepared into a creamy delivery tip and the macro canule of the EndoVac apical negative pressure delivery system (Axsis/SybronEndo, Coppell, Texas) was referred to the author.

Because of the presence of a wider than 4 mm open apex and thin dentinal walls prone to possible future fracture, it was felt that an attempt to achieve regeneration of the pulp should be made by a technique similar to that described by Rule and Winter and Iwaya et al.

An access cavity was made, purulent hemorrhagic drainage obtained, and the necrotic nature of the pulp confirmed. The root canal was slowly flushed with 20 ml of 5.25 percent NaOCl for 15 minutes. It was delivered with the mas-
consistency and spun down the canal with a lentulo spiral instrument to a depth of 8 mm into the canal. The access cavity was closed with a sterile cotton pellet placed in the chamber and blue Cosmocure (Cosmedent, Chicago) (Fig. 4).

The patient returned three weeks later and was asymptomatic. The access was opened and the canal again flushed with 20 ml of 3.25 percent NaOCl for 15 minutes. It was delivered in the same manner as in the first visit with the master delivery tip and the macro cannula of the EndoVac apical negative pressure delivery system.

The canal appeared clean and dry, with no signs of inflammatory exudate. A 30 K-file was introduced into the canal until vital tissue was felt at a depth of 10 mm into the canal space. It was used to irrigate the tissue gently to create a blood clot and allowed to harden for 30 minutes. After 30 minutes, the presence of the blood clot was confirmed. White mineral trioxide aggregate, MTA Angelus (Angelus, Londrina, Brazil) was placed in the canal and then the tooth was restored with bonded composite.

At the three-month follow-up appointment, the radiograph revealed excellent longitudinal apical and lateral dentin development (Fig. 5). The bleeding was stopped at a depth of 10 mm into the canal. The canal appeared clean and dry, with no signs of inflammation or periradicular thickening of the dentinal walls. Pulp testing was inconclusive (Fig. 6).

At the one-year follow-up appointment, the radiograph revealed that treatment had been performed on this tooth by another dentist, different from the original dentist who made the initial referral. The new dentist, not familiar with revascularization treatment performed, had entered the root canal space, cleaned it out and obturated it with gutta-percha and sealer. Fortunately, the treatment was successful (Fig. 7).

Conclusion

The future of endodontics is bright as we continue to develop new techniques and technologies that will allow us to perform treatment painlessly and predictably and continue to satisfy one of the main objectives in dentistry — being to retain the natural dentition wherever possible and wherever practical.

References

8. Dentsply Tulsa Dental. Pro-RootTM MTA Root canal re-pair material; Material safety data sheet (MSDS).