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Mineral Trioxide Aggregate (MTA) in the Management of Endodontic Complications: A Case Series

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ABSTRACT

Mineral trioxide aggregate (MTA) has gained great popularity as a dental material in the recent past. Compared to its predecessors, this is a stable material that maintains a long-term alkaline environment, facilitating the healing and repair of dental hard tissues and bone. MTA has a better track record compared to recently introduced substitutes. This case series details the management of various endodontic complications using MTA. The cases discussed were treated with MTA following one month of calcium hydroxide dressing; thus, the endodontic treatment was completed within a short time. Follow-ups ranging up to two years revealed that patients were asymptomatic. MTA spares a significant amount of time and surgical procedures for the patient.

KEYWORDS: *Mineral trioxide aggregate (MTA), Endodontic complications, Root canal treatment (RCT)*

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1 INTRODUCTION

Mineral trioxide aggregate (MTA) is a bioactive material that has gained popularity in dentistry (Milani et al. 2014, Roberts et al. 2008). It has fewer complications and induces natural healing with the least reactions in biological tissues. It stimulates repair through its ability to stimulate cell proliferation and cell migration, with subsequent differentiation (Torabinejad et al 2005). Treatment in one or two appointments using MTA avoids long-term use of calcium hydroxide dressings, which may desiccate and weaken the already thin dentine (Chandler 2010).

The cases described below are endodontic challenges such as open apices, refractive infection, posterior teeth with long-standing infections, root fractures, and perforations. Though the full complement of treatment was carried out within a short period, patients were reviewed long-term (two years), which confirmed the good clinical and radiological outcomes of the treatment.

This case series details the endodontic management with MTA at the Restorative Dentistry Specialist Clinic in Colombo South Teaching Hospital (CSTH), Sri Lanka.

Case 1

A 52-year-old female presented, complaining of a blister in relation to the buccal side of her right-side posterior tooth. History revealed a porcelain-fused-to-metal cantilever bridge placed by a general dental practitioner a few years back, incorporating the complaining tooth as the abutment. Her medical history was not significant.

Examination revealed missing 16, 18, and 38. A porcelain-fused-to-metal-bridge replacing the missing 15 was cantilevered to 14. The bridge was in place with reasonable aesthetics. There was a discharging sinus in relation to 14. Teeth 12, 13, and 17 gave positive results for sensibility testing. A periapical radiograph of 14 showed a periapical radiolucency (Figure 1a) with evidence of previous root canal treatment of 14.

It was diagnosed as a discharging sinus in relation to non-vital 14, i.e., a chronic periapical abscess in non-vital 14, which was the abutment of the cantilever bridge. The following treatment plan was finalized after discussion with the patient:

1. Root canal treatment of 14 with initial calcium hydroxide dressing
2. MTA apical plug to minimize subsequent complications
3. Obturation of the remaining root canal with gutta-percha
4. Porcelain-fused-to-metal (PFM) crown for 14
5. Review

Since access to the root canal treatment for 14 was challenging, the existing cantilever bridge was removed after informed written consent was obtained. After the access cavity preparation in 14, calcium hydroxide dressing was applied after thorough chemo-mechanical

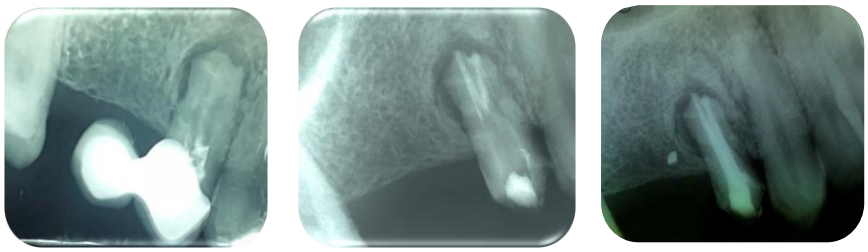
debridement of both root canals up to the measured working length.

The patient was reviewed after two weeks and was eased without much pain and discomfort. However, there was still mild tenderness over the apex of 14. Hence, the calcium hydroxide dressing was left in place for a further two weeks. A provisional crown for 14 and a denture for 15 to maintain occlusion and aesthetics until the root canal treatment was completed.

At the one-month review, the patient was asymptomatic, thus, it was decided to complete the endodontic treatment with an MTA apical plug of 3-5 mm. Calcium hydroxide was completely removed using copious manual irrigation with sodium hypochlorite combined with hand instrumentation and an EndoActivator from the root canals. MTA powder (Bio MTA, Cerkamed, Poland) was mixed with liquid supplied by the manufacturer. MTA was carried into the root canals with an MTA carrier and condensed at the apical third using a Buchanan hand plugger, which was marked 3 mm short of the working length using a rubber stopper. Once the required length of MTA was achieved in the root canals, moist cotton was placed, and access was sealed with a temporary restorative material.

The post-operative periapical radiograph showed a satisfactory MTA apical plug (Figure 1b). After three days, the MTA was assumed to be fully set, and the patient was recalled for the obturation of the remaining part of the root canal with cold lateral condensation technique, which involves the use of a master gutta-percha (GP) point with an ample amount of sealer in the remaining root canal, adding accessory GP points that are compacted together with the use of a spreader. The post-operative periapical radiograph showed satisfactory root canal obturation (Figure 1c).

Since the patient was free of symptoms for one month~~,~~ definitive prosthetic treatment was initiated. The patient is being periodically reviewed clinically and radiographically. Clinically the patient reported the absence of pain, and examination revealed no pain on percussion.



a **b** **c**

Figure 1. Pre-operative radiograph of 14 (a), after placement of MTA apical plug (b), post-operative radiograph following obturation of 14 (c)

Case 2

A 13-year-old boy presented, complaining of pain and swelling in relation to the upper anterior region. History revealed a traumatic injury to upper anterior teeth three years ago following an accidental fall. Tooth 11 had been mobile after the injury and had been splinted by a general dental practitioner. The patient had not continued with trauma follow-up.

His past medical history was non-contributory. He was ill-looking, with swelling of the upper lip involving the upper labial compartment. Intraorally, he had an intact dentition except for third molars, with satisfactory oral hygiene. Tooth 11 was discolored and exhibited severe tenderness to percussion.

Sensibility testing gave positive results for 13, 12, 13, 21, and 22, while 11 gave a negative response to both the electric pulp tester and heated gutta-percha. A periapical radiograph of the 11 region showed a large peri-apical radiolucency in relation to 11, which was an open apex (Figure 2 a).

Based on clinical and radiographic findings, it was diagnosed as an acute apical abscess involving the upper labial compartment due to non-vital 11 associated with a large apical lesion. After discussing with the patient and parents, the following care plan was formulated.

1. Endodontic treatment of 11 with a short-term dressing of calcium hydroxide
2. Apical plug of MTA to achieve apexification
3. Obturation of the rest of the root canal with gutta-percha
4. Non-vital bleaching of 11
5. Review

After obtaining the written informed consent, the root canal treatment of 11 was dressed with calcium hydroxide for one month. As the patient was free of symptoms at the one-month's recall visit, it was decided to continue with the rest of the treatment plan. Calcium hydroxide was removed from the root canal of 11, and the root canal length was re-measured. MTA was placed up to the measured working length (21 mm), achieving a 3-5 mm thickness of MTA at the apical third. The post-operative radiograph showed satisfactory MTA placement at the apex (Figure 2 b). After 72 hours, the patient was recalled, and the rest of the root canal was obturated with gutta-percha using the cold lateral condensation technique (Figure 2c). After close monitoring of the patient for six months, a non-vital bleaching of 11 was performed. The patient is still being followed up in the clinic.

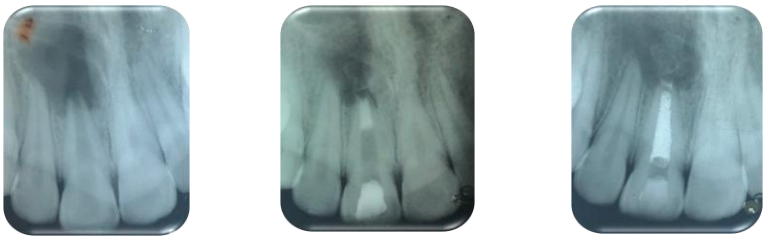


Figure 2. Pre-operative radiograph of 11 (a), after placement of MTA at the apex (b), obturation of 11 with gutta percha (c)

Case 3

An otherwise healthy 45-year-old male presented with pain on biting in relation to a lower right posterior tooth. History revealed a previous root canal treatment performed two months ago.

On intraoral examination, all teeth were present except for 47 and 48. 46 had a light-cured composite restoration and was tender to percussion. The periapical radiograph showed over-extended obturation with a lateral perforation in one of the mesial canals, an instrument separation in the apical third, and an overhanging restoration on the distal side of the restoration (Figure 3a). Root canal obturation in all other canals was satisfactory. The periapical radiograph (Figure 3a), taken with the tube mesially shifted, showed that the perforation and the file separation were in the mesiolingual canal. (Ingle's MBD rule, "Shoot from the mesial and the buccal root will be distal", was applied).

Based on the history, examination, and investigation findings, it was diagnosed as localized peri-apical periodontitis due to lateral perforation in 46. It was decided to perform re-root canal treatment with initial calcium hydroxide dressing, followed by obturation of canals with gutta-percha after repairing the perforation with MTA.

Informed written consent was taken. Gutta-percha in all four canals was removed using Hedstrom files. The separated file in the apical third of the mesiolingual canal could not be retrieved. Calcium hydroxide dressing was placed in 46, and the patient was recalled in two weeks. As the patient was out of symptoms, it was decided to proceed with the root canal obturation.

The working length was measured with an apex locator and confirmed with a radiograph. In the mesiolingual canal, the working length was recorded as 16 mm up to the perforation. After thorough chemo-mechanical debridement, MTA was placed up to the perforation in the mesiolingual canal using an MTA carrier. It was condensed in place using a Buchanan plugger. Then, the remaining part of the root canal and other canals were obturated with gutta-percha (Figure 3b). The post-operative radiograph showed satisfactory obturation and perforation repair. The access was then sealed with a light-cured composite restoration.

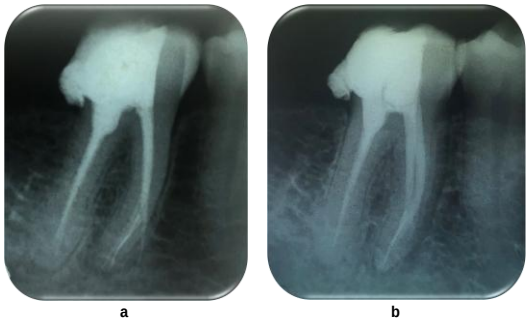


Figure 3. Periapical radiograph of 46 (a), radiograph of 46 after MTA placement and obturation (b)

The second molar tooth missing in the same quadrant was not replaced, adapting to the Shortened Dental Arch (SDA) concept, as the remaining dentition was intact. A subsequent appointment was arranged to correct the overhanging restoration on the tooth. The patient is asymptomatic and recently completed

the six-month recall appointment. Figure 3: Periapical radiograph of 46 (a), radiograph of 46 after MTA placement and obturation (b).

Case 4

A 20-year-old female was referred to the Restorative Dentistry Unit from the Outpatient Department for the management of pain from biting from 36. History revealed a previous root canal treatment and restoration performed three years ago. Her past medical history was not significant.

She had an intact permanent dentition except for third molars. 36 had a heavy, light-cured composite restoration with mild tenderness to percussion. A periapical radiograph showed a metal post perforating the floor of the pulp chamber (Figure 4a). Furcation radiolucency was present, and root canal obturation was reasonably acceptable.

Based on the history, examination, and investigation findings, it was diagnosed as furcation perforation due to a metal post in 36. The patient was informed about the guarded prognosis of the tooth, and it was decided to remove the metal post, repair the perforation with MTA, and then build up the tooth with light-cured composite. Informed written consent was taken. The existing composite restoration in 36 was carefully removed without damaging the head of the metal post. Once the metal post was relieved from the restoration, the post was removed using a post remover (Gold Plated Screw Posts®, Swe Dent). The pulp chamber floor was thoroughly excavated and irrigated with sodium hypochlorite. After achieving hemostasis at the perforation site, the area was dried, and a 1.5-2 mm thickness of MTA was applied over the perforated floor (Figure 4b). Moist cotton was placed, and a temporary restoration was applied to seal the cavity. Three days later, the patient was recalled, and the cavity was built up with a light-cured composite restoration. The patient was asymptomatic at the six-month recall appointment.

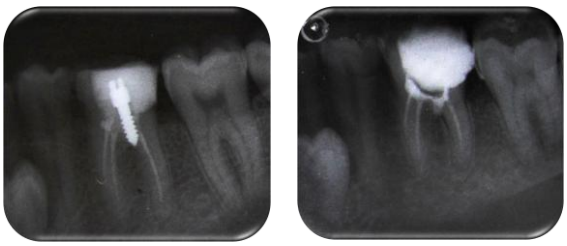


Figure 4. Pre-operative radiograph of 36 (a), post-operative radiograph of 36 after repair of the perforation (b)

Case 5

An 8-year-old boy presented with a fractured upper front tooth following a sports injury the previous evening. His past medical history was not significant. Extra oral examination revealed that there were no wounds or lacerations.

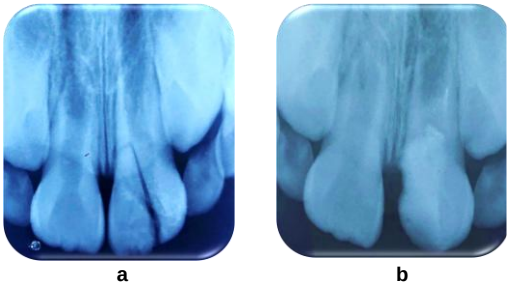
He had a mixed dentition with satisfactory oral hygiene. 21 was split obliquely, involving the pulp, and the mesial fragment was mobile. The fracture line extended sub-gingivally. Adjacent teeth were clinically stable.

Teeth 11, 21, 22, 31, and 41 gave positive responses to the electric pulp tester and heated gutta-percha. A periapical radiograph of 21 showed an oblique crown-root fracture across the pulp (Figure 5a). Both 11 and 21 had immature roots with wide open apices.

Based on the history, clinical examination, and investigation findings, it was diagnosed as a complicated crown root fracture of 21. The patient and parents were informed about the guarded prognosis of the tooth, and the following treatment plan was designed:

1. Removal of the mobile fragment of 21.
2. Radicular pulpotomy with MTA to achieve apexogenesis.
3. Light-cured composite restoration of 21.
4. Review.

Informed written consent was taken, and the mobile mesial fragment was removed under local anesthesia. The fracture line was just apical to the alveolar crest. Hemostasis was obtained, and the pulp was removed 2-3 mm below the fracture line until no copious bleeding was observed from the radicular pulp. The split rubber dam technique was used for isolation. The exposed pulp was irrigated with saline. A mixed 1.5-2 mm thickness of MTA was applied over the exposed healthy pulp, and the cavity was restored with glass ionomer cement. A periapical radiograph showed satisfactory radicular pulpotomy (Figure 5b). The patient was recalled in a week, and the tooth was restored with light-cured composite. The patient is still being reviewed in the clinic.



a b

Figure 5. Pre-operative radiograph of 21 (a), following radicular pulpotomy with MTA (b)

DISCUSSION

MTA was developed from commercial Portland cement with the addition of bismuth oxide powder for dental purposes. It is composed of tricalcium silicate, tricalcium aluminate, tricalcium oxide, and silicate oxide. Bismuth oxide is added as a radiopacifier (Lee et al. 1993). It has been widely used in endodontics for various treatments, such as direct pulp capping, retrograde filling, apexification (root-end induction), perforation repair, and treating internal root resorption. Moreover, it has several advantages, including biocompatibility, bacteriostatic activity, good sealing ability, and the ability to set in the presence of moisture (Roberts et al. 2008, Petta et al. 2020).

MTA, when placed in direct contact with human substances, releases calcium ions for cell proliferation and creates an antibacterial environment with its alkaline pH, regulating cytokine productio (Cervino et al. 2020). In the apexification of necrotic immature teeth, MTA is used as part of a two-step apical barrier (Milani et al. 2014, Roberts et al. 2008). MTA used for a height of 3-5 mm provides an excellent seal, which improves with time (Martin et al. 2007). The reason for time-related improvement is the deposition of apatite (Martin et al. 2007). It is also emphasized that there is no advantage in filling the whole root canal with MTA, as no additional strength is gained by this means.

Pulp therapy is performed to maintain the vitality of the remaining pulp tissue. The main advantage is that the pulp's continuous

physiological activities enable secondary dentine formation to be not affected. It also facilitates continuous root formation in all dimensions. By doing so the root walls become thicker, healthier, and resistant to fracture. It has also been used with success in direct capping and apexifications instead of calcium hydroxide, leading to quicker therapies and more predictable outcomes (Casella and Ferlito 2006). MTA produces better dentine healing than calcium hydroxide (Bonte et al., 2015). Leye Benoist et al. discovered that MTA has a higher success rate than calcium hydroxide (Leye Benoist et al. 2012). MTA provides a statistically significant success rate compared to calcium hydroxide (Dycal®) after three months when used as a direct pulp capping material (Leye Benoist et al. 2012). Research on pulpotomy reveals that MTA groups had a 100% success rate at 24 months, as opposed to 89.4% with Biodentine (Çelik et al. 2019).

Root canal therapy (RCT) is performed to maintain and restore the function of a tooth as a healthy component of the dentition without pathology. As in all other treatment protocols, this treatment is not free of complications. Common reasons for failure include aberrant anatomy, ongoing infections, and iatrogenic reasons. RCT involves cleaning, shaping, decontamination, and ultimate obturation of the root canals (Li et al. 2021). When there are complications, the common option is to perform surgical endodontics, which comprises a surgical procedure involving apicectomy and a retrograde restoration that seals the root canal from the root apex (Li et al. 2021). The inherent hassles of surgical treatment are embraced in this procedure. MTA was originally used as a retrograde filling after apicectomy, and sonic vibration improves the sealing ability (Bernabé et al. 2013).

As a root-end material in dentistry, MTA is biocompatible, radiopaque, and fast-hardening. The set material is resistant to infiltration and offers excellent sealing capacities compared to contemporary materials such as amalgam, glass ionomer cement, Super-EBA, and IRM (Bonte et al., 2015).

Having a good apical seal by ortho-grade route means that, with MTA, through the root canal access cavity prevents any surgical procedure. It also has the advantage of maintaining a long-term alkaline environment inducing healing. In the worst scenario even if the surgical endodontics is planned, cumbersome and unreliable retrograde restoration is prevented. Just the contouring of the apex is adequate, as MTA is already placed in the canal for a length of 3-4 mm.

MTA has some known drawbacks, such as lengthy setting time, high cost, and potential for discoloration (Parirokh & Torabinejad 2010). MTA prices have significantly decreased in recent years. Discoloration is yet another known disadvantage. The discoloration is often disregarded, weighing the advantages of its use in teeth with compromised tooth material as in pulpotomy. These teeth with the least amount of tooth substance will ultimately need crowns thus the discoloration would not be a concern.

The results confirm that MTA without matrix provides an effective seal for root perforations and promotes clinical healing of the surrounding periodontal tissue (Pace et al., 2008, Hosoya et al., 2019). It has been successfully used in lateral perforations (Lee et al., 1993).

CONCLUSION

The case series proves the clinical success of MTA in managing different endodontic complications. Careful case selection, evidence-based application, and skillful placement of MTA are mandatory in achieving the goals.

DATA AVAILABILITY STATEMENT

Radiographs are contained within the manuscript. It also contains details of the patient. Any additional data can be produced on request.

FUNDING/FINANCIAL ASSISTANCE

The cases described were performed at the Colombo South Teaching Hospital (CSTH), Sri Lanka, and the treatment was performed free of charge to the patients.

REFERENCES

Bernabé, PF, Gomes-Filho, JE, Bernabé, DG, Nery, MJ, Otoboni-Filho, JA, Dezan, E, Jr & Cintra, LT 2013. Sealing ability of MTA used as a root end filling material: effect of the sonic and ultrasonic condensation. *Braz Dent J,* 24**,** 107-10.

Bonte, E, Beslot, A, Boukpessi, T & Lasfargues, JJ 2015. MTA versus $Ca(OH)_2$ in apexification of non-vital immature permanent teeth: a randomized clinical trial comparison. *Clin Oral Investig,* 19**,** 1381-8.

Casella, G & Ferlito, S 2006. The use of mineral trioxide aggregate in endodontics. *Minerva Stomatol,* 55**,** 123-43.

Çelik, BN, Mutluay, MS, Arıkan, V & Sarı, Ş 2019. The evaluation of MTA and Biodentine as a pulpotomy materials for carious exposures in primary teeth. *Clin Oral Investig,* 23**,** 661-666.

Cervino, G, Laino, L, D'amico, C, Russo, D, Nucci, L, Amoroso, G, Gorassini, F, Tepedino, M, Terranova, A, Gambino, D, Mastroieni, R, Tözüm, MD & Fiorillo, L 2020. Mineral Trioxide Aggregate Applications in Endodontics: A Review. *Eur J Dent,* 14**,** 683-691.

Chong, BS (ed), Harty's Endodontics in Clinical Practice (Sixth Edition), Churchill Livingstone; 2010.

Hosoya, N, Takigawa, T, Horie, T., Maeda, H, Yamamoto, Y, Momoi, Y, Yamamoto, K & Okiji, T 2019. A review of the literature on the efficacy of mineral trioxide aggregate in conservative dentistry. *Dent Mater J,* 38**,** 693-700.

Lee, SJ, Monsef, M. & Torabinejad, M 1993. Sealing ability of a mineral trioxide aggregate for repair of lateral root perforations. *J Endod,* 19**,** 541-4.

Leye Benoist, F, Gaye Ndiaye, F, Kane, A W, Benoist, HM & Farge, P 2012. Evaluation of mineral trioxide aggregate (MTA) versus calcium hydroxide cement (Dycal(®)) in the formation of a dentine bridge: a randomised controlled trial. *Int Dent J,* 62**,** 33-9.

Li, H, Guo, Z, Li, C, Ma, X, Wang, Y, Zhou, X, Johnson, TM & Huang, D 2021. Materials for retrograde filling in root canal therapy. *Cochrane Database Syst Rev,* 10**,** Cd005517.

Martin, RL, Monticelli, F, Brackett, WW, Loushine, RJ, Rockman, RA, Ferrari, M, Pashley, DH & Tay, FR 2007. Sealing properties of mineral trioxide aggregate orthograde apical plugs and root fillings in an in vitro apexification model. *J Endod,* 33**,** 272-5.

Milani, AS, Jafarabadi, MA & Pakdel, MV 2014. Using mineral trioxide aggregate powder as an apical barrier: a bacterial leakage study. *Gen Dent,* 62**,** 55-9.

Pace, R, Giuliani, V & Pagavino, G 2008. Mineral trioxide aggregate as repair material for furcal perforation: case series. *J Endod,* 34**,** 1130-3.

Petta, TM, Pedroni, ACF, Saavedra, DF, Faial, K, Marques, MM & Couto, RSD 2020. The effect of three different pulp capping cements on mineralization of dental pulp stem cells. *Dent Mater J,* 39**,** 222-228.

Roberts, HW, Toth, JM, Berzins, DW & Charlton, DG 2008. Mineral trioxide aggregate material use in endodontic treatment: a review of the literature. *Dent Mater,* 24**,** 149-64.

Torabinejad, M Hong, Cu. Lee, Sj. Monsef, M. Pittford, Tr. Investigation of mineral trioxide aggregate for root-end filling in dogs. *J Endod.* 1995 Dec;21(12):603–8.

Parirokh, M Torabinejad, M Mineral trioxide aggregate: a comprehensive literature review--Part III: Clinical applications, drawbacks, and mechanism of action. *J Endod*. 2010 Mar;36(3):400–13.