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A comparative study of white and grey mineral trioxide aggregate as pulp capping agents in dog's teeth

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Abstract – Mineral trioxide aggregate (MTA) is widely used for different perforation repairs, root-end filling, pulp capping and many other endodontic procedures. Because of potential discoloration effect of gray MTA, white MTA has been introduced into endodontic treatment for the same purposes. This study examined the dental pulp responses in dogs to both types of MTA used as a pulp-capping agent. The pulps of 24 teeth of four male dogs were exposed with a No.1 round bur and capped with either gray or white MTA. Histologic analysis was performed one and 2 weeks after treatment. Calcified bridge could be seen 1 week after treatment with both types of MTA, with no significant differences between the two treatments.

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Key words: gray MTA; pulp capping; white MTA

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Vital Pulp capping is the dressing of exposed pulp with the aim of maintaining pulp vitality (1). It has long been recognized that traumatic exposure of the dental pulp can be successfully treated with calcium hydroxide preparations that produce calcified bridges across the wound surface (2–4). A number of new agents have been introduced during recent years. Of these, mineral trioxide aggregate (MTA), introduced by Torabinejad and colleagues at Loma Linda University, has been suggested to have more predictable effects in pulp capping than previously used materials (5–9). One of MTA's main properties is the ability to seal communication between the pulp and the external environment (5, 6). MTA has demonstrated minimal leakage of dye and bacteria in comparison with other restorative materials (10–12). In addition to pulp capping procedures, MTA has been recommended for radicular perforations, retrofilling and apexification (13, 14).

However, the gray color of the original MTA (GMTA) may cause tooth discoloration particularly when it is used to cap or seal a perforation site in incisors (15). Recently white MTA (WMTA) has been introduced in order to address this issue (15, 16). Holland and associates in their subcutaneous study showed that the mechanisms of action of WMTA and GMTA are similar (16). Although the composition differences of the two types of MTA have not been reported, the ingredients that alter the color may change the overall properties. The purpose of this study was to compare GMTA with WMTA when used as pulp capping agent in dogs.

Method and materials

Twenty-four teeth in four healthy 18–24 months old male beagle dogs were used. All experimental procedures were carried out according to protocols approved by the Ethics Committee of Research of

Kerman University of Medical Sciences. Under general anesthesia with intramuscular injection of 20 mg kg^{-1} Ketamine HCl (Dantex-Holland, Alfasan, Woerden, the Netherlands) and 0.2 mg kg^{-1} Xylazine (Bayer, Munich, Germany), dog's teeth were rinsed by 0.5% chlorhexidine. An infiltration injection with mepivacaine 3% (ESPE Dental AG, Seefeld, Germany) was used for local anesthesia and the teeth were isolated by rubber dam. Using a No.1 round bur in a high-speed hand piece with copious water spray cavities were prepared in labial surface of the teeth and standardized pulp exposures (1 mm in diameter) were obtained. Bleeding was controlled by irrigation with sterile saline and cotton pellets before placing the pulp capping materials. Both types of MTA [Pro-Root MTA (GMTA) and Tooth Colored MTA (WMTA) Dentsply, Tulsa Dental, Tulsa, OK, USA] were prepared according to the manufacturer's directions with MTA powders and sterile saline in a 3:1 ratio to provide putty mixture. Next, exposure sites and the cavities were covered and filled with one type of MTA. After 1 and 2-week intervals, vital perfusion fixation was performed with Karnovsky solution. Then teeth and their surrounding tissues were removed and the teeth were placed in 2.5% gluteraldehyde solution for 14 days and then all of the specimens were placed in 10% formic acid for 28 days. Following decalcification, specimens were prepared for standard pathologic processing. Six micrometer sections were cut in buccolingual direction every 100 μm and stained with Hematoxylin and Eosin (H&E). All of the samples were analyzed for necrosis, calcified bridge formation, inflammation (Acute or chronic), odontoblast configuration and resorption under a light microscope (Ziess, Göttingen, Germany). All specimens were seen by an oral pathologist who was not aware of the types of capping materials and time intervals.

Results

One week

In four WMTA and three GMTA samples a thin layer of complete calcified bridge could be seen. None of the capped teeth showed necrosis close to the exposure site. Odontoblasts like cells were observed at the periphery and under the calcified bridge (Fig. 1). The thickness of calcified bridges was greater at the border of the exposed area than in the center (Fig. 2a,b). The bridge material was amorphous and non-tubular. Mild inflammation as a few macrophages and lymphocyte could be seen under the odontoblast like cells. There were no significant differences between both types of MTA (Table 1).

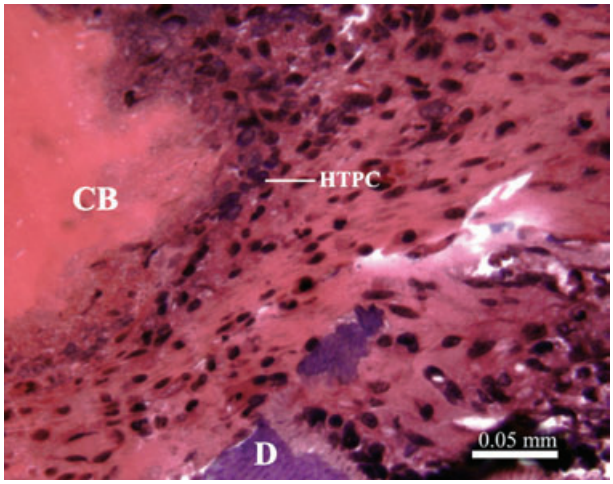

Fig. 1. High magnification of hard tissue productive cells (HTPC) just underneath of complete calcified bridge (CCB) after 1 week. D, dentin.

Two weeks

All of the specimens from both types of MTA except two GMTA samples showed complete calcified bridge formation just below the exposure site (Fig. 3a,b). The thickness of the bridge had increased and scattered inflammatory cells could be seen, but the numbers of inflammatory cells were less than in the 1-week specimens. The GMTA specimens that did not demonstrate calcified bridges had dense connective tissue in the exposure site (Fig. 4). Similar to the 1-week specimens, the calcified bridge was thicker in the periphery of the exposure sites than in the middle of the bridge. In many specimens calcified areas were scattered like islands in the center of the pulp (Fig. 5). In both types of MTA, the dentinal wall across from the exposure site showed areas of resorption and deposition of dentin (Fig. 5). Histologic evaluation also showed several large blood vessels without congestion far from the pulp.

Discussion

Currently, MTA is widely used for pulp capping, root-end filling, and repair of root perforations (17). MTA is a powder that consists of fine hydrophilic particles that set in the presence of moisture (14).

Several previous studies have shown that the pulp responds favorably to the protection by a MTA layer (5–9). The reparative dentin was consistently thicker and more uniform under MTA compared with calcium hydroxide (5, 6).

The main purpose of this study was to compare the response of the pulp to white MTA compared with grey MTA. Previous investigations (5, 6) have

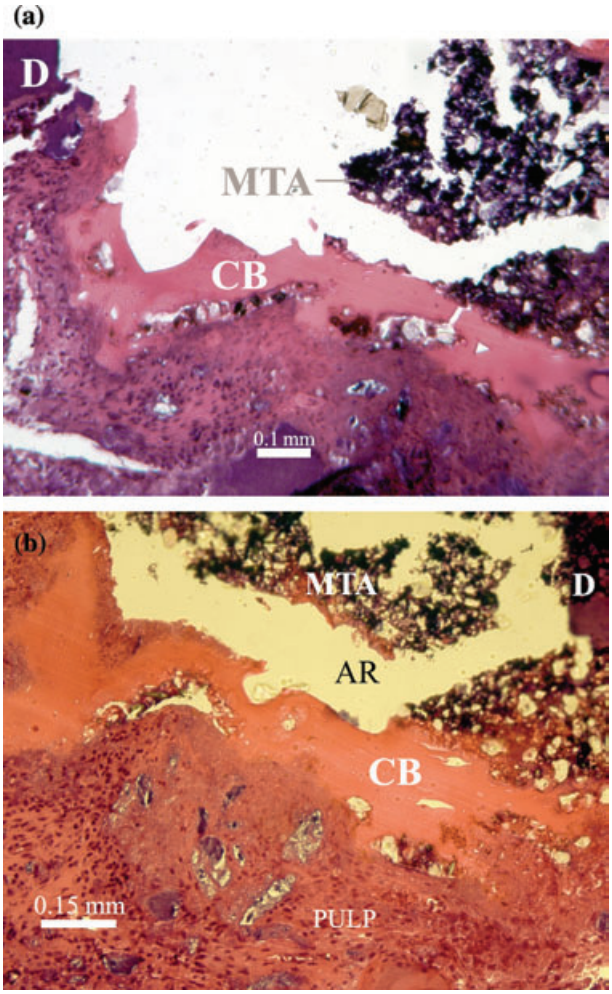

Fig. 2. Complete calcified bridge (CCB) formation after 1 week in both types of mineral trioxide aggregate (MTA). (a) Grey MTA and (b) White MTA. D, dentin.

Table 1. Pulpal responses in samples capped with grey mineral trioxide aggregate (GMTA) and white MTA

		Inflammation		Hard tissue formation		
Samples	Number of cases	Acute	Chronic	Bridge formation	Mid pulp calcification	Resorption and deposition
1 week						
WMTA	6	0	6	4	0	0
GMTA	6	0	6	3	0	0
2 weeks						
WMTA	6	0	6	6	4	4
GMTA	6	0	6	4	4	4

compared calcium hydroxide and MTA and have shown that MTA has significantly better results. Therefore, in this study authors elected not to include calcium hydroxide and instead used grey MTA as a gold standard to compare against.

Hebling and associate showed that after 7 days, the pulp tissue capped with the calcium hydroxide exhibited odontoblast like cells organized underneath

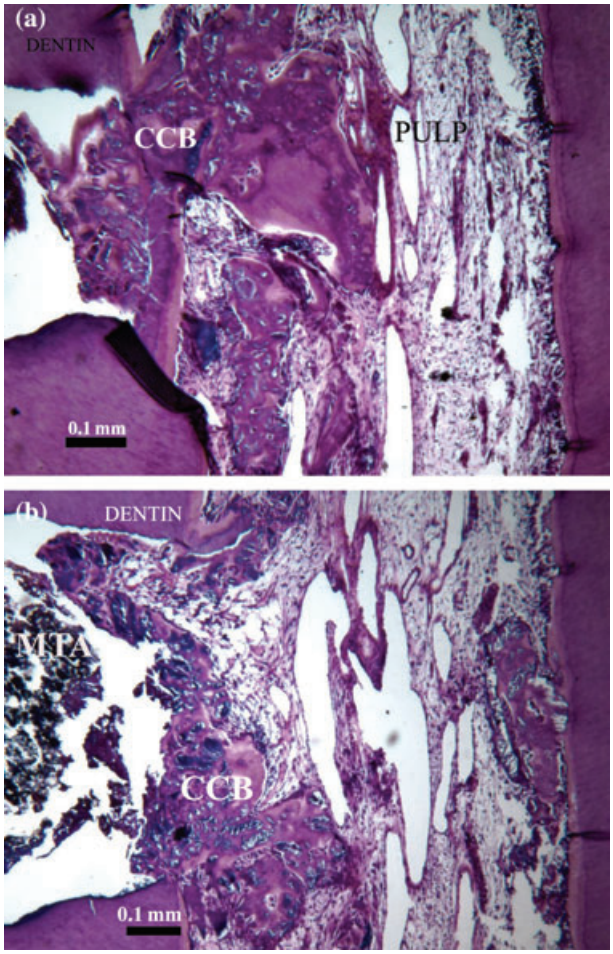

Fig. 3. Complete calcified bridge (CCB) formations after 2 weeks in both types of mineral trioxide aggregate (MTA). (a) Grey MTA and (b) White MTA.

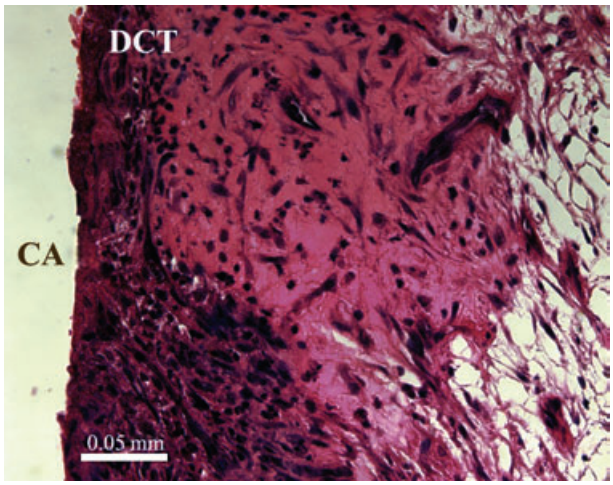

Fig. 4. Dense connective tissue (DCT) in 2 weeks grey mineral trioxide aggretage (GMTA) specimens which is ready to make hard tissue under capping materials. CA, floor of the cavity.

coagulation necrosis (18). Tezifas and associates in their study showed that after 2 weeks, there was a thin layer of calcified bridge on pulp exposure sites

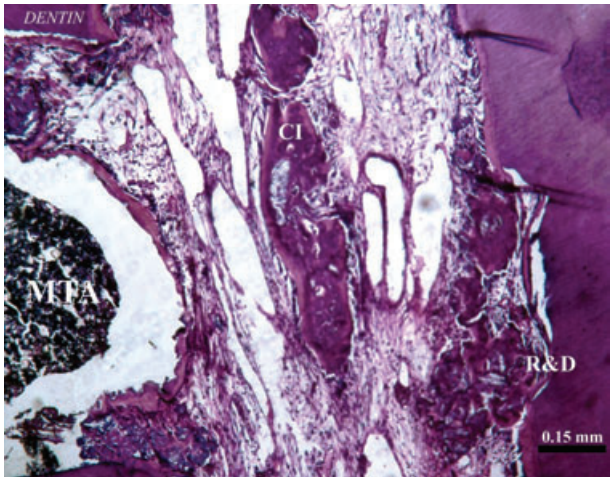

Fig. 5. Calcified areas were scattered like island (CI) in the middle area of the pulp. Resorption and deposition (R&D) of dentin in opposite wall of exposure site could be seen too.

when they used GMTA (8). In this study many hard tissue productive cells could be seen at 7 days under thin calcified bridge at the capping site.

Although it is important to have a calcified bridge under capping materials, but making a dentinal bridge may be a sign of either healing or irritation (19, 20). Therefore in judging the efficacy of a material as a pulp-capping agent, it is important to determine the presence or absence of inflammation (type and severity), necrosis and resorption of dentinal walls in addition to calcified bridge formation (20). The results of this study showed that in the short term there is no differences in production of hard tissue and inflammation between GMTA and WMTA as pulp capping material. In addition there were not any sign of necrosis in pulp tissue after capping with neither WMTA nor GMTA.

The presence of bacteria and their byproducts is one of the most important reasons for failure of pulp capping (5). It has been stated that along with pulpal health, provision of a seal against bacterial ingress is probably the most critical factor in the success of vital pulp therapy (21). In addition when a practitioner caps and fills the cavity with MTA it is necessary to use gentle pressure to pack the MTA and minimize any harmful effect on pulp tissues which would have been injured during cavity preparation. If amalgam is used as a final restoration just after pulp capping, more pressure will be needed to condense it and may dislodge MTA, which is not yet set at that time.

Cox and associates have shown that pulp healing is more dependent on the capacity of the capping material to prevent bacterial microleakage rather than the specific properties of the material itself (22). Therefore, if a tight seal is achieved and reasonable material is selected, mature dental pulp possesses the ability to differentiate into the specific cell lineage forming tubular dentine (23).

As recommended by Torabinejad and Chivian, use of MTA as a dressing material could help pulp to recover promptly. However, it would be more suitable dressing in cavities, which have no or little occlusal stress such as class V cavities (17). The lack of difference in calcified bridge formation between the two treatments in this study is evidence that WMTA as well as GMTA may allow minimal leakage.

Resorption and deposition on dentinal walls just opposite the exposure area were seen in teeth which were treated with either GMTA or WMTA at 2 weeks. The same effect after pulp capping has been shown by other authors (24). Mid-pulp calcification may be a consequence of MTA and dentinal chips being pushed into the subjacent pulp during the mechanical exposure and filling as have been seen by other researches (6, 24).

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References

1. Stockton LW. Vital pulp capping: a worthwhile procedure. J Can Dent Assoc 1999;65:328–31.
2. Stanley HR, Lundy T. Dycal therapy for pulp exposure. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1972;34:818–27.
3. Tronstad L. Reaction of exposed pulp to Dycal treatment. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1974;38:945–53.
4. Cox CF, Bergenholtz G, Heys DR, Syed SA, Fitzgerald M, Heys RJ. Pulp capping of dental pulp mechanically exposed to oral microflora: a 1–2 year observation of wound healing in monkey. J Oral Pathol 1985;14:156–68.
5. Pitt Ford TR, Torabinejad M, Abedi HR, Bakland LK, Kariawasam SP. Using mineral trioxide aggregate as a pulp capping material. JADA 1996;127:1491–94.
6. Faraco IM Jr, Holland R. Response of the pulp of dogs to capping with mineral trioxide aggregate or a calcium hydroxide cement. Endod Dent Traumatol 2001;17:163–6.
7. Aeinehchi M, Eslami B, Ganbariha M, Saffar AS. Mineral trioxide aggregate (MTA) and calcium hydroxide as pulp capping agents in human teeth: a preliminary report. Int Endod J 2003;36:225–31.
8. Tziafas D, Pantelidu O, Alvanou A, Belibasakis G, Papadimitriou S. The dentinogenic effect of mineral trioxide aggregate (MTA) in short term capping experiments. Int Endod J 2002;35:245–54.
9. Abedi HR, Torabinejad M, Pitt Ford TR, Bakland LK. The use of mineral trioxide aggregate cement (MTA) as a direct pulp capping agent (Abstract). J Endod 1996;22:199.

10. Torabinejad M, Hong CU, Pitt Ford TR, Karyawasam SP. Dye leakage of four root end filling materials: effect of blood contamination. J Endod 1994;20:159–63.
11. Nakata TT, Bae KS, Baumgartner JC. Perforation repair comparing mineral trioxide aggregate and amalgam using an anaerobic bacterial leakage model. J Endod 1998;24:184–6.
12. Torabinejad M, Rastegar AF, Kettering JD, Pitt Ford TR. Bacterial leakage of mineral trioxide aggregate as a root end filling material. J Endod 1995;21:109–12.
13. Wu MK, Kantakiotis EG, Wesselink PR. Long-term seal provided by some root-end filling material. J Endod 1998;24:557–60.
14. Torabinejad M, Hong CU, McDonald F, Pitt Ford TR. Physical and chemical properties of a new root-end filling material. J Endod 1995;21:349–53.
15. Glickman GN, Kennth A. 21st-Century endodontics. JADA 2000;131:39–46.
16. Holland R, de Souza VD, Nery MJ, Faraco Junior IM, Bernabe PFE, Otobni Filho JA et al. Reaction of rat connective tissue to implanted dentin tubes filled with a white mineral trioxide aggregate. Braz Dent J 2002;13:23–6.
17. Torabinejad M, Chivian N. Clinical applications of mineral trioxide aggregate. J Endod 1999;25:197–205.
18. Hebling J, Giro EMA, de Souza Costa CA. Biocompatibility of an adhesive system applied to exposed human dental pulp. J Endod 1999;25:676–82.
19. Schuurs AHB, Gruythuysen RJM, Wesselink PR. Pulp capping with adhesive resin based composite versus calcium hydroxide: a review. Endod Dent Traumatol 2000;16:240–50.
20. Mjør IA. Pulp reactions to calcium hydroxide-containing materials. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1972;33:961–5.
21. Swift EJ, Trope M, Ritter AV. Vital pulp therapy for the mature tooth – can it work? Endod Topics 2003;5:49–56.
22. Cox CF, Keall CL, Keall HJ, Ostro E, Bergenholtz G. Biocompatability of surface sealed dental materials against exposed pulps. J Prosthetic Dent 1987;57:1–8.
23. Smith AJ. Dentin formation and repair. In Hargreaves KM, Goodis HE, eds. Seltzer and Bender's Dental Pulp, Chapter 3, 3rd edn. Chicago: Quintessence Publishing Co; 2002. p. 41–62.
24. Cox CF, Bogen G, Kopel HM, Ruby JD. Repair of pulpal injury by dental materials. In Hargreaves KM, Goodis HE, eds. Seltzer and Bender's Dental Pulp, Chapter 14, 3rd edn. Chicago: Quintessence Publishing Co; 2002. p. 325–44.