Treatment of Tooth Discoloration after the Use of White Mineral Trioxide Aggregate

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Abstract

Introduction: A number of vital pulp therapy techniques have been recommended to preserve pulp vitality in teeth with complicated crown fractures, especially in young patients. Calcium hydroxide has been the gold standard as a pulp capping material, but recently mineral trioxide aggregate (MTA) has been recommended. This case report describes the treatment of tooth discoloration caused by white MTA (WMTA) used for the management of a complicated crown fracture. **Methods:** A partial pulpotomy was performed with the use of WMTA after a complicated crown fracture of the upper right central incisor. Seventeen months later, the WMTA was removed because of tooth discoloration, and internal bleaching was performed. **Results:** Upon access, the WMTA was completely discolored. After it was removed, a significant color change was observed in the tooth crown, which was further improved with internal bleaching. The tooth remained vital, and a dentin bridge was confirmed clinically and radiographically. **Conclusions:** The recommendation to use WMTA for vital pulp therapy in the esthetic zone may need to be reconsidered. Should discoloration occur with the use of WMTA, the technique described may be used to improve the esthetics. (*J Endod 2011;37:1017–1020*)

Key Words

Complicated crown fracture, mineral trioxide aggregate, partial pulpotomy, tooth discoloration

A complicated crown fracture involves enamel, dentin, and the pulp [1]. It is a relatively common type of dental trauma with a reported prevalence in the permanent dentition of 14% to 21% [2, 3].

A number of procedures have been recommended for the treatment of traumatically exposed pulps in young patients. The aim of treatment is to preserve pulp vitality to allow for continued physiological root development, including closure of the root apex and development of lateral root dentin. This treatment aims to prevent cervical root fractures caused by thin dentinal walls [4]. Vital pulp therapy in older patients is less predictable but can still be successful [5]. However, the decision whether to retain the pulp is usually governed by the amount of remaining tooth structure rather than the age of the patient.

Direct pulp capping is a procedure in which the capping agent is placed on the tissue that has been exposed to microorganisms and inflammation is present [6]. Partial pulpotomy, as described by Cvek [7], has an excellent prognosis and consists of the aseptic, surgical removal of the exposed pulp and dentin surrounding the exposure to a depth of 1.5 to 2.0 mm followed by sealing of the exposed pulp with a suitable material. Unlike direct pulp capping, the partial pulpotomy procedure creates space for the placement and retention of the pulp capping material. Calcium hydroxide has been the gold standard for vital pulp therapy since the 1930s [8]. However, the dentin bridge formed is porous, with multiple tunnel defects [9]. In some cases, it is associated with a chronic inflammatory response associated with the use of $Ca(OH)_2$ [10]. Subsequently, many materials have been shown to be biologically compatible with exposed pulps and permit an environment that is conductive to dentin bridge formation [11]. The healing of dental pulp exposures is not dependent on the type of pulp capping material but is related to the capacity of these materials to prevent bacterial leakage [11].

Mineral trioxide aggregate (MTA) has been shown to prevent dye and bacterial leakage and has a high level of biocompatibility [12, 13]. Based on animal and human studies, MTA is considered a suitable pulp capping material [5, 14–17]. Its use has been recommended for the treatment of complicated crown fractures [18].

One of the potential drawbacks of using gray MTA for vital pulp therapy in anterior teeth is the subsequent development of crown discoloration [19]. For this reason, white MTA (WMTA) was developed. Although it has been shown to be comparable to gray MTA as a pulp capping agent [20], reports show discoloration of WMTA *in vitro* and that WMTA discolors primary teeth *in vivo* after pulpotomy [21, 22]. The following case report describes the treatment of a complicated crown fracture in a permanent anterior tooth with WMTA and the favorable outcome of treatment for the resulting crown discoloration.
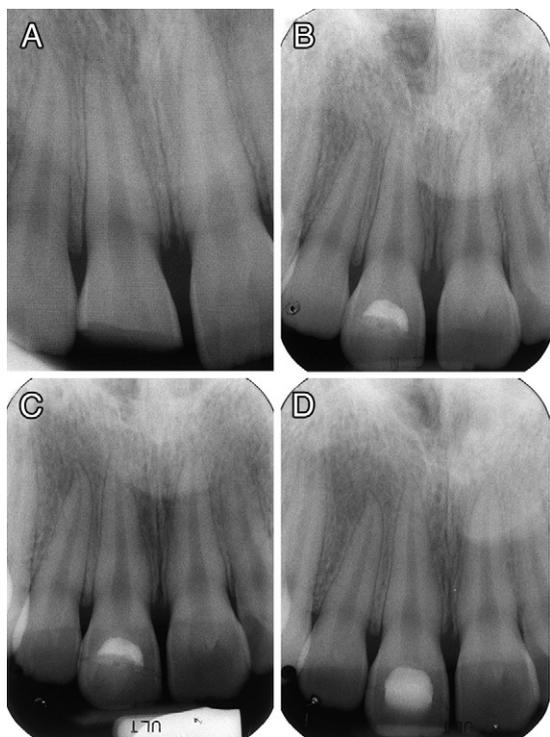
Case Report

A 12-year-old girl reported to the Emergency Department of the Royal Dental Hospital of Melbourne 4 hours after fracturing a tooth on the back of a chair. The

Figure 1. (*A*) A periapical radiograph of tooth #8 upon presentation. (*B*) The immediate postoperative radiograph showing the placement of WMTA and the reattachment of the coronal fragment. (*C*) A radiograph at 17 months showing the formation of hard-tissue bridge and root maturation. (*D*) A radiograph post-bleaching and restoration of the access cavity.

intraoral examination revealed a complicated crown fracture of the maxillary right central incisor (tooth #8). The fractured coronal fragment had been placed into a glass of milk. All teeth in the anterior segment of maxillary and mandibular arches responded to CO_2 pulp testing at the time of presentation. Radiographic examination (Fig. 1*A*) confirmed the clinical findings that tooth #8 had substantial coronal tooth structure remaining for restoration by reattachment of the coronal fragment or by a direct bonded resin composite restoration.

After the administration of local anesthesia, a partial pulpotomy was performed under rubber dam on tooth #8 using a high-speed size 2 round diamond bur with copious water coolant. The coronal pulp stump was rinsed with 1% sodium hypochlorite for 2 minutes until hemostasis was achieved. ProRoot WMTA (Dentsply Tulsa Dental, Tulsa, OK) was placed onto the pulp followed by Vitrebond (3M Dental Products Division, St Paul, MN), etching, Adper Single Bond Plus Adhesive (3M Espe, St Paul, MN), and flowable composite (Revolution Formula 2; Kerr, Orange, CA) to bond the coronal tooth fragment. The enamel surface at the fracture line was beveled, and a direct resin composite restoration (Tetric N-Ceram; Ivoclar Vivadent, Schaan, Liechtenstein) was placed to reinforce the two fragments (Fig. 1*B*). The patient was subsequently reviewed in the Endodontics Unit of the Royal Dental Hospital of Melbourne and did not report any immediate postoperative discomfort.

The patient was reviewed at 1, 5, and 17 months. Throughout the follow-up period, the maxillary anterior teeth remained asymptomatic and responsive to CO_2 pulp testing. At 1 month, a slight gray discoloration could be seen just apical to the fracture line (Fig. 2*A*). At 5 months, there was further evidence of crown discoloration (Fig. 2*B*).

At 17 months, the patient and her parents were concerned with the crown discoloration (Fig. 2*C*). The tooth responded to CO_2 pulp testing, and a hard tissue bridge and continued apical root maturation were

Figure 2. (*A*) An intraoral photograph at the 1-month follow-up. Note the slight gray discoloration apical to the fracture line. (*B*) Further crown discoloration at the 5-month recall. (*C*) Distinctly noticeable crown discoloration 17 months after partial pulpotomy with WMTA. (*D*) The removal of discolored WMTA.
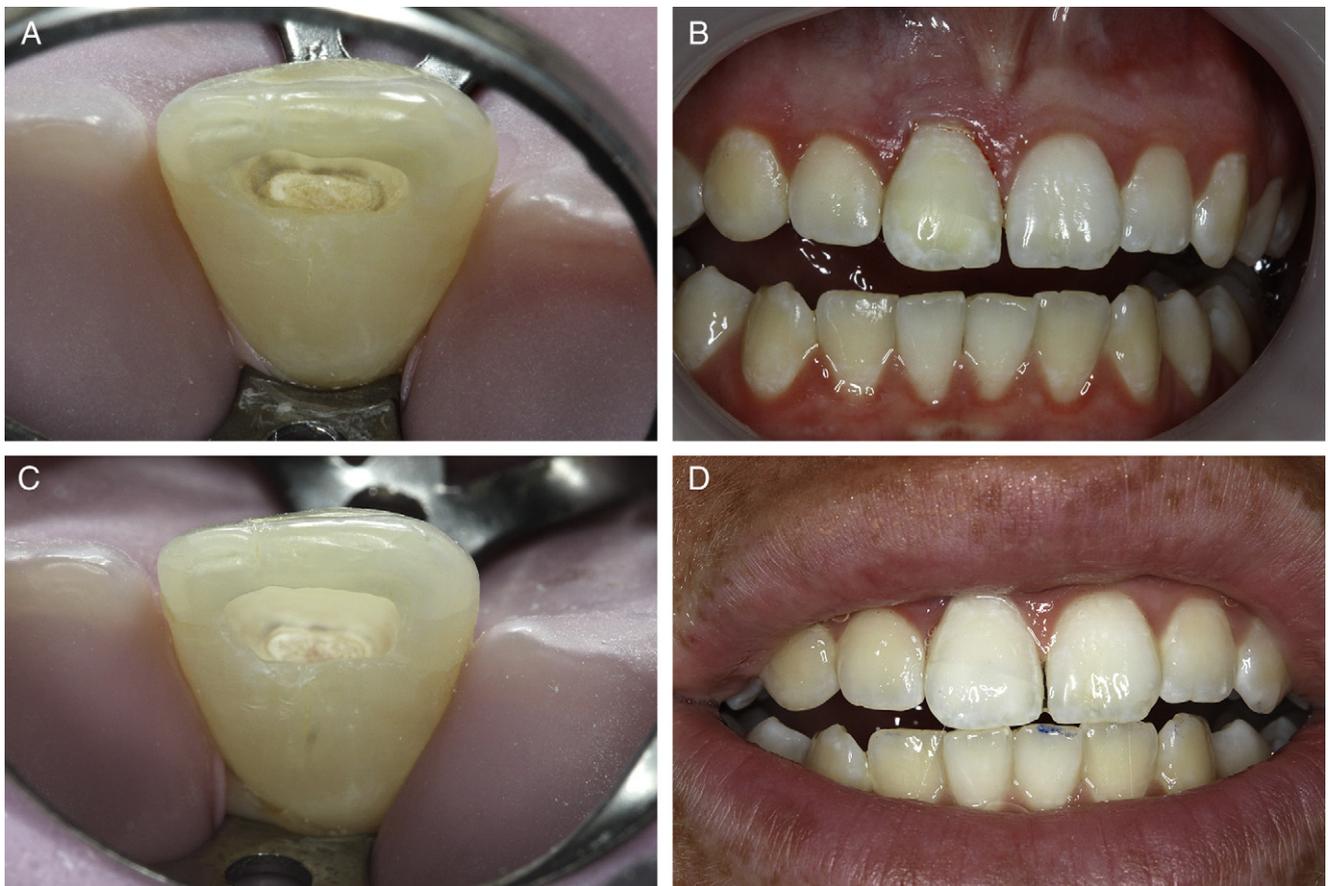
Figure 3. (*A*) All of the discolored WMTA was removed until a hard-tissue bridge was reached. (*B*) A noticeable improvement in the color of the crown could be seen immediately after the removal of discolored WMTA. (*C*) The dentin color after 1 week of internal bleaching. (*D*) The excellent esthetic result after the removal of discolored WMTA and internal bleaching.

radiographically evident (Fig. 1*C*). After discussion with the parents and the patient concerning internal bleaching, a local anesthetic was administered. Under a rubber dam, the pulp chamber was reaccessed. Using the operating microscope, a high-speed size 2 round stainless steel bur with water coolant was used to completely remove the discolored WMTA (Fig. 2*D*), exposing the hard-tissue bridge (Fig. 3*A*). The removal of WMTA was attempted using ultrasonics but was proved unsuccessful because of cutting inefficiency; therefore, the use of a high-speed bur with water cooling under a microscope was used, which was a quicker and just as conservative an option.

Considerable improvement in the color of the tooth was seen immediately after the removal of the discolored WMTA (Fig. 3*B*). At the same appointment, a mixture of sodium perborate and saline was placed in the access cavity to internally bleach the crown. No adverse pulpal effects were anticipated because of the lack of porosity in the dentine bridge formed after the use of MTA (10). Then, the access opening was sealed with Cavit W (3M, Dental Products Division, St Paul, MN).

The patient returned 1 week later asymptomatic, and the tooth was still responding to CO$_2$ pulp testing. Under rubber dam isolation, the tooth was reaccessed, and the internal bleaching paste was removed (Fig. 3*C*). The access cavity was subsequently restored with a polycarboxylate cement (Durelon, 3M ESPE) and resin composite restoration (Tetric N-Ceram). The labial composite was also replaced with a translucent (4 Seasons medium enamel value, Ivoclar Vivadent) composite resin restoration to match the patients improved esthetics (Figs. 1*D* and 3*D*). Because there was no noticeable improvement in the patient's oral

hygiene, further oral hygiene instructions were also provided. The patient was recalled 1 month later, and there was no change in the color of the crown; the tooth continued to respond to CO$_2$ pulp testing.

Discussion

This case confirmed that set WMTA was responsible for the gradual discoloration of tooth #8. The intraoral photograph in Figure 2*D* clearly distinguishes between the discolored WMTA and the surrounding dentin. The careful removal of WMTA under the operating microscope ensured that no additional tooth structure was removed. Although internal bleaching was used in this case, most of the discoloration was within the WMTA (Figs. 2*D* and 3*A*) and not in the dentin. Considerable improvement in crown color was achieved after the removal of the WMTA (Figs. 2*C* and 3*B*). Only a minor improvement was seen in the color of the dentin internally (Fig. 3*A* and *C*) after internal bleaching. Therefore, internal bleaching may not be required.

Although the biologic and the esthetic goals of treatment were achieved in this case, it may be reasonable to reconsider using WMTA for vital pulp therapy in the esthetic zone. Should discoloration occur after the use of WMTA in the esthetic zone, careful removal of set WMTA may be attempted after confirmation of dentin bridge formation.

Reattachment of the coronal fragment provides several advantages including exact restoration of crown morphology, reduced chair time, excellent esthetics, similar wear rate to opposing teeth, and a positive emotional response from the patient (23). When simple reattachment (ie, no preparation) is used, the use of resin composite in the adhesive

interface significantly increases the fracture strength compared with bonding agents only (24). Beveling of the margins further increases the fracture resistance and has been shown to have a better retention and esthetic prognosis than direct composite resin restoration (25).

MTA rather than calcium hydroxide was used for pulp capping after the partial pulpotomy. The main advantages of MTA are that it provides a good protective barrier against bacterial penetration (26) and is biocompatible (27). Furthermore, the presence of blood has little impact on the degree of leakage (12). It has also been shown that the bioactive property of MTA is superior (when compared with Ca[OH]$_2$ and other materials) in dentin bridge formation after pulp capping and pulpotomies (10, 17). Hence, the use of MTA has been recommended as the material of choice for vital pulp therapy (28, 29).

Because of the potential staining of tooth structure in an area in which esthetics is important, a white powder form of MTA was manufactured (30). However, *in vitro* studies have reported a gray discoloration of WMTA used in single-rooted human teeth and plastic blocks after the setting reaction (21, 31). In both studies, the material was affected in depth, which led the authors to speculate that a chemical reaction was responsible for the discoloration.

Histologically, MTA forms a superior dentin bridge with less underlying inflammation than Ca(OH)$_2$ (10, 14). It also has greater success for direct pulp capping carious exposures when there is bacterial presence (32). However, no clinical study has compared the use of MTA and Ca(OH)$_2$ after traumatic exposure of the pulp. Cvek (7) reported 96% success for partial pulpotomies using Ca(OH)$_2$. Therefore, the use of WMTA in the esthetic zone after traumatic exposure of the pulp, with its potential for discoloration of tooth structure, must be questioned.

Acknowledgments

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