CASE REPORT

MM-MTA® for a Complete Endodontic Obturation of an Avulsed Immature Permanent Incisor: A Case Report

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Abstract

The purpose of this report was to present the treatment of an avulsed immature necrotic permanent central incisor using the new mineral trioxide aggregate (MM-MTA®, Micro-Mega, Besançon, France) as an orthograde root filling. In such cases, the canal remains large, with thin and fragile walls, and the apex architecture remains divergent. This case demonstrates the efficacy of MTA in this particular situation as an effective material to support regeneration of apical tissue in immature necrotic teeth. External inflammatory resorption was detected after 3 months of the endodontic treatment. At the one-year follow-up, there were no clinical symptoms with radiographic healing of periradicular tissues, new hard-tissue formation in the apical area of the affected tooth and stabilization of the resorption.

Keywords: Apexification, avulsion, Mineral Trioxide Aggregate, obturation, resorption.

Introduction

Avulsion injuries of the tooth from the surrounding alveolar socket can result in pulp necrosis in immature teeth with open apices.(1, 2) Treatment of the immature non- vital tooth presents both endodontic and restorative challenge: the canal remains large, with thin and fragile walls and absence of apical constriction. These features make complete debridement, canal disinfection and obturation difficult (2, 3).

Traditionally, treatment for immature teeth involves creating a calcified barrier to promote formation of a hard apical barrier at the open apex through the process of apexification(4). It's defined by the American Association of Endodontics (AAE) as a method of inducing a calcified apical barrier or the continued apical development of an incompletely formed root in which the pulp is necrotic (2).

Several procedures by utilizing different materials have been recommended to induce root-end barrier formation. Apexification with calcium hydroxide is the most commonly advocated therapy for immature teeth with non-vital pulp and the healing rate has been reported to be high (5). However, the apexification procedure may take many months and require multiple visits, making patient compliance a problem (6). It may also further weaken the teeth and possibility of increased tooth fracture after the use of calcium hydroxide for extended periods. (For these reasons one visit apexification has been suggested. Mineral trioxide aggregate (MTA) has been proposed as a material suitable for one visit apexification. (7)

To date, mineral trioxide aggregate (MTA) has only been used to create an apical plug prior to final obturation with laterally condensed gutta-percha or thermoplastized gutta-percha.

The purpose of this paper was to report the use of mineral trioxide aggregate for complete endodontic obturation.

Case Report

A healthy 9-year-old male presented to the Emergency of the Department of Conservative Dentistry and Endodontic EPS Farhat–Hached, Sousse, Tunisia. The patient was injured from a fall during playing in school. The patient was accompanied by his father who came to the clinics 4 hours after the injury with teeth 11 totally avulsed and wrapped in tissue paper (Figure 1c, Figure 1d).

On the clinical examination, the patient did not show any signs or symptoms of neurological or craniofacial injury. Intraorally, right central incisor was avulsed, a blood clot was found in the alveolar socket and superficial lacerations were present in the maxillary attached gingiva around the avulsed tooth (Figure 1a). All of the adjacent teeth showed positive response to a vitality test. A stable, reproducible occlusion was present radiograph of the avulsed tooth was taken to detect any fracture of the tooth structure or adjoining hard tissue in that region (Figure1b).

The tooth was cleaned with saline to remove the necrotic periodontal tissue (Figure 2a). After local anesthesia; the blood clot was removed from the socket with a stream of saline (Figure 2b). The periodontal ligament was already necrotic and not expected to heal. Therefore, the control of bleeding during replantation was easy using surgical suction. The right central incisor was then replanted properly and splinted to the adjacent teeth by orthodontic wire splint stabilized by composite resin (Figure 3). Another periapical radiograph was obtained to confirm proper positioning of the replanted incisor (Figure 4). Amoxicillin syrup and a 0.12% chlorhexidine gluconate mouthrinse were prescribed. Instruction was given to the patient and his parent: Avoid participation in contact sports, soft diet for up to 2 weeks. Thereafter normal function as soon as possible, brush teeth with a soft toothbrush after each meal. A revascularization of the pulp after replantation cannot be expected because of the prolonged extraoral period. Therefore, the endodontic treatment was carried out after 7 days. After isolation with a rubber dam, the root canal was cleaned and shaped using rotary nickel-titanium instruments (Revo-S®, Micro-Mega, Besançon, France) and copiously irrigated with 2.5% sodium hypochlorite and 17% EDTA. The working lengths were determined using electronic apex locator (Rootor, META BIOMED Co,.Ltd. Korea) and established working lengths were controlled radiographically (Figure 5).Calcium hydroxide paste (MM-Paste™, Micro-Mega, Besançon, France) was placed as an intracanal medication . Then, the access cavity was sealed with a temporary filling (MD-Temp™, META BIOMED Co,Ltd. Korea). Calcium hydroxide was changed twice in order to achieve additional disinfection and neutralization of an acidic environment. A follow-up visit was scheduled for the patient for splint removal and further evaluation. Tooth 11 was stable with good gingival healing and physiological mobility.

The patient did not turn up for almost 2 months and reported no history of pain or symptoms. A clinical examination revealed that the maxillary central incisor response to percussion. A periapical radiograph showed an external inflammatory root resorption with periapical radiolucency (Figure 6). The canal was cleaned and irrigated with copious amount of sodium hypochlorite and dressed again with calcium hydroxide. The patient returned two weeks later for obturation with MTA (MM-MTA®, Micro-Mega, Besançon, France). The existing calcium hydroxide paste was removed and the canal was dried and obturated with the new MM-MTA® which consisting of capsules containing MM-MTA™ powder and liquid (Figure 7a). For activation of the MM-MTA Cap the plunger should be pressed on a hard and plane surface to the end into the MM-MTA Cap and then inserted into the MM-MTA Gun and click once to activate. Automatic mixing is achieved quickly with a vibrating mixer for 30 seconds. The resulting MM-MTA™ blend is extremely homogenous compared to the ProRoot MTA® (Dentsply, Tulsa, OK, USA). The pin was removed from the nozzle the MM-MTA Cap was inserted into the MM-MTA Gun. The lever was pulled 2 times (2 clicks) to prime the MM-MTA Cap. The mixed material was extruded directly on the cervical third of the root canal and the MM-MTA was condensed to the apical part (4 mm) using endodontic plugger (Figure 7b). The apical plug was checked radiographically and the canal was filled slightly with the rest of MM-MTA™ below the cement-enamel junction (Figure 7c). Condensation of MM-MTA™ was checked radiographically (Figure 8). After 3 days, the patient was referred back for final restoration of the lingual access with composite resin (Opallis®, FGM, Brazil).

At the 3 month follow-up, the patient was comfortable without symptoms. A periapical radiograph was taken and showed a considerable periapical healing with a decrease of the radiolucency, stabilization of the resorption process (Figure 9a). Six months later, the patient returns for additional radiographic follow-up showing an apical barrier without additional resorption (Figure 9b). Follow-up sessions were scheduled for every six months (Figure 9c, 9d).

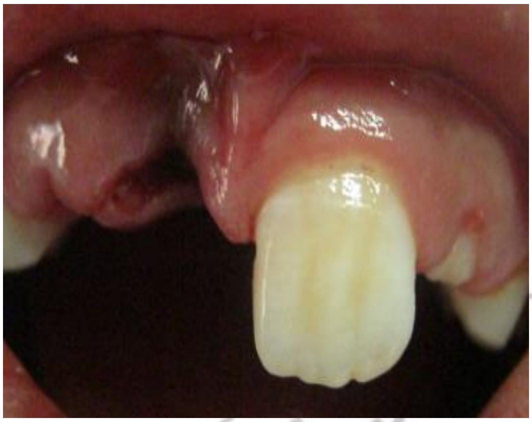

Fig. : 1(a)

Fig. : 1(b)

Fig. : 1(c)

Fig. : 1(d)

Fig. 1: a)Clinical view: Avulsion of tooth 11, blood clot in the alveolar socket with superficial lacerations b)Post traumatic periapical x-ray , c and d) permanent immature tooth (Open apex) in dry storage.

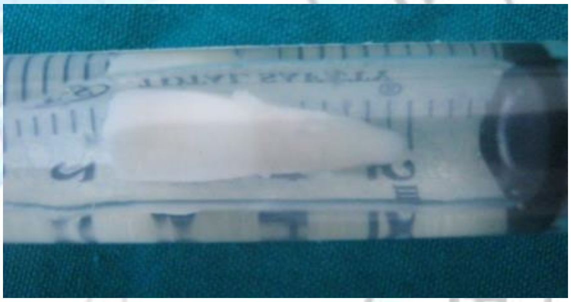

Fig. : 2(a)

Fig. : 2(b)

Fig. 2: a) tooth preparation for replantation b) Socket manipulation: remove of the blood clot.

Fig. 3: Avulsed tooth replanted and stabilized with flexible wire- composite splint.

Fig. 4: Immediate post replantation radiograph.

Fig. 5: Working length radiograph

Fig 6: inflammatory external resorption with periapical lesion.

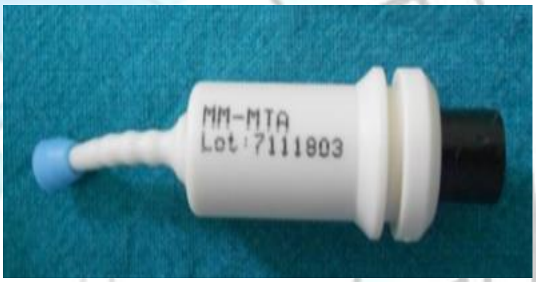

Fig. : 7(a)

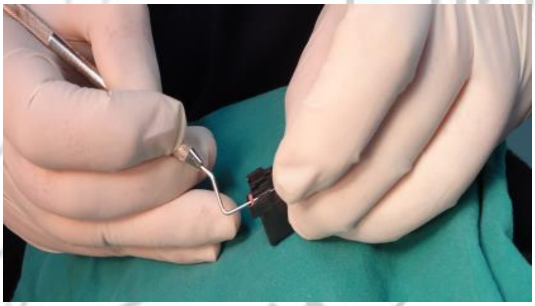

Fig. : 7(b)

Fig. : 7(c)

Fig 7: a) MM-MTA™ cap, b) Stopper placed on the plugger. c) Placement of the MM-MTA™ in the canal

Fig 8: Tooth 11 with MM-MTA™ Obturation.

Fig. : 9(a)

Fig. : 9(b)

Fig. : 9(c)

Fig 9: Radiograph at (a) 3 months recall, (b) 6 months recall, (c) 12 months recall

Discussion

Traumatic injuries to permanent teeth occur in 30% of children (Andreasen et al.,) (8). The majority of these incidents occurs before root formation is complete and may result in pulp inflammation and necrosis (Andreasen and Andreasen) (9). Treatment of traumatized teeth always carries extra challenge for clinicians due to the fact that these teeth are potential for many complications added to the nature of patients as most of them are young which make the treatment more difficult. Treatment modalities for such teeth depend on many factors including the maturity of teeth, nature of trauma, extra-oral dry time and many others (4). Delayed replantation has a poor long-term prognosis (10). The reported clinical success of avulsed teeth replanted varies from 4% to 5%. Authors agree that the most important factor to avoid root inflammatory resorption is to minimize severe damage to the periodontal ligament cells, what increases after 18 minutes of dry storage (8, 11). In the present case, the avulsed tooth stayed in dry storage for 4 hours, but the replantation proved to be successful after 18 months. This might be related to the early stage of development of the tooth by the time of the trauma. Another important factor related to the success of the replantation is the endodontic treatment. If the pulp is vital-Apexogenesis is performed to encourage continued physiological development and formation of the root end. If pulp has become non-vital, apexification is performed (12). The major challenges in performing root canal treatment in teeth with necrotic pulps and wide-open apices are achieving complete debridement, canal disinfection and optimal sealing of the root canal system is to obtain an optimal apical seal (13). The wide foramen requires a large volume of filling material that may extrude from root canal into peri-apical tissues creating foreign-body responses and eventually compromising the apical seal (14). Therefore, apexification has traditionally formed an integral part of the treatment of teeth with necrotic pulps with open apices. Apexification is defined as "a method of inducing a calcified barrier in a root with an open apex or the continued apical development of an incompletely formed root in teeth with necrotic pulp" (12). One aim of an apexification procedure is to establish a root canal space that can be successfully obturated. Numerous procedures and materials have been recommended to facilitate this by inducing root-end barrier formation. Historically, calcium hydroxide has been the material of choice used to induce the formation of an apical hard tissue barrier before placing a long-term root filling (15). However, despite a long history of use in apical closure procedures, there are several problems relating to the use of calcium hydroxide ($Ca(OH)_2$) for apexification. These include the long time required for root apices to close, the number of "dressings" necessary to complete closure, the role of infection, and the fracture resistance of teeth after the long-term application of calcium hydroxide (15). Over the last decade, Mineral Trioxide Aggregate (MTA) has been researched extensively and has been suggested as a preferred material for one-visit apexification. Felippe et al (2006) reported that MTA, when applied as an apical plug favored apexification and peri-apical healing, regardless of the prior use of calcium hydroxide paste (16).The shorter treatment time with MTA root-end barriers can be advantageous. The first advantage is that the success of treatment is less dependent on patient compliance. Long-term $Ca(OH)_2$ requires a motivated patient who will return for multiple follow-up appointments. (6)The MTA root-end barrier can be completed in little as one or two appointments. Another advantage for MTA root-end barriers is that they allow for immediate restoration. $Ca(OH)_2$ treatment requires that a patient be left in a provisional restoration for an extended period of time to allow for a change in the $Ca(OH)_2$ paste. This will leave a tooth with a weakened root and compromised crown exposed to forces that might lead to a catastrophic fracture (17, 18).MTA is a promising material as a result of its superior sealing property, its ability to set up in the presence of blood, and its biocompatibility (14) MTA has been shown to be a very biocompatible material, in fact more biocompatible than Super EBA and IRM (19).Moisture contamination at the apex of the tooth before barrier formation is often a problem with other materials typically used in apexification. As a result of MTA's hydrophilic property, the presence of moisture, specifically blood, does not affect its sealing ability (15).In a clinical retrospective outcome study, MTA was used as an artificial barrier in teeth with immature apices (18). By means of a periapical index score, 17 of 20 (85%) teeth showed healing. Also, when the MTA apexification procedure is compared against calcium hydroxide as a control, MTA demonstrated higher clinical and radiographic success at inducing root-end closure (20).When placed as an apical plug, MTA immediately releases calcium ions activating cell attachment and proliferation, and at the same time, the high pH creates an antibacterial environment. Furthermore, MTA modulates cytokine production and encourages differentiation and migration of hard tissue producing cells whereby hydroxyapatite is formed on the MTA surface, and a biologic seal is created (21) .Contemporary researchers have shifted the direction of investigations on endodontic materials, from basic measurements of cytotoxicity to more complex analyses of tissue response. These studies have demonstrated favorable and extensive cell-surface interactions with MTA materials, including cell attachment, cell proliferation and gene expression (22).When treating non-vital teeth, a main issue is eliminating bacteria from the root canal system. As instruments cannot be used properly in teeth with open apices, cleaning and disinfection of the root canal system rely on the chemical action of sodium hypochlorite (NaOCl) as an irrigant and calcium hydroxide as an intracanal dressing. NaOCl is known to be toxic, especially in high concentrations. When rinsing immature teeth with open apices, there is an increased risk of pushing the irrigant beyond the apical foramen. Therefore, it is advisable to use less concentrated NaOCl, which is less toxic (15, 24). In this case, 2, 5% NaOCl was used. Replanting the avulsed teeth with open apices after more than 60 minutes will result to a poor long-term prognosis. However, the practitioner must consider the young patient's esthetic, functional, and future restorative needs. In this case, the extensive nature of the external root resorption compromised the structural integrity of the root canal. The amount of root destruction mediated by the inflammatory process conceivably perforated the barrier that normally exists between the periodontal complex and the root canal system. Complete obturation of the root canal system by using MTA is a viable option for teeth that exhibit extensive external root resorption. A new MTA, the MM-MTA™ was used to obturate the entire canal system. MTA traditionally has a long setting time and an often grainy consistency which makes placement more difficult. MM-MTA™ is a modified Portland cement with added calcium carbonate ($CaCO_3$), which allows the reduction of the setting time (20 minutes) compared to the classic MTA (25). MM-MTA™ powder and liquid are directly contained in the cap, which insures the correct powder-to-liquid quantity for optimal consistency. This eliminates the need for a practitioner to prepare his own MTA paste by mixing the powder and liquid on a mixing plate which may result in a grainy consistency. MM-MTA™ is also much more hygienic. Therefore, once mixed, the MM-MTA™ is extremely homogenous with a pasty consistency for easy handling and placement (25). The MM-MTA has the same biological properties than the classical MTA described above. But, the setting time of this new material makes the differentiation and migration of hard tissue- producing cells faster .Because of its characteristics, MTA might become a viable alternative treatment option compared with gutta-percha–based materials and sealers (26). MTA exhibits superior sealability against bacterial microleakage, while demonstrating antibacterial and bio-inductive properties that can improve treatment outcomes. Furthermore, the material is sterile, radiopaque, resistant to moisture, and nonshrinking and stimulates mechanisms responsible for the bioremineralization and resolution of periapical disease. MTA can be considered the material of choice in preventing the extraction of involved teeth when some protocols might otherwise recommend unconventional alternatives (26). Canal obturation with MTA requires the same preparation and irrigation normally executed for gutta-percha placement, although the removal or retention of the smear layer before canal obturation still remains controversial. If smear layer removal is not implemented, it does not appear to affect the sealability of MTA materials, and its presence might actually improve the seal over time (27).Drawbacks of MTA include the presence of toxic elements in the material composition, high material cost and the absence of a known solvent to aid its removal (28) but it can be accomplished with the aid of ultrasonics. Because the obturation of the root canal system demands a material that actually provides a reliable and impervious hermetic seal, it might be a contradiction that the material should be easy to remove (26). Replanted teeth should be monitored by clinical and radiographic control after 4 weeks, 3 months, 6 months, 1 year, and yearly thereafter. Clinical and radiographic examination will provide information to determine outcome (10,29, 30)

Conclusion

Unsuccessful root canal treatments compromised by microleakage, inadequate cleaning and shaping, poor quality obturations, and large periapical lesions can demonstrate superior healing rates when osteo-inductive and cementogenic material like MTA is used to fill the root canal system. Although MTA might not exhibit all the characteristics necessary for the ideal filling material, patients requiring complex endodontic treatment might benefit from its bio-inductive properties in conventional and surgical therapies. Moreover, if a filling material can substantially improve endodontic outcomes and provide a wide range of treatment options that prolong the retention of the natural dentition and avoid implant placement.

Conflict of interest

No conflict of interests to declare

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