Mineral Trioxide Aggregate as Apical Plug in Teeth with Necrotic Pulp and Immature Apices: A 10-year Case Series

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Abstract

Introduction: This 10-year study evaluated the clinical and radiologic outcomes of teeth with necrotic pulp, immature apices, and periapical lesions treated with the mineral trioxide aggregate (MTA) apical plug technique. **Methods:** Seventeen single-rooted immature teeth with necrotic pulp and periapical lesion from 17 patients treated between January 2001 and December 2001 were included in this study. Apical obturation on all teeth included in the study was completed in 2 visits: first using calcium hydroxide as an interappointment intracanal medication and a second visit for the creation of the artificial apical barrier with MTA. The outcome, based on clinical and radiographic criteria, was assessed by 2 calibrated investigators using the periapical index (PAI). The Friedman test was used to verify the differences between baseline and the 1-, 5-, and 10-year PAI scores. **Results:** Of the 17 patients treated, 1 patient dropped out at 5 years. At the 10-year follow-up, 15 teeth were healed (PAI $\leq$2), and 1 tooth had been extracted because of the presence of a longitudinal root fracture. The PAI score exhibited a significant decrease between baseline and 1 year and between 1 and 5 years. The difference between 5 and 10 years was not significant. **Conclusions:** The apical plug with MTA was a successful and effective technique for long-term management of this group of teeth with necrotic pulps with immature root development and periapical lesions. *(J Endod 2014;40:1250–1254)*

Key Words

Apical plug, mineral trioxide aggregate, necrotic teeth with immature apices

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Conventional root canal filling procedures are challenging in cases of teeth with necrotic pulp, immature apices, and periapical lesions because of the absence of natural apical constriction and the presence of moisture contamination (Fig 1). In these cases, the risk of extrusion of the root filling materials and the difficulty in managing apical seals compromise the long-term outcome of treatment (1–3). The apexification procedure with mineral trioxide aggregate (MTA; Dentsply Tulsa Dental Specialties, Tulsa, OK) is one of the most reliable methods for the treatment of these teeth (4–7). Creating an artificial apical barrier with MTA is an alternative to long-term apexification with calcium hydroxide ($Ca[OH]_2$), and this approach might offer a more predictable and better long-term prognosis (6, 8, 9).

$Ca(OH)_2$-based apexification procedures require excellent patient compliance because of the necessary long-term application of the dressing material from 3–24 months to obtain complete closure of the root apex (10, 11). Although the traditional $Ca(OH)_2$ apexification treatment results in successful outcomes (12–14), there may be a weakening of the root structure as well as susceptibility to reinfection (13, 15, 16–18).

MTA is 1 of the most effective materials for sealing both iatrogenic and pathological communication between endodontic and periodontal spaces (19–21), and the presence of moisture does not affect its sealing ability (22). The biocompatibility of MTA is widely documented in the literature (23–25). Used in contact with periradicular tissue, MTA has the ability to induce cementum-like hard tissue (26–29). An MTA plug in the apical portion of the root promotes apical repair and prevents root canal overfilling, thus ensuring that the permanently bonded restoration enhances the retention of natural teeth, and it can increase the fracture resistance of immature teeth (30, 31).

A previous case series and other prospective studies reported a high percentage of successful outcomes at 1- or 2-year follow-ups when MTA was used as the apical plug in teeth with necrotic pulp and immature root development (4–8). Various techniques have been proposed for delivering MTA to the apical portion, the number of treatment visits (1 or 2 appointments), and the use of intermediate medication with $Ca(OH)_2$ as intracanal dressing. The lack of consensus regarding techniques and the limited follow-up studies encouraged the development of this 10-year case series study aimed at evaluating the outcomes of the MTA apical plug technique (5–9).

Materials and Methods

All patients, for a total of 17 teeth, who had received endodontic treatment or orthograde retreatment with MTA on teeth with immature root development at the Department of Endodontics of the University of Florence Dental School, Florence, Italy, from January 2001–December 2001 were followed up until December 2011. An a priori sample size calculation was not performed. From this search, cases were selected on the basis of the following criteria: (1) patients with noncompromised systemic health, (2) the presence of at least 1 single-rooted necrotic tooth with immature root development, and (3) teeth without mobility or/and periodontal probing depth. Seventeen patients were chosen for this study. As required for routine dental care, all the patients received a detailed explanatory form and gave their informed consent for treatment and for the use of their data in possible future studies (parental consent was obtained for minors). All patients, for a total of 17 teeth, were treated in a similar manner during routine care sessions by the same operator (RP).

Clinical preoperative testing included electric pulp testing, percussion, palpation, and evaluation of tooth mobility. The presence of any swelling was recorded by digital photos, and any sinus tract was detected by an endo-oral radiographic examination with gutta-percha cone. At least 1 preoperative radiograph was taken of each patient to view the status of the periapical tissues and the quality of any existing root filling. The teeth were isolated with a rubber dam, caries were removed if present, and the coronal access was created using diamond burs with continuous water irrigation.

Subsequently, the access cavity was refined with an RT2 ultrasonic tip (EMS, Nyon, Switzerland) powered by an ultrasonic unit (Piezon Master 600, EMS). RT2 ultrasonic tips with a limited diamond-coated extension offer cutting efficiency and enhance control while working in the pulp chamber and minimize the removal of tooth structure to obtain a direct access to the apical portion of the root canal. In the 2 cases of teeth needing orthograde retreatment, gutta-percha was removed with hand files or rotary nickel-titanium instruments used in a crown-down manner. The canals were frequently irrigated with a 5.25% sodium hypochlorite solution (Niclor 5; Ogna, Milan, Italy). The working length was measured by radiograph with a K-file and recorded for reference. The root canal was cleaned with copious irrigation of 5.25% sodium hypochlorite delivered to the apical portion of the root with disposable flexible polymer tips inserted until they reached the working length minus 2 mm. The irrigation was performed for 10 minutes, alternating 10% EDTA solution (Ogna) and 5.25% sodium hypochlorite, delivered in the same manner, until a total amount of 10 mL 5.25% sodium hypochlorite was used.

During the same appointment, the canal was dried with paper points at the working length, after which a temporary root canal filling with $Ca(OH)_2$ (Ultracalx Ultradent Inc, South Jordan, UT) was applied. The cement was delivered into the canal by means of capillary tips, and the access opening was filled with Cavit (3M ESPE). After 1 week, the rubber dam was placed as described previously, and the tooth was reaccessed; $Ca(OH)_2$ was removed by rinsing with 2 solutions: 5.25% NaOCl and 17% EDTA. A final rinse was performed with 5.25% NaOCl. ProRoot MTA (Dentsply Tulsa Dental, Tulsa, OK) was mixed according to the manufacturer's instructions, and a 4-mm-thick apical plug was created. The MTA was introduced into the apical portion of the canal from the orthograde direction with a Messing gun (MTA Endo Gun; Dentsply Maillefer, Ballaigues, Switzerland) and adapted to the canal walls with an endodontic plugger hand instrument. Correct placement of the MTA was confirmed with a radiograph. The access chamber was temporarily filled with a cotton pellet dampened with sterile water and Cavit. During the next appointment, 1 week later, after the isolation of the tooth by means of a rubber dam, the canal was reaccessed and backfilled with injection-moulded thermoplastic gutta-percha (Obtura Corp, Spartan, Fenton, MO) and sealer (Pulp Canal Sealer Kerr, Romulus, MI). All the procedures described were performed under 10× magnification using a dental operative microscope. The teeth were restored with a dentine bonding agent and resin composite, and an immediate post-treatment radiograph was taken.

Calibration

Two investigators (VG and GP) who had specialized in endodontics for at least 10 years were designated to perform the clinical and radiographic follow-up examinations on all patients. The radiographic calibration was conducted on the basis of the periapical index (PAI). A calibration kit of 100 original periapical radiographs not associated with the study and representing a wide range of periapical bone densities (32) was used. Agreement between and within examiners was determined by using the intraclass correlation coefficient.

Radiographic and Clinical Outcome Assessment

All the patients were recalled by telephone at 1, 5, and 10 years after treatment. If the patient did not respond after 3 calls, the case was considered a dropout. The recorded clinical findings included the presence or absence of clinical signs and symptoms (sensitivity to percussion, sinus tract, pain, or discomfort), root or tooth fracture, loss of function, tooth mobility, and pathological probing depths. The seal of the coronal restoration was assessed clinically by visual inspection using a mirror and radiography; any marginal gaps or decay were recorded. The status of periradicular tissue was verified by radiography. The signs of apical extrusion of MTA were recorded. All radiographs from this study were evaluated by 2 calibrated investigators in random order and in a blinded manner using the PAI. Based on the clinical and radiographic features as described in a previous study (8), teeth that scored PAI $\leq$2 and displayed no symptoms or clinical signs were classified as healed.

For any disagreement on the PAI score for a particular tooth, the investigators jointly revaluated the radiograph and reached a consensus score. Median and interquartile intervals for quantitative data (PAI score) and frequency and percentage for qualitative data (clinical signs and symptoms) were calculated for descriptive analysis.

The radiographic analyses were controlled by the intrarater and inter-rater agreement procedures. A 2-way intraclass correlation coefficient was calculated. The intraclass correlation coefficient was considered excellent if it was greater than 0.75 (33). The Friedman test was

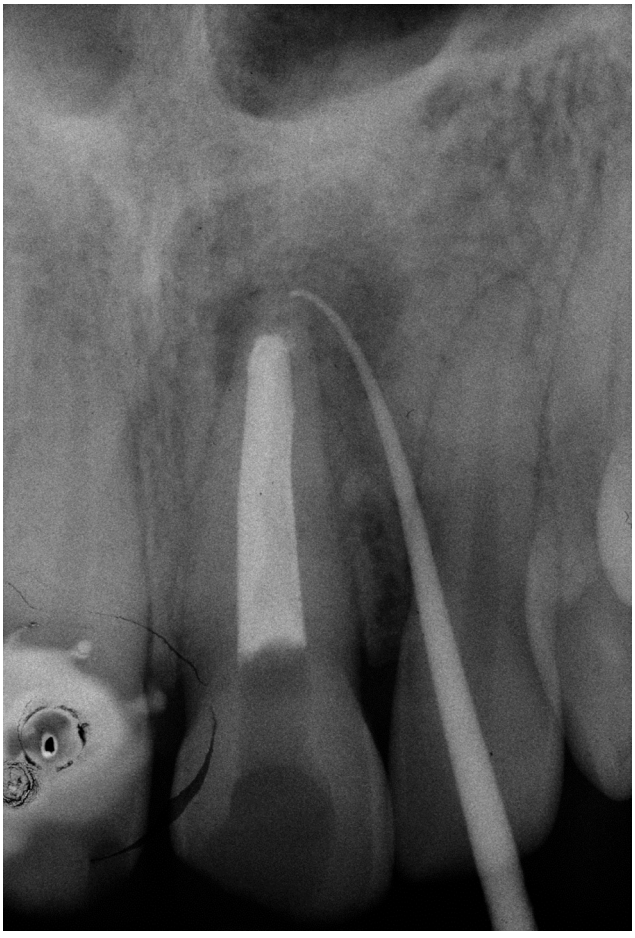

Figure 1. A radiographic image of failed root canal treatment of a maxillary central incisor with open apices in a 20-year-old woman.