Mineral Trioxide Aggregate for Intruded Teeth with Incomplete Apex Formation

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Abstract

The axial displacement of a tooth within the alveolar bone is called traumatic intrusive luxation. The treatment of immature permanent teeth with incomplete root formation is a challenging procedure, as the prognosis is uncertain. The objective of the present article is to report the successful treatment of traumatic intrusive luxation in teeth with incomplete root formation, where mineral trioxide aggregate (MTA) was used as an apical plug to induce apexification. A 10-year-old boy was referred to our department for emergency treatment of dentoalveolar trauma to the maxillary central incisors. After clinical and radiographic examination, the teeth were surgically repositioned and rigidly fixed. Three months later, a pulp vitality test of both teeth elicited a negative response. Endodontic therapy with an MTA plug was used to induce apexification as root formation was incomplete. The root canals were then filled. Clinical and radiographic examination was then performed again at 2 and 4 months later. The MTA apical plug was effective in inducing apexification and maintaining both teeth.

Key words: Endodontics — Mineral trioxide aggregate — Apexification — Root canal preparation

Introduction

Intrusive luxation is one of the most difficult types of dentoalveolar trauma to manage and obtain a favorable prognosis for9. Its consequences include pulp tissue necrosis or calcification, dentoalveolar ankylosis, and defects in root development, such as root resorption9,15. Some studies have indicated that only three strategies are available for the
treatment of immature teeth affected by traumatic intrusion in the permanent dentition: spontaneous re-eruption, orthodontic repositioning, or surgical repositioning. One of the most common complications of intrusive luxation is pulp necrosis, and when it affects a tooth with incomplete root formation, root development is inhibited. In such cases, apexification is required to induce the formation of a calcified barrier in the root apex. In addition, filling of a wide and straight root canal with an open apex risks extrusion of the filling material, which may compromise the long-term outcome of treatment.

Mineral trioxide aggregate (MTA) has been reported as a potential biomaterial for a number of clinical procedures, including as an alternative to calcium hydroxide in inducing apexification. It is a calcium silicate-based cement composed of a mineral powder of hydrophilic particles which sets in the presence of moisture. Several studies have reported that MTA stimulates the deposition of hard tissue, inducing apical formation, particularly in dental traumatology cases.

Due to its low toxicity and pH of 12.5, MTA has satisfactory biological properties and stimulates tissue repair. It is also capable of inducing the formation of a hard tissue apical barrier, and provides better sealing than other materials used for surgical or non-surgical purposes.

The objective of this case report is to describe and discuss the endodontic management of traumatic intrusive luxation of maxillary permanent central incisors with incomplete root formation using MTA as an apical plug to induce apexification.

**Case Report**

A 10-year-old boy was referred to the Amazon Institute of Higher Education (AIHE) for assessment of teeth #11 and 21. According to his mother, the patient had fallen, causing the teeth to intrude. The patient was taken to a 24-hour emergency clinic, where the teeth were repositioned using semi-rigid fixation and orthodontic wire, followed by antibiotic therapy. Fifteen days later, the patient was referred to the Department of Maxillofacial Surgery at AIHE, where the semi-rigid fixation was removed due to bad oral conditions and incorrect teeth positioning. Panoramic radiography was performed to evaluate the teeth (Fig. 1) and the patient referred to the Continuing Education Program in Endodontics.

During endodontic assessment, the two maxillary central incisors (teeth #11 and 21) presented a negative response to pulp vitality (Endo-Ice, Coltene/Whaledent Inc., Cuyahoga Falls, OH, USA) and percussion tests. Clinical examination revealed that their crowns were not in occlusion and that there was no mobility, even though there was evidence of edema and reddish mucosa (Fig. 2). Radiographic examination revealed incomplete root formation in both teeth (Fig. 3).

Based on the results of these examinations, it was decided to surgically reposition the maxillary central incisors, as both teeth remained out of occlusion. The teeth and adjacent tissues were anesthetized with 2% lidocaine hydrochloride (Cristália Produtos Químicos Farmacêuticos Ltda., Itapira, SP, Brazil) using a short needle to administer nasopalatine and anterior superior alveolar nerve block. The teeth were repositioned with the aid of No. 150 forceps under copious irrigation with a physiological saline solution (Fig. 4).
After repositioning, rigid fixation was achieved using composite resin (Z250, 3M ESPE, St. Paul, MN, USA) (Fig. 5). The patient was prescribed 250 mg amoxicillin suspension to be taken in 5-ml doses every 8 h for 7 days.

Three months later, the patient returned for re-evaluation. The pulp vitality test elicited a negative response again, confirming the initial diagnosis of pulp necrosis of the maxillary central incisors. Clinically, the teeth showed no mobility, edema, or change in the mucosa, but the incomplete root formation led us to perform endodontic therapy with an MTA apical plug to induce apexification.

Initially, the mucosa was anesthetized with 2% lidocaine hydrochloride. Next, the rigid fixation was removed and coronal access obtained under rubber dam isolation using a tapered flame-shaped bur (No.2200, KG Sorensen, Cotia, SP, Brazil) coupled to a high-speed device (Extra Torque 605C, Kavo, Joinville, SC, Brazil) (Fig. 6). This was followed by copious irrigation with 2.5% sodium hypochlorite solution (Biodinâmica, Ibiporã, PR, Brazil). The working length was established at 23 mm up to a size-80 K-file (Dentsply/Maillefer, Ballaigues, Switzerland) (Fig. 7A). After biomechanical preparation, the root canals were filled with calcium hydroxide paste associated with camphorated paramonochlorophenol and glycerin with the aid of a Lentulo spiral (Dentsply/Maillefer). The coronal access cavities were then temporarily sealed.
with glass-ionomer cement (Vidrion R, SS White, Rio de Janeiro, RJ, Brazil).

After 14 days, the calcium hydroxide dressing was removed. Next, the root canals were irrigated with 1 ml of 17% EDTA (Biodinâmica) for 3 min for smear layer removal. A final, and copious, irrigation with 2.5% sodium hypochlorite solution was performed. A gutta-percha cone test was performed and the two size-80 cones fused using thermal plasticization to obtain a better fit in the root canal (Fig. 7B).

The root canals were dried with size-80 sterile absorbent paper points (Dentsply/Maillefer). The MTA (Ângelus, Londrina, PR, Brazil) was then prepared in accordance with the manufacturer’s specifications and placed within the root canals in small portions with the aid of an MTA holder (Ângelus). It was then condensed with a Paiva plunger, creating an apical plug. The MTA was placed carefully to avoid extrusion of the cement into the peri-apical area. Next, radiographic examination was performed to verify the correct positioning of the MTA (Fig. 7C).

After the MTA set, cement residue attached to the root canal walls was observed radiographically (Fig. 7C). The remnants of the cement were removed using a size-70 K-file, followed by irrigation with 2.5% sodium hypochlorite solution. To facilitate visualization of any MTA remaining attached to the root canals, an operative optical microscope (DF Vasconcelos, Valencia, RJ, Brazil) was used. The middle and cervical thirds of the root canals were then filled with Grossmann root canal sealer (EndoFill, Dentsply, Petrópolis, RJ, Brazil) by thermomechanical technique, using a size-80 McSpadden compactor. A final periapical radiograph was obtained to determine whether the root canals had been properly sealed (Fig. 7D). The coronal access cavities were sealed with glass-ionomer cement as a temporary restorative material before final restoration with composite resin (Z350, 3M ESPE).

The patient was subsequently called back for follow-up clinical (Fig. 8) and radiographic examination (Fig. 9) at 2 and 4 months later. The patient did not complain of discomfort or pain, and proper sealing of the root canals,
including the apical third, was noted radiographically, indicating a favorable prognosis regarding apexification.

### Discussion

In most cases, dental trauma is restricted to the teeth, but may sometimes also affect bone and adjacent soft tissue\(^\text{[10]}\). In addition to a clinical examination, a radiographic analysis is also required for a proper diagnosis of possible bone fracture\(^\text{[10]}\). Both were therefore performed in the present case.

Conventional filling techniques depend on the presence of apical constriction in the root canal\(^\text{[11]}\). The absence of this constraint due to incomplete root formation, however, is a great challenge in endodontic therapy\(^\text{[11]}\). Filling of permanent teeth with wide-open apices may lead to extrusion of the filling material, which can compromise the long-term outcome of treatment\(^\text{[11]}\). In the present case, the absence of apical constriction in the root canal was the primary reason for applying an MTA apical plug. This prevented the risk of extrusion of the filling material, which would have compromised the outcome of endodontic treatment.

Prior to the introduction of MTA on the
market, calcium hydroxide was adopted for many years as the gold standard biomaterial for inducing apical closure and creating a hard tissue barrier. Several clinical cases with a successful long-term outcome have been documented in the literature, even though the intracanal use of calcium hydroxide for a period longer than 30 days causes denaturalization of the organic components of dentin, compromising tooth strength.

For this reason, apexification with calcium hydroxide for extended periods of time may lead to possible root fracture. The period of treatment of immature permanent teeth depends on a number of factors, such as the size of the apical opening, the direction of the traumatic displacement of the tooth (strict axial, axial-labial, or axial-lingual), and how it is repositioned. Therefore, in the present case, calcium hydroxide was not used to induce mineralized apical barrier formation, as it has disadvantages when compared with MTA.

The use of MTA as an alternative in the treatment of traumatized immature permanent teeth has been reported to enhance their long-term survival. However, calcium hydroxide as an intracanal medication must precede the application of MTA to limit bacterial infection. Therefore, it was decided to use calcium hydroxide as intracanal medication during a period of 14 days prior to MTA placement.

In addition to the well-documented biological features of MTA, its use as an apical plug reduces treatment time and the number of sessions required. Several studies have reported that MTA yielded a significantly higher frequency of mineralized bridge formation, thicker and less porous dentin, and less periapical inflammation than calcium hydroxide. It has also been reported that MTA induces migration and proliferation of osteogenic and odontoblastic cells, which, in turn, promotes mineralized tissue deposition, reducing inflammation in its site of action.

Such a protocol, combining the use of these two biomaterials (calcium hydroxide and MTA) in treating teeth with incomplete root formation, has been reported to offer favorable outcomes, and the present results support the findings of these earlier studies.

Despite the uncertain prognosis for traumatized immature permanent teeth, the case described in the present report demonstrated that using MTA as an apical plug was effective in maintaining the teeth. Thus, MTA appears to offer a feasible option in enhancing the long-term survival of a tooth. The present case showed that MTA provided adequate sealing of the teeth apices, a shorter treatment time, and induction of apical closure by the formation of a mineralized barrier.

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