Mineral Trioxide Aggregate as an Apical Plug in Endodontic Management of Non-Vital Permanent Teeth with Open Apex: A Case Report

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Abstract
Apexification is a widely used technique to manage immature permanent teeth and can be performed either using calcium hydroxide (Ca(OH)₂) or mineral trioxide aggregate (MTA). This paper illustrates a case report of an unsuccessful apexification with Ca (OH)₂ of a maxillary incisor that was then treated by an apical barrier made of MTA.

Keywords: Mineral trioxide aggregate; Immature teeth; Apexification

Introduction
In Endodontics, one of the most significant difficulties is the management of immature necrotic teeth. The apical closure is essential to endodontic therapy because it properly seals the root canals system as well as maintains the filling material restricted to the root canals. Traditionally, such conditions is treated using calcium hydroxide in order to induce apexification and by that establish a natural constriction of the apical portion [1,2]. However, the need of multiple appointments illustrates a relevant disadvantage regarding the use of calcium hydroxide. Besides that, the period time required for treatment achievement using Ca(OH)₂ may range from 5 to 20 months [3-5] which is considered a long-term therapy and it can be associated to many risks such as root weakening and tooth fracture [6]. To overcome prolonged treatment time related to the technique mentioned above, mineral trioxide aggregate (MTA) has been reported to be an effective material for root end filling due to its excellent sealing ability and biocompatibility [7,8]. Further more, MTA also promotes the hard tissue formation, which enhances its potential to prevent leakage of bacteria and their by-products [9].

Considering these properties and taking into account the lack of patient motivation to attend to multiple visits, the MTA apical plug placement has been suggested. In addition to its several favorable characteristics, the insertion of MTA in the apical end of the root canal enables the treatment to be achieved more quickly since the root canal can be immediately filled [2].

This case report presents unsuccessful apexification with Ca(OH)₂ more than 20 months and then a successful MTA apical plug placement in a maxillary central incisor with pulp necrosis and open apex.

Case Presentation
A 13-year-old female presenting good general health was referred to continue root canal treatment that had been started 3 years earlier due to a dental trauma suffered in the left maxillary central incisor. Clinical examination revealed crown fracture, coronary darkening and absence of abnormal mobility (Figure 1A). The tooth was unresponsive to cold test (Endo-Ice, The Hygenic Corp.,Akron, OH, USA). Radiographic examination (Figure 1B) revealed an immature tooth 21, with wide canal, open apex and extensive radiolucent lesion around the periapex. The apexification procedure was explained to the patient’s parents and they consented to the treatment.

After anesthesia and rubber dam placement, endodontic access was performed following conventional guidelines. The coronal and middle thirds were then irrigated using saline solution in order to remove remnant intracanal medication placed 3 years before. The working length was determined, and the apical third dentin walls were cleaned up to a K-file # 80 (Dentsply Maillefer, Ballaigues, Switzerland). The canal was irrigated with copious amounts 1% sodium hypochlorite.
irrigation with negative apical pressure with NaviTip tips and dried by capillary tips (Ultradent, South Jordan, UT). A calcium hydroxide paste with aqueous vehicle was inserted into the apical portion of canal with a spiral lentuloas intracanal medication. The access cavity was sealed with glass ionomer. Periodic changes (up two months) of the root canal dressing material were made for more than 20 months (using calcium hydroxide powder mixed to propylene glycol vehicle). After this period, on a follow-up visit, it was observed the remission of radiolucent image, which meant the initial healing of the periapical lesion. On the other hand, calcium hydroxide apicification was unable to adequately form an apical root canal barrier. Due to the extent of the root canal width and the lack of an apical stop barrier, a novel endodontic treatment using mineral trioxide aggregate (MTA) as an apical plug was preconized. The intracanal medication was removed by repeated irrigation with saline solution and the root canal was dried with absorbent paper points (Dentsply, Petrópolis-RJ, Brazil). MTA (Angelus, Londrina-PR, Brazil) was prepared according to the manufacturer’s instructions and placed in the apical portion of root canal (3–4 mm) using the MTA carrier (1.6 mm, Dovgan Tip, USA), creating an apical barrier. Periapical radiograph was taken to confirm the correct position and size of the MTA plug (Figure 2A). Remaining root canal space was obturated by the lateral condensation technique using gutta-percha modeled main point (Dentsply-Maillefer, Ballaigues, Switzerland) (Figure 2B), with AHPlus (Dentsply) as a endodontic sealer. Finally, obturation was partially removed (Figure 2C) and the tooth was restored with fiber posts and composite resin core (F250 3M-ESPE, St. Paul, MN, USA------) (Figure 2D) 5.

One week after the patience receives desease bleaching and esthetic restoration (Figure 3A). At both 22 months and four-year follow-up, patient was clinically asymptomatic and the periapical lesion had disappeared (Figure 3B).

Discussion

The prognosis of a dental injury is uncertain, especially when it involves immature teeth, because it may become non-vital and infected. The loss of its blood supply interrupts the continued maturation and the apical closure of the root canal [10]. In Endodontic field the treatment of injured permanent immature teeth presents an exceptional challenge faced by endodontists due to the thin and fragile dentine walls. This paper illustrates unsuccessful apicification closure with Ca(OH)2 along 18 months of an immature maxillary incisor that was then successfully treated with MTA as root end filling material.

For many decades apicification using calcium hydroxide has been the treatment of choice aiming the formation of hard tissue barrier and healing in non-vital immature permanent teeth [11]. However, the long treatment time associated to this technique constitutes a relevant drawback once it depends on the patient’s cooperation to attend several follow-up appointments [6,12]. Another issues related to the use of calcium hydroxide for a long period is the risk of root weakening along with tooth fracture [6,13] and coronal microleakage during treatment [14]. Additionally, the formed barrier achieved during apicification, usually appears to be calcified, though it is actually porous and may contains small amounts of softtissue [15].

On this regard, mineral trioxide aggregate (MTA) apical plug has been proposed as an effectivetechnique for apical sealing of necrotic immature teeth and has shown excellent results [16]. This material is provided of excellent biocompatibility, antibacterial properties, decreased apical leakage, better marginal adaptation, short setting time (approximately 4 hours) and also has the capability to induct hard tissue formation [17,18]. Furthermore, both the patient and dentist benefit from the use of MTA since the whole treatment time is greatly reduced [12].

Besides the apicification with calcium hydroxide and MTA apical plug placement techniques, pulp revascularization is also among the treatment options for necrotic immature teeth [19-21]. It involves disinfecting the root canal system, providing a matrix of blood clot into which cells could grow, and sealing of the coronal access. Although, the decision for apicification instead of revascularization was made primarily because the diameter of the open apex was not more than 2 mm, which may be difficult to induce bleeding. All cases of unfavorable revascularization outcome apparentlywere related to a failure to induce any bleeding into the canal [22, 23]. The difficulty to achieve an impeccable control of bacterial infection also seems to be highly relevant to the complexity and unpredictability of the outcome of this procedure. Long-termclinal results are as yet not available. Moreover, it is likely that the entire canalwill be calcified, compromising esthetics and potentially increasethe difficulty in future endodontic procedures, if required [24]. Thus, now many endodontists are recommending revascularization just in
cases where the root formation is in the very beginning, divergent apex, these situations normally lead to tooth loss in the past due to do not resist to occlusion forces. In the present case, postand core were the final restorative treatment plan with bleaching, therefore so, revascularization did not seem the right best treatment option because the vital tissue in apical two thirds ofthe canal cannot be violated for post placement.

For this case, MTA plug was an effective method for apical sealing enabling posterior obturation. The apical plug placement was performed in one single appointment, but the previous placement of calcium hydroxide had significant improvement of the lesion remission. It is worth mentioning that, In MTA plug technique, a temporary calcium hydroxide medication should precede the application of MTA to disinfect and restrict bacterial infection in the root canals [13,25]. Otherwise, the Ca(OH)₂ intracanal medication can be maintained for only two weeks, differently from our case, which the first option treatment was the apexification with calcium hydroxide.

Additionally, there are some recent released materials like the new MTA (Angelus, Londrina, Brazil) and Biodentine (Septodont, Saint Maur des Fosses, France) that are reported to do not cause discoloration, which is even better regarding its use as apical plug. However, new clinical studies need to be performed in order to confirm better protocols.

**Conclusion**

Dental injuries in immature permanent teeth often result in endodontic complications. Apexification technique using calcium hydroxide is associated with certain flaws, such as long treatment time, the possibility of tooth fracture and incomplete calcification. The use of an apical plug employing mineral trioxide aggregate (MTA) is an alternative treatment option with the advantage of a shorter chair-time treatment and immediate tooth reinforcement by fiber posts.

**References**