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Apexification in immature permanent teeth with apical periodontitis, using mineral trioxide aggregate (MTA): A case series

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Abstract
The completion of root development and closure of the apex occurs up to 3 years after the eruption of the tooth. treatment of choice for necrotic teeth with immature root is apexification, which is induction of apical closure to produce more favorable conditions for conventional root canal filling. The most commonly advocated medicament is calcium hydroxide. However, this material requires a long time to form the hard tissue barrier. It has also been shown that the use of calcium hydroxide weakens the resistance of the dentin to fracture. Recently considerable interest has been expressed in the use of mineral trioxide aggregate (MTA). The most important properties of these material in dentistry are its biocompatibility and sealing ability. High biocompatibility encourages optimal healing responses. This has been observed histologically with the formation of new cementum in peri radicular tissues area and a low inflammatory response with bridge formation in the pulp space. Moreover, MTA offers the option of a two-visit apexification procedure so that the fragile tooth can be restored immediately.

Keywords: apexification; mineral trioxide aggregate; calcium hydroxide

Introduction

Management of tooth with necrotic pulp, immature root and apical periodontitis is a challenging task. Due to lack of apical barrier for containing the root filling material, obturation of the root canal is difficult and the infected root canal space cannot be disinfected with standard protocol. In such cases apexification procedure is the treatment of choice to establish an apical barrier. Apexification is a method to induce a calcified barrier in a root with an open apex or the continued apical development of an incompletely formed root in teeth with necrotic pul [1]. Calcium hydroxide has been widely used for the induction of hard tissue barrier. However, this material requires 5–20 months to form the hard tissue barrier. It has also been shown that the use of calcium hydroxide weakens the resistance of the dentin to fracture [2, 3] and there is a chance of re-infection due to loss of temporary restoration. In recent times, mineral trioxide aggregate (MTA) has gained widespread popularity for the apexification procedure. Materials used in apexification are frequently placed in close contact with the periodontium, so must be biocompatible with host tissues. MTA, a biocompatible material [4] can be used to create a physical barrier. Apical hard tissue formed with MTA showed significantly greater consistency than calcium hydroxide[5] It also helps in the formation of bone and periodontium through remineralization, and production of transforming growth factor-β1 around its interface due to bioactivity [6]. The possibility of root fractures is reduced because a bonded restoration can be placed without any delay. Various authors have reported clinical success using MTA for one-visit apexification. Nowadays, interest has centered on the use of MTA for apexification.

Case 1

A 10-year-old girl was referred to the Department of Conservative dentistry and Endodontics, Govt Dental college, Calicut for the treatment of tooth #8. At the age of 7 years the patient had suffered a dental trauma, and tooth #8 had been treated by another private practice dentist. After 1 year the patient noticed darkening of color over the same tooth. Now the patient reported pain on mastication since 2 weeks and slight mobility. Clinical examination showed that tooth #8 had an Ellis class III fracture of the crown, blackish discoloration and the probing depth was within normal limits. The tooth gave no response on sensitivity tests (heat, cold, and electrical pulp testing). The tooth was tender to percussion, and grade I mobility was observed. A periapical radiograph of the tooth showed that the coronal fracture appeared to reach the mesial pulp horn of tooth #8. A diffused radiolucency and a radiopaque line (suggestive of extruded intracanal medication) was seen at the periapical area of the root. The root apex was not fully formed (Fig. 1).

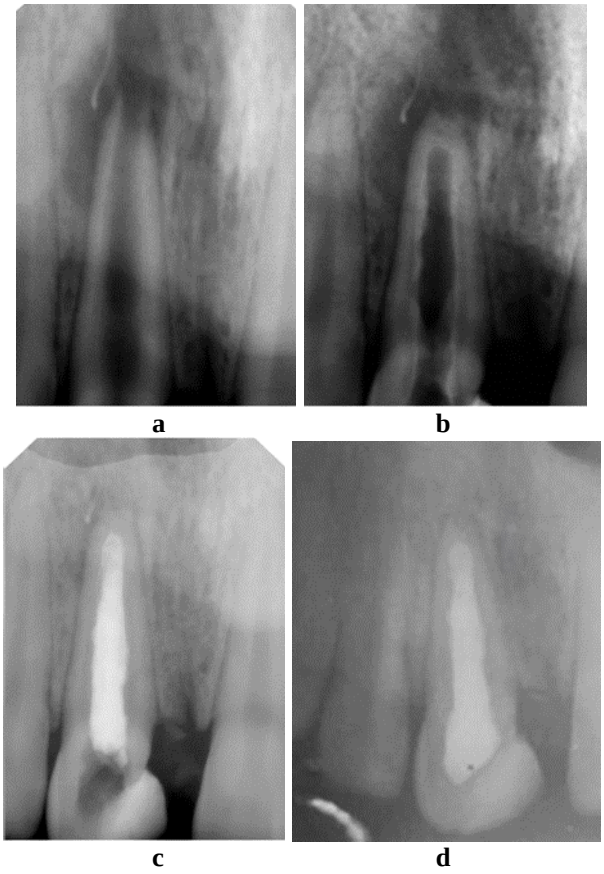

Fig 1

The clinical diagnosis of tooth #8 was previously initiated therapy and symptomatic apical periodontitis. The decision for apexification instead of revascularization was made primarily because the diameter of the open apex was not more than 1 mm [7] and the patient's parent was not willing for the procedure. The apexification treatment with MTA was selected with the informed consent of patient's parents**.**
First Session: Local anesthesia with 2% lignocaine was administered, and after isolation with a rubber dam, the material that had been placed by previous dentist was removed. Using an Endo-Z drill (Dentsply Maillefer, Ballaigues, Switzerland), the previous access cavity was rectified. A #25 K-file was introduced to ensure the patency of the canal. Working length was confirmed radiographically. Root canal was chemo-mechanically debrided with circumferential filing using the International Organization for Standardization (ISO) 25 K-file (Dentsply Maillefer, Switzerland) in conjunction with copious amount of 2.5% sodium hypochlorite (prevest dentpro,India)**..** Smear layer was removed using a volume of 3 ml of 17% ethylenediaminetetraacetic acid (EDTA) solution (Prevest Denpro, India). ApexCal medicament paste (Ivoclar Vivadent AG Schaan, Liechtenstein) was placed in the root canal, and access cavity was restored with Temp Paste (Pyrex Exports, India)**.** One week later, tooth was again accessed under rubber dam isolation, and copious amount of normal saline was used to remove any remnants of the calcium hydroxide medicament. Canal was thoroughly dried with absorbent paper points (DiaDent). White MTA Angelus (Angelus, Londrina, PR, Brazil) was mixed according to manufacturer's instructions. Using an MTA Endo Gun (Dentsply Maillefer, Ballaigues, Switzerland), posterior pluggers [8], customized gutta percha sized according to the apical diameter;MTA gently condensed to the apex to form 4 mm of apical plug [Figure 1b]**.** A sterile sponge pellet moistened with sterile water was placed over the canal orifice and the access cavity was sealed temporarily with Temp Paste (Pyrex Exports, India). Next day, root canal was backfilled using thermoplasticised Gutta-percha with Calamus Dual (Dentsply maillefer) and AH-Plus root canal sealer (Dentsply Detrey GMBH, Germany), [Figure 1 c] and tooth was restored with composite restoration (Te- Econom Plus, Ivoclar vivadent) . The patient was recalled after 6 months for clinical and radiographic evaluation. At the follow-up visit, clinical examination revealed normal mobility, probing depths, and normal function without symptoms. Radiograph demonstrated the resorption of the apically extruded intracanal medication and healing periapical lesion [Figure 1d].

Case 2
A 12-year-old female patient presented with the chief complaint of discomfort while chewing in front region of upper jaw**.** Patient gave a history of traumatic incident 4 years back for which she had visited a private clinic. Medical history was insignificant**.** Clinical examination revealed slightly grayish discolored tooth #9 and previously attempted treatment in the same tooth**.** The tooth was tender to percussion and did not respond to cold and electric pulp vitality tests. Grade I mobility was evident. Intraoral periapical radiograph revealed a diffuse radiolucency with an open apex root. On the basis of clinical and radiographical findings, a diagnosis of pulpal necrosis with symptomatic apical periodontitis was made with respect to upper left central incisor**.** After detailed discussion with the

patient's parent we decided to perform MTA apexification procedure. Written consent was obtained**.** After rubber dam isolation and working length determination using the radiograph (Fig2)

Fig 2

Chemo mechanical preparation of root canal was done using ISO 60 K-file (Dentsply Maillefer, Switzerland) and 3% sodium hypochlorite (prevest dentpro,India)**.** A volume of 3 ml of 17% EDTA solution (Prevest Denpro, India) was used for smear layer removal**.** A calcium hydroxide (CH) paste (Metapex; Meta Biomed, Chungju, Korea) was placed into the apical portion of canal with a lentulo spiral as intracanal medication. The patient was scheduled for a second visit after 2 weeks**.** In the second session the tooth was asymptomatic during the entire postoperative period, and the temporary filling was intact. Local anesthesia was accomplished with 2 % lignocaine. After isolation with rubber dam, the glass ionomer and cotton pellet were removed from the access cavity. A copious amount of 2.5% sodium hypochlorite ultrasound activated irrigation with negative apical pressure by using EndoVac system was used to remove the CH paste from the canal. A final rinse of 17% EDTA for 1 minute was performed. The canal was dried with absorbent paper points (DiaDent). PRO ROOT MTA was prepared according to the manufacturer's instructions. The powder was mixed with 5 drops of liquid and activated in the dental triturator for 30 seconds. It was carried into the canal with a MTA Endo Gun [9] and condensed with hand pluggers to form apical plug of 4 mm in thickness. The excess material from the walls were removed with paper points, and after 24 hr, the rest of the canal was backfilled with thermoplasticized gutta-percha and AH Plus resin sealer (Dentsply De Trey, Konstanz, Germany) using Calamus Dual (Dentsply maillefer)[Figure 2b] . Tooth restored with composite restoration. The patient was recalled after 6 months for clinical and radiographic evaluation. At the follow-up visit, clinical examination revealed normal mobility, probing depths, and normal function without symptoms. Radiograph demonstrated healing periapical lesion [Figure 2 c].

Discussion

Children between the age of 6 and 9 years are very prone to dental injuries. Pulp necrosis is a serious complication of these traumas and it's prevalence varies with the type of traumatism from 1% to 6% for crown fractures to nearly 100% for intrusions [10] Pulp necrosis of permanent immature teeth results in interrupted root formation with open apex**.** The presented cases show successful management of immature permanent teeth with periapical lesions. Revascularization was not attempted for these cases because of the chronic nature of the lesion. Furthermore, previous endodontic procedure could have damaged SCAP (stem cells from apical papilla) or vital mature pulp cells, which play a critical role in regeneration by acting as a source of odontoblast and are responsible for the root maturation [11] Hence an apexification procedure was selected as the treatment of choice. The goal of apexification is to obtain an apical barrier to prevent the passage of toxins and bacteria into periapical tissues from root canal [4]. In reviewing literature, many materials, such as calcium hydroxide in combination with sterile water, saline, local anesthetic, CMCP, polyantibiotic paste [5] zinc oxide paste with cresol and iodoform [6]. and tricalcium phosphate [12]. have been used for apexification. Ca $(OH)_2$ has been conventionally used as a successful material for apexification. However, this requires a long treatment time with regular changes of $Ca(OH)_2$, and poor coronal seal increases the susceptibility to infection [13]. Furthermore, there is a risk of tooth fracture after dressing with calcium hydroxide for extended periods [3] Recently, a material called mineral trioxide aggregate (MTA) has been investigated as a potential compound to seal off the pathways of communication between the root canal system and the external surface of the tooth. MTA is a powder that consists of fine hydrophilic particles that sets in the presence of moistur [4] A colloidal gel with a pH of 12.5 that solidifies to a hard structure is formed hydration of the powder**.** The setting time for the cement is nearly 175 minutes. The compressive strength of MTA at 21 days is -70 MP [14]. Compared to teeth treated with $Ca(OH)_2$, the time required for the formation of the barrier is significantly less in teeth treated with MTA . When MTA comes into contact with human cells cultures it releases calcium ions and enhances cell attachment and proliferation; due to its alkaline pH it shows anti-bacterial activity; it induces differentiation of cells, migration of cells and modifies cytokine production, thus assuring a biological seal through hard tissues, and formation of hydroxyapatite on its surface [15]. In the present case series the type of hard tissue formed on the apical canal walls and in the apical canal space is not known without histologic examination. But clinical and radiographic evaluation at 6 months were suggestive of successful apexification, ie; on clinical evaluation, there was absence of swelling, pain in percussion, sinus tract and reduced mobility. Decrease in radiolucency was also evident [fig 1e & 2e].

On reviewing literature a more easier modified apexification procrdure was described by Kamolthip Songtrakul *et al* in which 3 mm MTA can be placed 4-5 mm from the apex with 3mm of biocompatible resorbable membrane between apex and MTA[16]. Due to persistent apical periodontitis and trauma from previously initiated treatment we anticipated damages to Hertwig epithelial root sheath (HERS); so conventional apexification procedure was chosen.

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