The Apex Dilemma: Restoring Apical Integrity in a Non-Vital Immature Tooth Using MTA"

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Abstract: *The management of non-vital immature permanent teeth with open apices presents a significant clinical challenge due to the absence of an apical constriction. Immature non-vital teeth are prone to complications due to incomplete root formation and thin dentinal walls. Traditional calcium hydroxide apexification requires multiple visits and prolonged treatment time, increasing the risk of reinfection. Mineral Trioxide Aggregate (MTA) has emerged as a biocompatible material capable of creating a predictable and immediate apical barrier, allowing for more efficient treatment and offering a minimally invasive solution that prioritizes biological repair.*

Keywords: *MTA, Apexification, Bioactive material, Immature tooth, Regenerative Endodontics, Apical barrier, Open Apex.*

1. Introduction

Dental trauma to the anterior dentition is common in the young adolescent patient. Prevalence estimates suggest that up to one-half of children, ages 5-18, will incur some type of dental injury during their school years. Also showed that the majority of dental trauma occurred before the age of 12 (86%). Trauma leading to complicated crown fractures and/or pulp necrosis can be a significant problem in this population due to incomplete root development commonly found in these teeth.[1] Pulpal damage to the immature teeth due to trauma or deep caries results in disruption of the root development process. Because of thin walls and short roots, immature teeth have a greater fracture risk and reduced retention.[2] Treating teeth compromised by infection or trauma prior to full root development presents significant challenges.[3]

Endodontic therapy of a tooth with open apex and necrotic pulp presents multiple challenges during treatment. Cleaning and disinfection of the infected root canal cannot be done with standard root canal protocols. A lower strength of irrigants is used because of the danger of its extrusion through the apex of the immature teeth. Obturation of the root canal system is difficult as there is no apical barrier for containing the obturating material without impinging on the periodontal tissues. Hence, obtaining a fluid-tight seal is often difficult. Also, the presence of thin roots increases the susceptibility to fracture.[4] Successful endodontic treatment depends on the closure of the apical foramen with calcified tissue, a critical step in the maturation process.[3]

Apexification is defined as 'a method to induce a calcified barrier in a root with an open apex or the continued apical development of an incomplete root in teeth with necrotic pulp.'[5] This procedure consists of removal of inflamed or necrotic pulp from the root canal, and disinfection of the canal to create an environment favourable for closure of the apex. The functional goal of this procedure is to provide a hard tissue barrier that will provide an apical stop which will create a platform for effective obturation of the canal allowing the patient to maintain the tooth .[6]

Amongst a variety of materials that have been proposed for induction of apical barrier formation, calcium hydroxide is the most popular. The use of calcium hydroxide was first introduced by Kaiser in 1964 who proposed that this material mixed with Camphorated Para Chlorophenol (CMCP) would induce the formation of a calcified barrier across the apex. [5] For an extended period of time, apexification entails the application of calcium hydroxide Ca $[OH]_2$ paste to achieve root-end closure, which was subsequently followed by root canal therapy. This long-term therapy presents several

disadvantages, such as challenges in patient follow-up, inconsistency in process of apical closure, and compromised tooth structure, which increases the risk of root fracture. [7]

The invention of mineral trioxide aggregate (MTA) by Torabinejad in the early 1990s changed the conventional therapeutic approaches employed for various dental treatments.[8]
Mineral trioxide aggregate (MTA) was described as an alternative to traditional apexification treatment which incorporates the application of the material in the apical third of the canal to create an apical barrier. MTA is a biomaterial with excellent biocompatibility and superior sealing abilities even in the presence of moisture. [9] In addition, MTA minimizes sessions, reduces clinical costs, improves patient adherence to treatment, and reduces the risk of vertical or oblique root fractures. [10]
In recent times interest has centered on the use mineral trioxide aggregate (MTA) one visit apexification. Morse et al. defines one visit apexification as the non-surgical condensation of biocompatible material into the apical end of the root canal.[5]

In this context, the aim of this article was to report a case of apexification of an immature traumatized tooth with necrotic pulp using white MTA.

2. Case report

Case 1

A 21 years old female patient, reported to the Department of Conservative Dentistry & Endodontics, Kalka Dental college (Meerut) with the chief complaint of discoloration in her lower front tooth region. There was a history of trauma to the same tooth 8 years back. The medical history of the patient was non-significant. On clinical examination, tooth wrt 31 showed discoloration and was asymptomatic. Pulp sensibility testing revealed no response, indicating pulp necrosis. There was no tenderness or swelling, and no sinus tract was observed. (Fig 1.)

Fig 1. Pre- operative

Radiographs revealed an open apex with an immature root and a well-defined periapical radiolucency wrt 31. (Fig.2)

Fig 2. Preoperative Radiograph

The treatment plan involving MTA Apexification followed by crown restoration was explained to the patient, and written informed consent was obtained prior to initiation of the treatment.

In the first appointment, the access cavity was refined with a safe-end tapered bur (Endo Z bur, Dentsply Maillefer). A No. 15 K file was employed to achieve apical patency, with the working length measured using an apex locator (Root ZX Mini, J. Morita, Saitama, Japan) and confirmed radiographically. Cleaning and shaping were accomplished with hand K-files (Mani, New Delhi, India) and ProTaper Universal rotary files (Dentsply Maillefer). The canals were irrigated with 3% sodium hypochlorite (Hyposol; Prevest DenPro, Jammu, India), 17% EDTA (Neoedta; Orikam, Gurgaon, India), and saline, followed by drying with sterile paper points (MetaBiomed, South Korea). Triple Antibiotic paste was placed as an intracanal medicament for 21 days and the tooth was temporarily restored. (Fig 3 & Fig 4)

Fig 3. Working Length

Fig 4. Master Cone

After 21 days, the intracanal medicament was removed and canal was irrigated with 3% NaOCl solution (Hyposol; Prevest DenPro, Jammu, India). The canal was dried with sterile paper points (MetaBiomed, South Korea). MTA (Angelus, Londrina, Brazil) was mixed according to manufacturer's instructions. The mixture was applied inside the canal using MTA carrier and positioning of the material was checked radiographically. Using hand pluggers (Queen, Hungary), 4-mm thick MTA plug was created and packed into the apical segment followed by a confirmatory radiograph (Fig 5). A moistened cotton pellet was applied over the canal orifice and the tooth was temporarily restored.

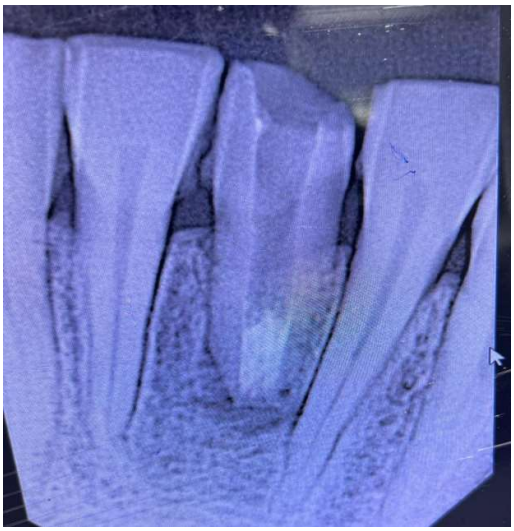

Fig 5. MTA Apical Plug

Next day, the setting of the plug was checked with an MTA plugger and the rest of the canal (Fig 6) was obturated with thermoplasticized gutta percha (Fi-G, Woodpecker) and AH Plus sealer (Dentsplay Maillerfer) using vertical compaction and followed by post endodontic restoration with composite resin was done (Fig. 7) (Tetric N Ceram, Ivoclar) followed by tooth preparation and placement of a full - coverage crown aimed to achieving optimal aesthetics, function, and long term structural support. (Fig. 8).

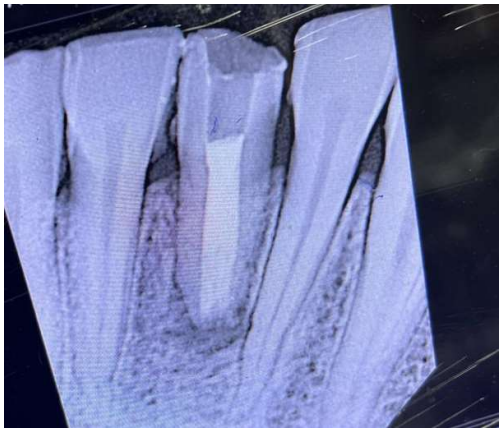

Fig 6. Obturation

Fig 7. Post Endodontic Restoration

Fig 8. Crown Cementation

The patient's asymptomatic status and progressive radiographic evidence of periapical healing at 6 months and 1 year of post-treatment indicate effective resolution of periradicular pathology. These findings underscore the significance of periodic clinical and radiographic evaluations in confirming successful healing and guiding prognosis (Fig 9, Fig 10)

Fig 9. 6 month follow up

Fig 10. 1 Year Follow

Case 2

A 19 years old male patient, reported to the Department of Conservative Dentistry & Endodontics, Kalka Dental college (Meerut) with the chief complaint of discoloration in his lower front tooth region. There was a history of trauma to the same tooth 6 years back. The medical history of the patient was non-significant. On clinical examination, tooth wrt 41 showed discoloration and was asymptomatic. Pulp sensibility testing revealed no response, indicating pulp necrosis. There was no tenderness or swelling, and no sinus tract was observed. Radiographs revealed an open apex with an immature root and a well-defined periapical radiolucency wrt 41.

The treatment plan involving MTA Apexification followed by crown restoration was explained to the patient, and written informed consent was obtained prior to initiation of the treatment. (Fig1.)

Fig 1. Preoperative Radiograph

In the first appointment, isolation was achieve using OptraDam (Ivoclar, Vivadent).

The access cavity was refined with a safe-end tapered bur (Endo Z bur, Dentsply Maillefer). A No. 15 K file was employed to achieve apical patency, with the working length measured using an apex locator (Root ZX Mini, J. Morita, Saitama, Japan) and confirmed radiographically. Cleaning and shaping were accomplished with hand K-files (Mani, New Delhi, India) and ProTaper Universal rotary files (Dentsply Maillefer). The canal were irrigated with 3% sodium hypochlorite (Hyposol; Prevest DenPro, Jammu, India), 17% EDTA (Neoedta; Orikam, Gurgaon, India), and saline, followed by drying with sterile paper points (MetaBiomed, South Korea). Triple Antibiotic paste was placed as an intracanal medicament for 21 days and the tooth was temporarily restored. (Fig 2)

Fig 2. Working Length + Master cone

After 21 days, the intracanal medicament was removed and canal was irrigated with 3% NaOCl solution (Hyposol; Prevest DenPro, Jammu, India). The canal was dried with sterile paper points (MetaBiomed, South Korea). MTA (Angelus, Londrina, Brazil) was mixed according to manufacturer's instructions. The mixture was applied inside the canal using MTA carrier and positioning of the material was checked radiographically. Using hand pluggers (Queen, Hungary), 4-mm thick MTA plug was created and packed into the apical segment followed by a confirmatory radiograph (Fig 3). A moistened cotton pellet was applied over the canal orifice and the tooth was temporarily restored.

Fig 3. MTA Apical Plug

Next day, the setting of the plug was checked with an MTA plugger and the rest of the canal (Fig 4) was obturated with thermoplasticized gutta percha (Fi-G, Woodpecker) and AH Plus sealer (Dentsplay Maillerfer) using vertical compaction. Followed by post endodontic restoration with composite resin was done (Fig. 5) (Tetric N Ceram, Ivoclar), followed by tooth preparation and the placement of a full-coverage crown to ensure functional rehabilitation, aesthetic restoration and structural reinforcement (Fig 6).

Fig 4. Obturation

Fig 5. Post endodontic restoration

Fig 6. Crown cementation

Progressive periapical healing observed radiographically at 6 and 12 months, along with the absence of symptoms, indicates effective resolution of the periradicular lesion. These results underscore the importance of periodic clinical and radiographic follow-up in evaluating the treatment success. (Fig 7 & Fig 8)

Fig 7: 6 month Follow up

Fig 8: 1 Year Follow up

3. Discussion

Various materials, including calcium hydroxide, MTA, and Biodentine, are suitable for apexification procedures. While calcium hydroxide requires a prolonged period for apical barrier formation, MTA and Biodentine offer enhanced sealing properties and shorter setting times, making them increasingly popular choices.[3]

The satisfactory characteristics of MTA make it an ideal material for various dental procedures, including apexification.[11]. Duggal et al. support the use of MTA followed by root canal filling as the treatment of choice in apexification.[12]

MTA is a substance with physicochemical characteristics that promote matrix synthesis and mineralization while promoting restorative dentinogenesis through the recruitment and activation of cells that produce hard tissue. By isolating soluble cytokines entrenched in the surrounding root dentine from growth factors in the extracellular matrix that mediate wound repair of pulp dentin complex, it induces the creation of restorative hard tissue. Fibroblasts move from the central pulp to the wound site when MTA is present. It encourages the differentiation of progenitor cells into odontoblast-like cells and the multiplication of progenitor cells without inducing cell death.[13]

When MTA comes into exposure to human tissues, it can release calcium ions for cell development. Because of alkaline pH, it also regulates the production of cytokines and supports an antimicrobial environment. As a result, it promotes hard tissue -producing cells migration and differentiation, which in turn results in the production of hydroxyapatite on the surface of MTA and formation of a biological seal.[14]

Nicoloso et al. concluded that MTA apical plugs appear to produce the best clinical and radiographic success rates among all available endodontic treatments (calcium hydroxide and regeneration) for immature necrotic permanent teeth.[15] These three systematic reviews concluded that MTA showed better clinical and radiographic results, and the apical barrier was formed in a shorter time compared to the use of calcium hydroxide.[15,16,17]

With the advent of bioceramic cements, some studies have compared their efficiency and success rate in relation MTA. However, both materials seem to show results that both MTA and bioceramic endodontic cement showed successful results in the apexification of immature permanent teeth.[10]

The 4mm thickness of the MTA plug reported in this article is in accordance with the 3 to 5mm thickness recommended in the literature. The protocol used in this reported case, as well as other published scientific studies, present a faster treatment option, using the MTA plug, a material with good physical and biological properties.[18,19]

The use of MTA as an apical barrier allows the immediate accomplishment of the root canal filling and final restoration, probably reducing the possibility of recontamination of the root canal system as well as the risk of tooth fracture, increasing the probability of obtaining favourable results.[20]

4. Conclusion

Apexification with a novel biocompatible material like MTA is a new boon in effective management of the teeth with open apex. This case illustrates that MTA apexification is a predictable and efficient treatment modality for managing nonvital immature teeth, promoting apical barrier formation and periapical healing with fewer visits and improved patient compliance.

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