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Case Report

Single-visit MTA apexification: A progressive approach for immature teeth with Ellis Class IV fractures- case report

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ABSTRACT

Trauma to developing teeth can disrupt root formation, leading to an open apex and complicating endodontic treatment. Apexification is essential in managing immature non-vital teeth to induce a calcified apical barrier for effective obturation. Traditionally, calcium hydroxide has been the material of choice, but it presents challenges such as extended treatment time and risk of root fractures. Mineral trioxide aggregate (MTA) has emerged as a reliable alternative, offering faster treatment with fewer complications.
A 12-year-old male presented with a history of trauma to the maxillary central incisors (teeth 11 and 21), resulting in Ellis Class IV fractures. The trauma occurred six months prior during a fall. Clinical examination revealed pulpal necrosis, and radiographs confirmed incomplete root formation with open apices. The patient underwent root canal therapy, including pulpal debridement and one-visit apexification with MTA to induce an apical barrier. The MTA was compacted at the apical ends of the canals to provide immediate sealing.
Root canal obturation was successfully completed, and radiographic follow-up demonstrated satisfactory apical sealing. The patient experienced no post-operative complications, and long-term follow-up will be conducted to monitor root maturation and tooth stability.
MTA provides an efficient, biocompatible alternative to calcium hydroxide in apexification, offering faster treatment and reduced risk of root fracture. One-visit apexification with MTA can be considered a viable treatment for non-vital immature permanent teeth with open apices.

1. Introduction

Trauma to developing teeth during root formation can result in incomplete root development, leading to an open apex. Endodontic treatment is essential for eliminating infection from the root canal and preserving the tooth. However, the lack of a natural apical constriction in a non-vital permanent tooth presents challenges during treatment. To facilitate effective obturation, it becomes necessary to create or induce an apical barrier. Traditionally, calcium hydroxide has been the gold standard for promoting apexification, allowing the obturating material to be condensed against the newly formed barrier. Apexification is described as the process of inducing a calcified barrier at the root's open apex or promoting continued apical development in an immature root with necrotic pulp.[1]

Among various materials suggested for apical barrier induction, calcium hydroxide has been the most widely

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used. Its use was first introduced by Kaiser in 1964, who demonstrated that mixing calcium hydroxide with camphorated Para chlorophenol (CMCP) could stimulate the formation of a calcified barrier at the apex of the tooth.[2]

However, Calcium hydroxide [Ca $(OH)_2$] apexification often requires multiple monthly visits to eradicate intracanal infection. It has notable drawbacks, including altering the mechanical properties of dentin, which increases the risk of root fractures. Additionally, it can take 5 to 20 months for a calcific barrier to form, and the resulting apical plug may not be entirely impervious due to porosities in the barrier.[3]

Although calcium hydroxide has long been the preferred material for apexification, researchers have explored other alternatives. In recent years, attention has shifted to mineral trioxide aggregate (MTA) for one-visit apexification. Morse et al. describe one-visit apexification as the non-surgical compaction of a biocompatible material at the apical end of the root canal, creating an immediate apical stop that allows for prompt root canal filling.[4]

2. Case Report

A 12-year-old male patient presented with a history of trauma from a fall, which resulted in fractures of the maxillary central incisors (teeth 11 and 21). The trauma had occurred six months prior while playing at school. Upon clinical examination, both teeth exhibited Ellis Class IV fractures, discoloration, and tenderness to percussion, suggesting pulpal necrosis. (Figure 1)

Radiological investigations confirmed incomplete root development and open apices in both teeth (Figure 2). After discussing the treatment options with the patient's parents, root canal therapy was chosen as the preferred approach. Informed consent was obtained from the parents, ensuring ethical compliance. The procedure involved pulpal debridement under rubber dam isolation, followed by the placement of mineral trioxide aggregate (MTA) to facilitate apical barrier formation. Subsequently, obturation was performed to ensure proper sealing of the root canal system.

2.1. The treatment plan was carried out in two stages

2.1.1. Apexification procedure

1. Access opening done followed by initial working length determination done with #15 K file. (Figure 3)
2. The canal was irrigated with saline. Biomechanical preparation was performed using 60 K-file with a circumferential filing motion.
3. Thorough root canal debridement was achieved with alternating irrigation using a generous amount of 2.5% sodium hypochlorite (NaOCl) and saline.
4. Smear layer removal was carried out using 3 ml of 17% ethylene diamine tetra acetic acid (EDTA) solution. Calcium hydroxide paste was placed in the root canal as a disinfectant, and the access cavity was restored with temporary filling.
5. The patient was recalled after 7 days. At the follow-up appointment, the root canal was irrigated to remove any remnants of calcium hydroxide and ensure complete disinfection.
6. The canal was dried with absorbent paper points. White MTA Angelus was mixed with distilled water according to the manufacturer's instructions and placed in the canal with an amalgam carrier.
7. An apical plug of approximately 4 mm of MTA was placed and confirmed radiographically (Figure 4). A sterile cotton pellet moistened with sterile water was placed over the canal orifice, and the access cavity was sealed with temporary filling.

2.1.2. Obturation and restoration

1. After 48 hours, the MTA was confirmed to have set properly. The remaining part of the root canal was obturated with gutta-percha and root canal sealer using the lateral condensation technique (Figure 5). The access cavity was sealed with glass ionomer cement. Composite build up was performed to restore the structural integrity of the teeth, followed by full-coverage crowns for esthetics. (Figure 6)

Figure 1: Pre-operative (Facial view)

Figure 2: Pre-operative IOPA

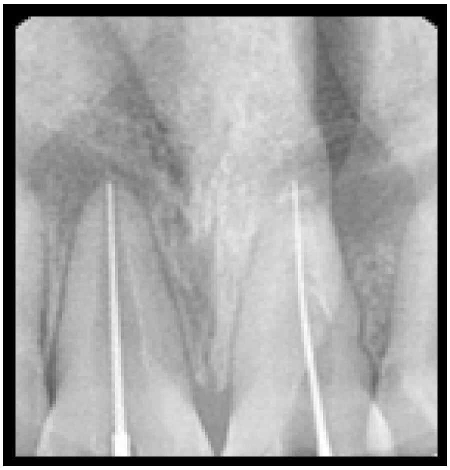

Figure 3: Initial working length determination with #15 K File irt 11,21

Figure 4: MTA plug formation after 24 hours

Figure 5: Obturation done by lateral condensation method irt 11,21

Figure 6: Post-operative - Composite buildup done IRT 11,21 followed by esthetic crown

Figure 7: A post-operative radiograph at a 3-month follow-up showed a reduction in the size of the periapical radiolucency

A post-operative radiograph at a 3-month follow-up showed a reduction in the size of the periapical radiolucency and follow-up radiographs confirmed adequate apical closure. (Figure 7)

3. Discussion

Apexification is a vital endodontic procedure aimed at creating an environment conducive to the continued deposition of cementum, bone, and periodontal ligament, thereby supporting ongoing root development. The primary objective of this treatment is to establish an apical barrier that prevents the ingress of toxins and bacteria into the periapical tissues through the root canal. This barrier is crucial as it ensures proper compaction of the root filling material, thereby enhancing treatment success.[5]

Mineral Trioxide Aggregate (MTA), developed in the 1990s at Loma Linda University, emerged as a root-end filling material and an alternative to traditional materials for repairing root perforations, pulp capping, and retrograde root fillings. Its superior biocompatibility and ability to effectively seal the root canal system have made it a preferred choice in endodontics. Torabinejad identified MTA's key components as tricalcium silicate, tricalcium aluminate, tricalcium oxide, and silicate oxide, along with other mineral oxides that contribute to its chemical and physical properties. The powder consists of fine hydrophilic particles that set in the presence of moisture. Upon hydration, it forms a colloidal gel with an initial pH of 10.2, which rises to 12.5 within three hours, ultimately hardening in approximately three hours.[6]

Single-visit apexification, a non-surgical technique, involves the condensation of a biocompatible material into the apical end of the root canal to create an apical stop, allowing for the immediate filling of the root canal. MTA offers several advantages in this context: (i) it reduces treatment time, (ii) enables prompt tooth restoration, thereby preventing root fractures, and (iii) minimizes alterations in the mechanical properties of dentin that may result from prolonged calcium hydroxide use. Furthermore, MTA exhibits excellent biological properties, promoting repair, sealing ability, and antibacterial effects due to its high pH.[7]

In the presented case, MTA facilitated apical barrier formation in a single visit, eliminating the need for prolonged calcium hydroxide therapy. Additionally, the use of Ribbond and composite post-core buildup provided both esthetics and functional rehabilitation. Literature supports this approach, demonstrating high success rates in similar cases. However, regular clinical and radiographic monitoring remains essential to ensure long-term success.

Torabinejad et al.,[8] in their comprehensive literature review, highlighted that MTA offers superior long-term outcomes for direct pulp capping compared to calcium hydroxide. However, its prolonged setting time remains a notable drawback. Studies have reported varying setting times for MTA; for instance, Torabinejad et al. (1995) observed a setting time of approximately 2 hours and 45 minutes for grey MTA, while Islam et al. (2006) recorded 2 hours and 55 minutes for grey MTA and 2 hours and 20 minutes for white MTA.[9] Sluyk et al. (1998) suggested an optimal mixing time of less than four minutes for improved handling. Despite these benefits, concerns persist regarding the high cost and potential discoloration associated with grey MTA.[10]

When MTA comes into contact with tissue synthetic fluid, hydroxyapatite crystals form on its surface, serving as a nucleus for calcified structure formation in endodontic treatments. While human studies have reported positive outcomes with MTA, authors have emphasized the need for further longitudinal studies. The absence of well-designed and controlled clinical trials currently limits the ability to conduct systematic reviews and meta-analyses on MTA's various clinical applications.[8]

Tziafas et al. investigated the early pulpal cell response and reparative dentin formation following MTA application in mechanically exposed pulps. Their findings demonstrated MTA's dentinogenic potential, surpassing that of calcium hydroxide, which remains a viable option for cases requiring rapid healing. While MTA promotes dentin formation, calcium hydroxide may still be preferred in certain clinical scenarios.[11]

In comparison, Biodentine has emerged as a material with superior physical and biological properties, offering easier handling than MTA. Kokate et al. evaluated microleakage using dye penetration and concluded that Biodentine exhibited the least leakage compared to MTA and glass ionomer cement.[12] Refaei et al. assessed the sealing efficiency in open-apex teeth and found Biodentine to be more effective than ProRoot MTA.[13] Similarly, Tang et al. demonstrated Biodentine' s superior sealing ability in root-end fillings, further reinforcing its clinical advantages over MTA.[14]

Kalaoglu et al. emphasized the importance of treatment duration, particularly in uncooperative pediatric patients where general anaesthesia or sedation is not an option. Their study found that Biodentine outperformed MTA in terms of filling speed, making it a more practical choice in such cases. Given these findings, the selection of an appropriate material should be based on clinical requirements, ensuring optimal outcomes for apexification procedures.[15]

4. Limitation

MTA has several limitations in apexification procedures. Its prolonged setting time (2-3 hours) can delay treatment, requiring proper isolation and the use of faster-setting alternatives when need. Handling MTA can be challenging, particularly in narrow canals, and it may lead to air voids or contamination; this can be mitigated by using proper mixing techniques and specialized delivery systems. Grey MTA can cause tooth discoloration, so white MTA or alternatives like Biodentine are preferred in aesthetic areas. The high cost of MTA may limit its use, and careful moisture control is essential, as excessive moisture can interfere with its setting. Overextension of MTA can lead to complications, requiring meticulous placement, and its strong bonding properties make retreatment difficult, necessitating specialized tools or alternative materials.

5. Conclusion

In conclusion, this case report underscores the clinical success of single-visit apexification using Mineral Trioxide Aggregate (MTA) in the management of non-vital, immature permanent teeth following trauma. The patient, a 12-year-old male, presented with delayed pulp necrosis and open apices six months post-trauma. The use of MTA not only facilitated the formation of an apical barrier but also minimized treatment duration, enhanced patient comfort, and ensured effective sealing of the root canal system.

This case highlights the advantages of MTA in pediatric apexification, especially in cases where timely intervention is crucial.

The favourable clinical and radiographic outcomes, including apical closure and periapical healing, contribute valuable insights to endodontic literature, demonstrating MTA's potential as a preferred material for single-visit apexification. Furthermore, the emphasis on long-term follow-up to monitor root development and apical maturation reinforces the importance of ongoing care in ensuring lasting success. This report adds to the growing body of evidence supporting the use of MTA in pediatric endodontics, offering a promising approach to managing immature teeth with pulpal necrosis.

6. Source of Funding

None.

7. Conflict of Interest

None.

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