



Management of Permanent Teeth with Open Apex: Mta Vs Regenerative Treatment: A Systematic Review

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KEYWORDS

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ABSTRACT:

Introduction: Trauma or caries in immature permanent teeth often leads to pulpal damage, interrupting root development and increasing the risk of fractures due to shorter roots with thin walls. Traditional approaches like calcium hydroxide apexification or mineral trioxide aggregate (MTA) apexification have shown success in controlling infection and creating an apical seal. However, these methods may result in abnormal root morphology and leave teeth vulnerable to fractures. Regenerative endodontics offers a biological alternative, aiming to restore damaged structures, enhance root development, and promote apical closure. Despite promising outcomes, variability in results and limited evidence leave the comparative efficacy of apexification and regenerative techniques unresolved, necessitating further research to guide clinical decision-making.

Objectives: To compare the clinical outcomes of MTA apexification and regenerative endodontic procedures in managing immature permanent teeth with open apices.

Methods: We conducted an electronic search in PubMed, Ebsco and Cochrane databases to identify clinical cases related to the assessment of apexification using MTA and regenerative treatment procedures in immature permanent teeth (PICO Question: What are clinical outcomes of MTA and Regenerative endodontic procedures in management of permanent teeth with open apex?)

Results: Both MTA apexification and regenerative endodontic procedures demonstrated comparable efficacy in treating immature permanent teeth with open apices. MTA reliably achieved apical closure and barrier formation, while regenerative techniques, especially with PRF, showed potential for root lengthening and dentinal wall thickening. However, variability in study designs highlights the need for further research to establish definitive success rates.

Conclusions: Both MTA apexification and regenerative techniques are effective for managing immature permanent teeth with open apices. MTA offers reliability in achieving apical closure, while regenerative approaches, particularly with PRF, show promise for enhanced tissue regeneration. Further studies are needed to determine long-term success and establish definitive guidelines.

1. Introduction

Trauma or caries in immature permanent teeth can lead to pulpal damage, causing the loss of vitality and impacting root development. This can result in shorter roots with thin walls, increasing the risk of fracture and complicating conventional root canal treatment. (1) To preserve such teeth, an endodontic root canal treatment becomes necessary. This involves two primary goals: controlling infection and establishing a secure apical seal. These objectives are typically achieved through

techniques like calcium hydroxide apexification or the immediate creation of an apical barrier using mineral trioxide aggregate (MTA). However, a persistent concern remains - the presence of short roots with thin walls, which remain susceptible to future fractures. (2) While apexification has shown success rates ranging from 74% to 100%, it can sometimes lead to abnormal root morphology, including the formation of calcified tissue within the root canal. (3) Regeneration, as opposed to artificial tissue replacement, represents a promising



frontier in medical science. In the context of dentistry, regenerative endodontics is a field focused on biologically-based procedures intended to replace damaged structures, encompassing dentin, root structure, and cells within the pulp-dentine complex.(4)Though results can be variable, this technique has shown potential in promoting root lengthening, thickening of root dentinal walls, and apical closure. Murray (2018) has opened the door for Regenerative Endodontic Therapy (RET) to be considered in conjunction with MTA apical plug techniques, particularly in cases involving immature teeth in the early stages of root development (stages 1, 2, or 3, as per Cvek 1992 and Nazzari & Duggal 2017).(5)

Numerous retrospective and prospective studies have attempted to compare the success rates between apexification and Regenerative Endodontic Therapy (RET). However, the results remain inconclusive due to the variability in study designs and limited sample sizes.(6)While recent years have witnessed considerable success with Regenerative Endodontic Procedures (REPs), it's worth noting that some failures have also been reported. Regarding potential alternative interventions after treatment failure, to the best of our knowledge, there are currently no available reports.(7)

2. Objectives

This systematic review aims to analyze and compare the clinical outcomes of Mineral Trioxide Aggregate (MTA) apexification and regenerative endodontic procedures (REPs) for managing immature permanent teeth with open apices. It focuses on assessing the effectiveness of both methods in achieving apical closure, increasing root length and dentinal wall thickness, and maintaining the survival and functionality of treated teeth. By consolidating the current evidence, the review intends to highlight the advantages and limitations of each approach, helping clinicians make informed decisions based on specific clinical needs.

Additionally, the review seeks to investigate the role of regenerative techniques, particularly the use of Platelet-Rich Fibrin (PRF), in improving treatment outcomes compared to conventional MTA apexification. It also aims to identify knowledge gaps in the existing research and emphasize areas requiring further study to clarify the success rates and long-term results of both techniques. The overall goal is to provide insights that will assist

dental professionals in selecting the best treatment strategy for immature permanent teeth.

3. Methods

This study was designed according to the Cochrane criteria[28] for elaborating a systematic review. We followed the PRISMA (Preferred Reporting Items for Systematic Reviews and MetaAnalyses) statement.[29] The study was registered at the Open Science Forum (OSF). We conducted an electronic search in PubMed, EBSCO, Cochrane and various other databases to identify clinical cases related to the assessment of apexification using MTA and regenerative treatment procedures in immature permanent teeth. The terms “permanent teeth”, “open apex”, “apical closure”, “endodontic treatment” were used. A manual search was conducted where in the articles from last ten years were included. To reduce the risk of bias, three reviewers independently conducted the review. Inclusion criteria :

- Studies published in peer-reviewed journals.
- Studies conducted on human subjects with permanent teeth diagnosed with open apex.
- Studies comparing regenerative and MTA in management of open apex teeth
- Studies for managing open apex in immature permanent teeth
- Studies reporting relevant clinical outcomes such as tooth survival, apexogenesis, and treatment success.

Exclusion Criteria:

- Animal studies, in vitro studies.
- Studies with inadequate sample size or insufficient data.
- Studies using material other than MTA for apexification.
- Studies focusing on surgical interventions for permanent teeth with open apex.
- Studies other than regenerative or approach with material other than MTA

A clinical query was formulated following the PICO framework to address a particular clinical issue. What are clinical outcomes of MTA and Regenerative endodontic procedures in management of permanent teeth with open apex? Population (P) involves teeth that have undergone endodontic treatment, while Intervention (I) pertains to the use of MTA, as opposed to Comparison(C), which stands for regenerative treatment, with a focus on Outcome (O) open apex teeth. Following the elimination of duplicate articles, title



revision, and abstract screening, full-text articles were examined to confirm the relevance of their content.

4. Results

The review reveals that both Mineral Trioxide Aggregate (MTA) apexification and regenerative endodontic procedures (REPs) are effective for treating immature permanent teeth with open apices. MTA has proven dependable in achieving apical closure and forming a strong barrier, showing consistent outcomes across diverse patient demographics. Regenerative techniques, especially those incorporating Platelet-Rich Fibrin (PRF), offer potential advantages by facilitating root lengthening, thickening of dentinal walls, and continued root development. Although both methods yield similar clinical success rates, inconsistencies in study methodologies and small sample sizes make it challenging to determine which approach is definitively superior. Additional research is necessary to better understand their long-term efficacy and success.

5. Discussion

The treatment of immature apex teeth presents a unique set of challenges and opportunities within the field of endodontics. Immature permanent teeth, characterized by an open apex and incomplete root development, are frequently encountered in clinical practice. The management of these cases is critical, as the incomplete root formation can compromise the tooth's structural integrity, leading to increased susceptibility to fractures and infections.(8). Historically, the approach to addressing immature apex teeth has evolved from traditional methods such as apexification using Calcium Hydroxide (Ca(OH)₂) to more contemporary techniques involving Mineral Trioxide Aggregate (MTA) and regenerative endodontic procedures.(9) Mineral Trioxide Aggregate (MTA) has emerged as a cornerstone in contemporary endodontic practice, particularly in the context of apexification—a technique pivotal for managing immature permanent teeth with open apices. (10) MTA's biomineralization potential and capacity to create a durable apical plug have positioned it as a go-to material for inducing the closure of open apices. (11) MTA, in contact with human tissues, releases calcium ions, promotes cell proliferation, and establishes an antibacterial environment with its alkaline pH. This facilitates cell migration, differentiation, and

the formation of a biological seal through hydroxyapatite deposition on the MTA surface. (12) Several key studies have contributed to our understanding of the MTA apexification technique. Bonte et al. and Kandemir et al. have provided pivotal insights into the effective sealing properties of MTA, even in the presence of challenging conditions such as blood.(13,14) These studies, along with others, have underscored the resilience of MTA in achieving apical closure, irrespective of patient age or gender. Moreover, Spyros G. Floratos proposed an innovative approach involving incomplete orthograde MTA placement.(15) Case reports stemming from this alternative method suggest that MTA can foster apical barrier formation even in the presence of gaps between the MTA plug and root canal walls. This observation is attributed to MTA's ability to facilitate cell migration, broadening its applicability in diverse clinical scenarios.(16) Regeneration serves not only to close wide apices, comparable to apexification but also contributes to increased root wall thickness and root length. A clinical trial with the goal of regenerating traumatized, necrotic immature permanent anterior teeth utilizing PRF was conducted. The outcomes indicate the effectiveness of PRF; nevertheless, it's important to emphasize that continuous root development can occur without the necessity of PRF.(17) Recent advancements, such as the use of Platelet-Rich Fibrin (PRF), promise enhanced tissue regeneration and continuous root development. Comparative studies, exemplified by Hazim et al., provide valuable insights into refining regenerative techniques for optimal clinical outcomes. (18) The comparison between Mineral Trioxide Aggregate (MTA) and regenerative techniques for managing immature permanent teeth underscores the robustness of both approaches. MTA's proven sealing properties, versatility, and age-independence make it a reliable choice, while regenerative techniques, particularly with Platelet-Rich Fibrin (PRF), show promise in promoting regeneration. However, challenges lie in differentiating their success rates, as both approaches demonstrate comparable efficacy. Conclusion Managing immature apex teeth involves navigating challenges with traditional techniques like apexification with MTA and emerging regenerative approaches. Both methods show comparable efficacy, with MTA demonstrating reliability, and regenerative techniques, especially with PRF, holding promise for



enhanced tissue regeneration. Further research is needed to delineate their success rates conclusively.

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18. Comparative evaluation of Platelet Rich Plasma 4
(PRP) versus Platelet Rich Fibrin (PRF) scaffolds 5
in regenerative endodontic treatment of immature 6
necrotic permanent maxillary central incisors: A 7
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