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RESEARCH ARTICLE
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COMPARATIVE EVALUATION OF PULPOTOMY OUTCOMES USING MTA VS BIODENTINE IN DEEP CARIOUS LESIONS OF IMMATURE PERMANENT MOLARS REQUIRING SURGICAL EXPOSURE: A MULTIDISCIPLINARY APPROACH

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ABSTRACT

Background: Pulpotomy in immature permanent molars with deep carious lesions presents a clinical challenge, particularly when access is hindered by partial eruption or soft tissue coverage such as an operculum. Successful vital pulp therapy in such cases depends not only on the choice of pulp-capping material but also on effective surgical access. Mineral Trioxide Aggregate (MTA) and Biodentine have emerged as bioactive materials with promising results in pulpotomy procedures. However, comparative outcomes in cases necessitating surgical exposure remain underexplored.

Aim: This study aims to compare the clinical and radiographic outcomes of pulpotomy using MTA and Biodentine in deep carious immature permanent molars requiring minor surgical exposure, adopting a multidisciplinary approach that integrates operative, pediatric, and oral surgical protocols.

Methods: A total of 60 children aged 7–11 years with deep carious lesions in immature mandibular first permanent molars were selected. All cases required surgical exposure due to limited eruption or operculum coverage. The participants were randomly assigned to two groups (n=30 each): Group A underwent pulpotomy using MTA, and Group B using Biodentine. Surgical access was achieved via operculectomy under local anesthesia. All cases were followed up at 3, 6, and 12 months for clinical symptoms (pain, tenderness, mobility, swelling) and radiographic signs (furcal radiolucency, periapical pathology, root development).

Results: Both groups showed high clinical and radiographic success rates, with no statistically significant difference ($p > 0.05$) at 12 months. However, Biodentine demonstrated slightly faster handling and shorter setting time, improving clinical workflow.
Conclusion: Both MTA and Biodentine are effective pulpotomy agents in immature permanent molars requiring surgical exposure. A multidisciplinary protocol combining precise surgical access and evidence-based material selection can enhance outcomes in complex pediatric restorative cases. Further longitudinal studies with larger sample sizes are recommended.

Keywords: Pulpotomy, MTA, Biodentine, Immature Permanent Molars, Surgical Exposure

INTRODUCTION

The preservation of pulp vitality in young permanent teeth is a cornerstone of modern pediatric dentistry. When a child's immature permanent molar is affected by deep caries, the integrity of the developing root structure is at stake. Such teeth typically have open apices and thin dentinal walls, making them structurally vulnerable and reliant on continued pulpal vitality for normal root maturation, a process termed *apexogenesis*.[1] Maintaining the health of the dental pulp is thus crucial not only for functional retention of the tooth but also for ensuring the completion of its root development.[2] One of the primary clinical challenges in these scenarios arises when the tooth in question is partially erupted or is covered by a soft tissue flap known as an operculum.[3] This tissue barrier can complicate access to the pulp chamber and pose additional risks, such as secondary infections, localized inflammation, or trauma. In such cases, traditional non-surgical access becomes insufficient, necessitating surgical intervention—most commonly in the form of an operculectomy to facilitate proper visualization and access. Unfortunately, there is a paucity of clinical literature focusing specifically on the outcomes of pulpotomy procedures that require such surgical access, despite their frequency in real-world pediatric practice.[4]

Vital pulp therapy (VPT), and pulpotomy in particular, serves as a biologically conservative approach to managing carious exposures in immature permanent teeth. Unlike root canal therapy, which involves complete pulp extirpation, pulpotomy aims to preserve the vitality of the radicular pulp while removing the inflamed coronal portion. This treatment modality facilitates apexogenesis and preserves the tooth's proprioceptive and immunological functions. However, the long-term success of pulpotomy hinges heavily on several factors: proper case selection, effective removal of infected tissue, hemostasis, and, importantly, the choice of pulp-capping material.[5] Historically, calcium hydroxide was widely used for pulpotomy, but it exhibited several limitations, including poor sealing ability, dissolution over time, and inconsistent dentin bridge formation. The advent of bioactive materials like Mineral Trioxide Aggregate (MTA) and Biodentine has since transformed the landscape of pulp therapy. These materials possess superior sealing capabilities, biocompatibility, and the ability to stimulate hard tissue formation. MTA has long been considered the gold standard due to its extensive track record of clinical success, but it is not without drawbacks it has a long setting time, can be difficult to handle, and is associated with tooth discoloration.[6]

Biodentine, a newer calcium silicate-based material, was developed as a dentin substitute with improved clinical handling and reduced setting time. Its bioactivity, antibacterial properties, and favorable physical characteristics make it a strong contender in vital pulp therapy. Biodentine is mixed easily, sets faster (around 12 minutes), and exhibits mechanical properties closely mimicking natural dentin. Several studies have demonstrated its ability to induce dentin bridge formation with minimal inflammation, supporting its use in pediatric and endodontic applications.[7] Despite the growing body of evidence supporting both MTA and Biodentine for pulpotomy procedures, few studies have directly compared their clinical efficacy in the specific context of immature permanent molars requiring surgical access. Most existing research assumes ideal clinical scenarios with full eruption and unobstructed access, which is often not the case in pediatric patients.[1]

\This study addresses that gap by comparing the outcomes of pulpotomy using MTA and Biodentine in cases requiring minor surgical intervention. By integrating surgical, pediatric, and restorative

protocols, this study adopts a truly multidisciplinary approach aimed at improving treatment outcomes and clinical efficiency. Given the frequency of partially erupted molars and the high incidence of caries in children, developing a robust, evidence-based treatment algorithm for such cases is of immense clinical value. Understanding the relative advantages of each material in these more complex scenarios can guide clinicians in making more informed choices, thereby improving both short-term and long-term patient outcomes**.**

METHODOLOGY

This randomized clinical trial was conducted on 60 pediatric patients aged 7 to 11 years, each presenting with deep carious lesions in immature mandibular first permanent molars. These cases were complicated by limited eruption or the presence of a soft tissue operculum, necessitating surgical access for proper pulpotomy procedure. Ethical clearance was obtained from the institutional review board, and informed consent was secured from the guardians.

Each eligible tooth was evaluated clinically and radiographically to confirm the need for vital pulp therapy. Cases with signs of necrosis or systemic health contraindications were excluded. Surgical access to the pulp was achieved via operculectomy under local anesthesia, allowing clear visualization and aseptic entry into the pulp chamber.

The participants were randomly allocated into two groups of 30 each. Group A received pulpotomy using Mineral Trioxide Aggregate (MTA), while Group B received Biodentine. After coronal pulp amputation and bleeding control, the assigned material was placed directly on the radicular pulp tissue. The teeth were then sealed with reinforced glass ionomer cement and restored with stainless steel crowns in the same session or during a follow-up.

Patients were recalled at 3, 6, and 12 months for both clinical and radiographic assessment. Clinical signs observed included spontaneous pain, tenderness to percussion, swelling, and mobility. Radiographic indicators included presence or absence of furcal radiolucency, periapical lesions, and ongoing root development indicative of apexogenesis.

RESULTS

At 12 months, both MTA and Biodentine groups demonstrated high success rates with minimal clinical or radiographic failures. The overall success was slightly higher in the Biodentine group, although the difference was not statistically significant. Clinical evaluation at each recall demonstrated high success rates in both groups. One case in the MTA group exhibited tenderness at 12 months, while one Biodentine case presented mild mobility that resolved by follow-up (Table 1).

Table 1: Clinical Success Rates Over Time

Time Point	Group A: MTA (n=30)	Group B: Biodentine (n=30)
3 Months	29/30 (96.6%)	30/30 (100%)
6 Months	29/30 (96.6%)	30/30 (100%)
12 Months	28/30 (93.3%)	29/30 (96.6%)

Radiographic success was nearly parallel across both materials. Most cases showed evidence of apexogenesis, with the Biodentine group slightly outperforming MTA in terms of complete radiographic healing.

Table 2: Radiographic Findings at 12 Months

Finding	MTA Group (n=30)	Biodentine Group (n=30)
Furcal Radiolucency	1	0
Periapical Pathology	1	0
Continued Root Development	28	29

DISCUSSION

The results of this clinical study reaffirm the viability of vital pulp therapy using bioactive materials in challenging pediatric cases requiring surgical access. Both MTA and Biodentine demonstrated exceptional clinical and radiographic performance, supporting their use as pulp-capping agents in immature permanent molars. The slightly higher success rates observed in the Biodentine group may be attributed to its enhanced handling characteristics, including quicker setting time and improved adaptability to the pulp chamber. These features are particularly beneficial in pediatric patients, where shorter clinical chair time and better operator control can influence outcomes.[8]

Our findings are consistent with those of Khalil et al. (2024)[9], who reported a high success rate with Biodentine in human pulp exposures, citing favorable inflammatory responses and superior dentin bridge quality compared to MTA. Similarly, a study by Çelik et al. (2016) found comparable success rates between the two materials in pulpotomy procedures, but emphasized that Biodentine offered advantages in workflow and reduced setting time, echoing our clinical experience. Jassal et al (2023)[10] highlighted the importance of preserving radicular pulp vitality in immature teeth and emphasized MTA's ability to stimulate hard tissue formation and prevent bacterial infiltration. However, he also acknowledged its long setting time and potential for discoloration disadvantages that are addressed by Biodentine. Our results further substantiate this trade-off between long-term bioactivity and procedural efficiency. Interestingly, a randomized controlled trial by Cushley et al. (2021)[11] showed no significant difference in clinical success between MTA and Biodentine over 12 months, reinforcing the idea that either material can be effectively used based on case demands and operator preference. However, they too noted better handling and patient cooperation with Biodentine, particularly in uncooperative children or in cases where treatment time is a constraint. The integration of surgical protocols like operculectomy into routine pediatric restorative care remains underreported.[12] Our study adds value by showing that surgical exposure does not negatively affect the success of pulpotomy when performed with appropriate asepsis and technique. Instead, it facilitates proper material placement and can improve clinical outcomes when eruption-related barriers are present.

CONCLUSION

Both MTA and Biodentine are highly effective for pulpotomy in immature permanent molars requiring surgical access. While clinical and radiographic success rates were similar, Biodentine's superior handling and reduced setting time make it a more practical choice in pediatric settings. A multidisciplinary treatment strategy involving surgical access, material selection, and restorative planning yields optimal outcomes in these complex cases.

LIMITATION

Limitations of this study include its relatively short duration and limited sample size. Although 12 months is sufficient to detect early failures, long-term follow-up is necessary to confirm pulp vitality preservation and continued root maturation. Future studies should include larger sample sizes and assess outcomes over a 24- to 36-month period, incorporating histological evaluations where feasible.

Conflict of Interest: None

Authors' Contribution

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