

Comparison of Mineral Trioxide Aggregate (MTA), Biodentine, and Calcium-Enriched Mixture Cement in Pulpotomy Procedures

Gunjan Chawla*

BDS, MDS, (Conservative dentistry & Endodontics), India.

ABSTRACT

Pulpotomy is still one of the pillars of vital pulp therapy, whereby the goal is to maintain the vitality of the functional pulp of the tooth, and to remove inflamed tissue. The decision of pulp-capping material is a strong determinant of the success of this procedure since biocompatibility of the material, its sealing power, and the ability to induce the growth of dentin bridges are strong determinants of the prognosis in the long-term. Mineral Trioxide Aggregate (MTA), Biodentine, and Calcium-Enriched Mixture (CEM) cement are the most popular bioactive cement to study in pulpotomy. MTA has shown stable clinical results because of its high sealing capacity and biological characteristics but limitations to its universal use are the time-consuming setting and difficulties in handling. Biodentine is an interesting dentin substitute with good handling properties and quicker setting, as well as, bioactivity, and less microleakage, and is a clinically appealing option. With its calcium-based composition, CEM cement demonstrates antimicrobial property, dentinogenic potential, and cost-efficiency that makes it a prospective material in the wide range of clinical solutions.

Recent data indicate that there are similar clinical rates of success with these three materials, but that differences exist in the characteristics of handling, radiographic results and the patient's consideration. The use of advanced diagnostic systems, including cone-beam computed tomography (CBCT), has also contributed to the possibility of measuring the outcomes of healing and treatment and making evidence-based decisions regarding the choice of material. Together, the existing literature facilitates the application of MTA, Biodentine, and CEM cement as the viable alternative in pulpotomy, and the choice has been usually under the influence of the case requirements, the preference of an operator, as well as availability of materials. Long-term follow-ups should be done in the future to fine tune the clinical procedures and draw final guidelines on the use of these in the vital pulp therapy.

Keywords: Mineral Trioxide Aggregate, Biodentine, Calcium-Enriched Mixture, Pulpotomy, Vital Pulp Therapy, Bioceramics.

1. INTRODUCTION

Vital pulp therapy (VPT) is a procedure that has acquired a new importance as dentistry turns into a field of minimally invasive and biologically oriented practices.¹⁻³ By preserving the vitality of the radicular pulp and eliminating the infection of the coronal pulp, pulpotomy procedures enable keeping the teeth long-term instead of using the more invasive treatment.⁵⁻¹⁰

The material used is an important factor in determining the success of pulpotomy, and it should include biocompatibility, sealing, antimicrobial protection, and the promotion of the formation of hard tissue. Mineral Trioxide Aggregate (MTA) is generally considered as the standard material, but such disadvantages as long set time, discoloration of teeth, and cost are leading to

the creation of alternatives. More recent calcium silicate cement is biodentine, which has fast setting, better handling and esthetic benefits. Calcium-Enriched Mixture (CEM) is a bioceramic that proves to be economical when compared to the rest, exhibiting similar biological performance and antimicrobial properties but is currently less researched.

Treatment planning and outcome assessment is further enhanced by the use of more sophisticated diagnostic modalities like cone-beam computed tomography (CBCT), which enables clinicians to assess the process of dentin bridge formation and periapical healing with a high degree of accuracy.¹¹⁻¹⁴

The review is a comparison of MTA, Biodentine, and CEM cement in pulpotomy procedures, their biological nature, clinical results, limitations, and future outlook.

Corresponding author

Gunjan Chawla

Email : Gunjanchawla84@gmail.com

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2. METHODS

A narrative literature review was conducted using databases including PubMed, Scopus, and Google Scholar. The search covered studies published up to 2022 with the following keywords: Mineral Trioxide Aggregate, Biodentine, Calcium-Enriched Mixture, Pulpotomy, Vital Pulp Therapy, Bioceramic Materials. Relevant studies evaluating material composition, biological response, handling properties, clinical outcomes, and limitations were included.^{15,16} Priority was given to clinical trials, systematic reviews, and key in-vitro studies. Reference lists of retrieved articles were screened to ensure completeness. The review also integrated key insights from Singh to contextualize findings.

3. RESULTS

3.1. Mineral Trioxide Aggregate (MTA)

- **Success rate:** ~95% in pulpotomy outcomes.
- **Advantages:** Biocompatibility, excellent sealing, predictable dentin bridge formation.¹⁷
- **Limitations:** Long setting time (3–4 hrs), potential tooth discoloration, expensive.¹⁸
- **Applications:** Gold standard in permanent teeth requiring long-term reliability.¹⁹

3.2. Biodentine

- **Success rate:** ~90–95%.
- **Advantages:** Rapid setting (~12 minutes), tooth-colored, easy handling.
- **Limitations:** Higher cost, fewer long-term clinical trials compared with MTA.
- **Applications:** Favorable in pediatric and esthetic cases.²⁰

3.3. Calcium-Enriched Mixture (CEM) Cement

- **Success rate:** ~85–90%.

- **Advantages:** Antimicrobial, dentinogenic, cost-effective.
- **Limitations:** Limited global availability, evidence base still emerging.
- **Applications:** Promising in resource-limited settings.

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4. DISCUSSION

The comparative analysis demonstrates that MTA remains the gold standard for pulpotomy due to its well-documented clinical reliability. Its ability to promote dentinogenesis and seal against bacterial penetration accounts for consistently high success rates. However, drawbacks such as prolonged setting time, cost, and esthetic concerns limit its universal application.^{21,22}

Biodentine provides a strong alternative, with fast setting, favorable esthetics, and easier handling. Its calcium silicate composition promotes bioactivity similar to MTA, and its clinical performance is particularly advantageous in pediatric patients or anterior teeth where esthetics are essential. Despite these benefits, high cost

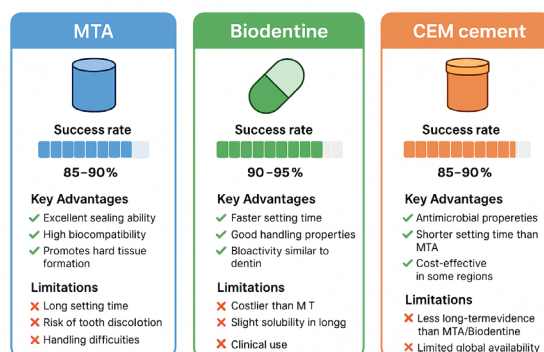


Figure 1: An infographic comparing MTA (blue), Biodentine (green), and CEM cement (orange). All three materials are effective; selection depends on case requirements, patient needs, and resource availability

Table 1: Comparative Features of MTA, Biodentine, and CEM Cement

Parameter	MTA	Biodentine	CEM Cement
Success Rate	~95%	~90–95%	~85–90%
Setting Time	Long (~3–4 hrs)	Short (~12 min)	Moderate (~50 min)
Handling	Difficult	Easy	Moderate
Esthetics	Discoloration	Tooth-colored	Acceptable
Cost	High	High	Low
Availability	Widely available	Widely available	Limited
Evidence Base	Extensive	Growing	Emerging

and limited long-term clinical data temper its widespread adoption.

CEM cement represents an innovative material, particularly suited for resource-sensitive environments. Its calcium-rich formulation enhances dentin bridge formation and antimicrobial properties, while cost-effectiveness makes it attractive for broader use. However, its global availability and limited large-scale trials currently restrict definitive recommendations.²³⁻²⁷

The integration of CBCT into clinical evaluation enhances accuracy in detecting dentin bridge formation and periapical healing, contributing to more evidence-based material selection.

5. CONCLUSION

All three types of cement: MTA, Biodentine, and CEM show positive results and biological efficacy in pulpotomy. MTA is the standard material, although Biodentine and CEM cement have situational benefits. Clinicians need to select the material according to the needs of patients, clinical demands and resources at hand.

Future trends involve the creation of quick setting, non-discolouration MTA mixture, increased clinical studies of Biodentine and CEM, and economic measures to enhance its accessibility. These bioactive materials are considered as a major breakthrough in vital pulp therapy, which serves as the trend toward biologically focused, least invasive dentistry.

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