Journal of Advanced Medical and Dental Sciences Research

@Society of Scientific Research and Studies *NLM ID: 101716117*

Journal home page: www.jamdsr.com doi: 10.21276/jamdsr Indian Citation Index (ICI) Index Copernicus value = 100

(e) ISSN Online: 2321-9599; (p) ISSN Print: 2348-6805

Review Article

Regeneration: a review of pulpotomy advancements in pediatric dentistry

Sadef Naqvi[1], Sayali Mohile[2], Gargi Nimbhorkar[3], Samiksha Dharampuria[4]

[1]Senior Lecturer, Department of Pediatric and Preventive Dentistry, Rajasthan Dental College and Hospital, Jaipur, Rajasthan, India;
[2,3,4]Senior Lecturer, Department of Pediatric and Preventive Dentistry, Swargiya Dadasaheb Kalmegh Smruti Dental College & Hospital, Nagpur, Maharashtra, India;

ABSTRACT:
The primary goal of pediatric endodontics is to retain the primary tooth as a functional unit in the dental arch until natural exfoliation. The pulpotomy procedure has undergone a significant paradigm shift over the last two decades. This review outlines the transition from cytotoxic "mummification" techniques (Formocresol) to bioactive, biocompatible, and regenerative approaches (MTA, Biodentine, and Lasers), analyzing their clinical efficacy and biological plausibility.
Keywords: Ferric Sulfate, Mineral Trioxide Aggregate, Calcium Enriched Mixture

Received: 08 November, 2025 Accepted: 11 December, 2025 Published: 15 December, 2025

Corresponding Author: Sadef Naqvi, Senior Lecturer, Department of Pediatric and Preventive Dentistry, Rajasthan Dental College and Hospital, Jaipur, Rajasthan, India

This article may be cited as: Naqvi S, Mohile S, Nimbhorkar G, Dharampuria S. Regeneration: a review of pulpotomy advancements in pediatric dentistry. J AdvMed Dent Scie Res 2025; 13(12):73-76.

INTRODUCTION

Pulpotomy involves the surgical amputation of the infected coronal pulp tissue, followed by the application of a medicament to the remaining radicular pulp to promote healing or fixation. It is the indicated treatment for carious or traumatic exposure in vital primary teeth where inflammation is confined to the coronal portion(1,2).

Criteria for Success

- **Clinical:** Absence of pain, swelling, fistula, or abnormal mobility.
- **Radiographic:** Normal periodontal ligament space, absence of furcation involvement, and no pathologic root resorption.

THE HISTORICAL BENCHMARK: FORMOCRESOL (FC)

Introduced by Buckley in 1904, Formocresol was considered the "Gold Standard" for nearly a century.

- **Mechanism:** It fixes the tissue (mummification), creating a zone of fixation, a zone of coagulative necrosis, and a zone of vital tissue apically(3).
- **Current Status:** Despite high clinical success rates (90-97%), its use has declined significantly due to concerns regarding **carcinogenicity, mutagenicity, cytotoxicity, and potential immune sensitization**. The International Agency for Research on Cancer (IARC) classifies formaldehyde (a component of FC) as a known human carcinogen(4,5).

PHARMACOLOGICAL ADVANCEMENTS: THE SEARCH FOR BIOCOMPATIBILITY

As safety concerns regarding FC grew, the focus shifted toward medicaments that preserve vitality rather than fixating it.

A. Ferric Sulfate (FS)

- **Mechanism:** A hemostatic agent that forms a ferric ion-protein complex, mechanically sealing blood vessels to control haemorrhage. It does not have a direct biological effect on the pulp tissue itself.
- **Advantages:** Non-toxic, rapid application, and inexpensive.
- **Limitations:** Studies have shown slightly higher rates of **internal resorption** compared to FC, though clinical retention rates remain comparable.

B. Glutaraldehyde

Proposed as a milder fixative than FC. It causes rapid surface fixation with less systemic penetration. However, due to its instability and continued cytotoxicity, it has largely fallen out of favor in routine practice(6).

THE BIOACTIVE REVOLUTION: CALCIUM SILICATES

The most significant advancement in pulpotomy therapy is the introduction of bioactive materials that induce hard tissue formation (dentin bridges).

A. Mineral Trioxide Aggregate (MTA)

MTA is currently considered the **new biological gold standard**.

- **Composition:** Tricalcium silicate, dicalcium silicate, tricalcium aluminate, and bismuth oxide.
- **Mechanism:** It creates a high pH environment (bacteriostatic) and releases calcium ions, stimulating cytokine release that promotes odontoblastic differentiation and a thick dentin bridge formation.
- **Evidence:** Systematic reviews consistently show MTA has higher clinical and radiographic success rates than Formocresol.
- **Drawbacks:** High cost, potential for tooth discoloration (graying), and difficult handling characteristics(7,8).

B. Biodentine (Dentin Replacement Material)

Often referred to as "Bio-active dentin substitute."

- **Advancement over MTA:**Biodentine was developed to overcome MTA's shortcomings. It sets faster (approx. 12 minutes) and has better handling properties(9).
- **Clinical Performance:** Studies indicate Biodentine exhibits success rates comparable to MTA. It is mechanically stronger and less likely to cause discoloration due to the use of Zirconium Oxide as a radiopacifier instead of Bismuth Oxide(10).

C. Calcium Enriched Mixture (CEM)

A bioactive cement similar to MTA but with a different chemical composition (resembling natural tooth structure). It offers good handling, creates an effective seal, and promotes dentin bridge formation.

NON-PHARMACOLOGICAL AND TECHNOLOGICAL ADVANCEMENTS

A. Laser Pulpotomy

The use of Light Amplification by Stimulated Emission of Radiation (LASER) is gaining popularity as a non-chemical alternative.

- **Types:**Nd:YAG, Er:YAG, CO2, and Diode lasers.
- **Mechanism:** Lasers create a superficial zone of coagulation necrosis for hemostasis and sterilize the wound surface without penetrating deep into the radicular pulp.
- **Outcome:** High success rates comparable to FC and FS, with the added benefit of being a "touchless" and sterile technique(11,12).

B. Electrosurgery

Utilizes radiofrequency energy to cut and coagulate soft tissue. While effective for hemostasis, extreme care is required to avoid heat generation that could damage the alveolar bone or cause root resorption.

FUTURE DIRECTIONS: REGENERATIVE BIOLOGY

A. Platelet Rich Fibrin (PRF)

PRF is an autologous immune-platelet concentrate.

- **Concept:** It releases growth factors (PDGF, TGF-β, VEGF) that enhance tissue healing and regeneration.
- **Current Status:** While promising in producing healthy pulp tissue response, the technique is sensitive and requires drawing blood from the pediatric patient, which can be a behavior management challenge.

B. Stem Cells

Research is ongoing into using SHED (Stem cells from Human Exfoliated Deciduous teeth) to regenerate the entire pulp-dentin complex, moving beyond amputation toward total revitalization(13).

Figure 1. Stages of Tooth Decay

Table 1. COMPARATIVE SUMMARY OF MATERIALS(14)

Material	Mechanism	Success Rate	Key Advantage	Key Disadvantage
Formocresol	Fixation/Devitalization	High	Long history	Cytotoxic/Carcinogenic risk
Ferric Sulfate	Hemostasis	Moderate-High	Quick, Easy	Internal Resorption
MTA	Regeneration (Bridge)	**Very High**	Biocompatible, Seal	Cost, Discoloration
Biodentine	Regeneration (Bridge)	**Very High**	No stain, Fast set	Cost
Lasers	Coagulation/Sterilization	High	Bactericidal	Equipment cost

CONCLUSION

The field of pediatric pulpotomy has moved from **preservation of the tooth** (via mummification) to **preservation of the pulp** (via regeneration).While Formocresol served the profession well for decades, the biological superiority of Calcium Silicate-based materials (MTA and Biodentine) is undeniable(15). These materials offer the best combination of clinical retention and histological health. Clinicians should prioritize these bioactive materials to ensure the highest standard of care, reserving older fixative techniques for specific cases where cost or isolation difficulties preclude newer methods.

REFERENCES

1. Buckley JP. The chemistry of pulp decomposition, with a rational treatment for this condition and its sequelae. Am Dent J. 1904;3:264-71.
2. Fuks AB. Vital pulp therapy with new materials for primary teeth: new directions and treatment perspectives. J Endod. 2008;34(7 Suppl):S18-24.
3. Sakai VT, et al. Pulpotomy of human primary molars with MTA and Portland cement: a randomised controlled trial. Br Dent J. 2009;207(3):E5.
4. Ng FK, Messer LB. Mineral trioxide aggregate as a pulpotomy medicament: a narrative review. Eur Arch Paediatr Dent. 2008;9(1):4-11.
5. American Academy of Pediatric Dentistry. Pulp therapy for primary and immature permanent teeth. The Reference Manual of Pediatric Dentistry. Chicago, Ill.: AAPD; 2022:415-23.
6. Zanini M., Sautier J.M., Berdal A., Simon S. Biodentine Induces Immortalized Murine Pulp Cell Differentiation into Odontoblast-like Cells and Stimulates Biomineralization. J. Endod. 2012;38:1126–1220.
7. Poggio C., Beltrami R., Colombo M., Ceci M., Dagna A., Chiesa M. In Vitro Antibacterial Activity of Different Pulp Capping Materials. J. Clin. Exp. Dent. 2015;7:584.
8. Rajasekharan S., Martens L.C., Cauwels R.G., Anthonappa R.P. Biodentine™ Material Characteristics and Clinical Applications: A 3-year Literature Review and Update. Eur. Arch. Paediatr. Dent. 2018;19:1–22.
9. Laurent P., Camps J., De Méo M., Déjou J., About I. Induction of Specific Cell Responses to a Ca3SiO5-based Posterior Restorative Material. Dent. Mater. 2008;24:1486–1494.
10. Singh H., Kaur M., Markan S., Kapoor P. Biodentine: A Promising Sentin Substitute. J. Interdiscip. Med. Dent. Sci. 2014;2:2.
11. Koubi G., Colon P., Franquin J.C., Hartmann A., Richard G., Faure M.O., Lambert G. Clinical Evaluation of the Performance and Safety of a New Dentine Substitute, Biodentine, in the Restoration of

Posterior Teeth—A Prospective Study. Clin. Oral Investig. 2013;17:243–249.
12. Asgary S., Shirvani A., Fazlyab M. MTA and Ferric Sulfate in Pulpotomy Outcomes of Primary Molars: A Systematic Review and Meta-analysis. J. Clin. Pediatr. Dent. 2014;39:1–8.
13. Debelian G., Trope M. The Use of Premixed Bioceramic Materials in Endodontics. G. Ital. Endod. 2016;30:70–80.
14. Mahgoub N., Alqadasi B., Aldhorae K., Assiry A., Altawili Z.M., Hong T. Comparison between iRoot BP Plus (EndoSequence Root Repair Material) and Mineral Trioxide Aggregate as Pulp-capping Agents: A Systematic Review. J. Int. Soc. Prev. Community Dent. 2019;9:542.
15. Jha S., Goel N., Dash B.P., Sarangal H., Garg I., Namdev R. An Update on Newer Pulpotomy Agents in Primary Teeth: A Literature Review. J. Pharm. Bioallied Sci. 2021;13:57.