



LESION STERILIZATION AND TISSUE REPAIR (LSTR) IN PEDIATRIC ENDODONTICS

Pedodontics

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ABSTRACT

Background: Premature loss of primary teeth frequently leads to space loss, malocclusion, and disrupted eruption sequences. Traditional pulpectomy techniques present technical challenges due to complex root canal anatomy, physiological root resorption, and paediatric behaviour management. Lesion Sterilization and Tissue Repair (LSTR) offers a conservative, minimally invasive endodontic approach that utilizes broad-spectrum antibiotic mixtures to sterilize infected tissues without mechanical instrumentation. **Objective:** This literature review evaluates the microbiological profile of primary tooth endodontic infections, antibiotic formulations, clinical protocols, success rates, and current limitations of LSTR compared to conventional therapies. **Discussion:** LSTR commonly employs combinations like 3Mix-MP (metronidazole, ciprofloxacin, and minocycline) to eradicate polymicrobial infections. Clinical evidence demonstrates high success rates, reduced treatment time, and effective tissue repair. **Conclusion:** LSTR serves as a viable alternative to pulpectomy, though potential tooth discoloration, antibiotic resistance, and long-term outcomes warrant careful case selection.

KEYWORDS

Lesion Sterilization and Tissue Repair, Non-Instrumentation Endodontic Technique, 3 Mix-paste, Pediatric Endodontics

1. INTRODUCTION

Preserving primary teeth in the dental arch until physiological exfoliation is essential for maintaining arch perimeter, guiding permanent succedaneous teeth into proper alignment, preventing tongue thrusting, and maintaining proper mastication and speech development¹. Pulpal involvement resulting from deep carious lesions or trauma typically warrants endodontic therapy—such as pulpotomy or pulpectomy—or extraction¹. However, conventional pulpectomies are technically challenging due to the intricate, tortuous morphology of primary molar root canals, secondary furcation canals, physiological root resorption, and behavioral management challenges in young children¹.

To address these limitations, Lesion Sterilization and Tissue Repair (LSTR) was developed as a minimally invasive, non-instrumentation endodontic technique (NIET)^{1,2}. Conceptualized primarily by the Cariology Research Unit at Niigata University School of Dentistry in Japan, LSTR relies on the topical application of a broad-spectrum antibiotic mixture—most notably 3Mix-MP (metronidazole, ciprofloxacin, minocycline mixed with propylene glycol and polyethylene glycol/macrogol)—to sterilize carious lesions, necrotic pulp tissue, and periapical pathoses without mechanical debridement or canal enlargement^{1,2}. By eliminating intracanal pathogens, LSTR aims to control infection and promote natural periradicular tissue repair, providing a practical alternative to extractions or conventional pulpectomies in pediatric dentistry^{1,2}.

2. Microbial Flora In Primary Tooth Infections

Endodontic infections in deciduous teeth are polymicrobial and dynamic, consisting of aerobic, facultative, and obligate anaerobic bacteria^{3,4}. Carious dentin and necrotic pulp chambers harbour complex bacterial communities that invade dentinal tubules and periradicular tissues^{3,4}.

Commonly isolated microbial genera in primary teeth with irreversible pulpitis and pulp necrosis include:

- *Prevotella*, *Porphyromonas*, *Fusobacterium*, and *Peptostreptococcus* species, which predominate in acute and chronic dentoalveolar abscesses³.
- *Streptococcus* species and black-pigmented anaerobic rods, which are consistently identified in necrotic primary root canals with periapical lesions⁴.
- *Treponema denticola*, *Porphyromonas gingivalis*, and *Enterococcus faecalis*, which represent key pathogens associated with persistent endodontic lesions⁵.
- *Actinomyces* species (*A. naeslundii*, *A. israelii*, *A. odontolyticus*), which are frequently implicated in secondary and refractory root canal infections^{4,2}.

Because endodontic pathogens reside deep within dentinal tubules (up to 300–400 µm) and complex root anatomy, monotherapy is usually

insufficient^{7,42}. While standard penicillins and amoxicillin demonstrate activity against common aerobes and anaerobes, resistant strains require combinations containing metronidazole, macrogol, tetracyclines, clindamycin, or beta-lactamase inhibitors^{6,7}.

3. Agents, Medicaments, and Formulations for LSTR

The concept of topical poly-antibiotic decontamination dates back to Grossman (1951), who introduced PBSC (penicillin, bacitracin, streptomycin, and sodium caprylate)⁸. Over time, the American Association of Endodontists (AAE) recognized intracanal formulations as vital tools for controlling endodontic pathoses⁹.

3.1 Antibiotic Formulations

1. **3Mix/Triple Antibiotic Paste (TAP):** Metronidazole, Ciprofloxacin, and Minocycline^{2,10}.
2. **Clindamycin-Modified TAP (Clim-TAP):** Minocycline replaced with Clindamycin to prevent coronal enamel discoloration^{10,44}.
3. **Alternative TAP Mixtures:** Replacement of Minocycline with Amoxicillin, Cefaclor, Cefroxadine, Fosfomycin, or Rokitamycin¹⁰.
4. **CTZ Paste:** Chloramphenicol, Tetracycline, and Zinc Oxide Eugenol¹⁴.
5. **GAM Paste:** Gentamicin, Amoxicillin, and Metronidazole³⁷.
6. **3Mixtatin:** Modified 3Mix combined with Simvastatin to promote bone regeneration^{13,34,41}.
7. **CMD Paste:** Clindamycin, Metronidazole, and Doxycycline⁴³.
8. **Double Antibiotic Paste (DAP):** Metronidazole and Ciprofloxacin without a third agent⁵⁰.
9. **Other Commercial/Herbal Agents:** Ledermix, Septomixine Forte, Odontopaste, Pulpomixine, and Propolis-mixed Endoflas^{16,17,18,19,36}.

3.2 Mixing Ratios and Vehicles

The mixing ratio for 3Mix components remains varied in the literature:

- **Takushige et al.:** 1:3:3 (Ciprofloxacin : Metronidazole : Minocycline)².
- **Hoshino et al.:** 1:1:1 ratio^{2,15}.
- **Garcia et al.:** 3:1:3 ratio^{10,15}.

The vehicle plays a key role in delivering antibiotics through dentinal tubules. The standard vehicle, MP, consists of Macrogol (polyethylene glycol) and Propylene Glycol². Propylene glycol provides high antibacterial diffusion through root dentin and optimal paste consistency^{25,31}. Furthermore, removing the dentinal smear layer using chemical conditioning (e.g., 35% phosphoric acid or NaOCl) significantly enhances drug penetration into dentinal tubules^{2,10}.

4. Indications and Contraindications

4.1 Indications

Primary teeth with irreversible pulpitis which are characterized by

deep carious lesions with spontaneous pain, carious lesion extending to the pulp either clinically/radiographically, chronic pulpitis showing clinical signs of gingival swelling/sinus tract, pulpitis cases in which there is extensive root resorption and which are contraindicated for conventional pulpectomy and presence of furcation radiolucency.[20]

4.2 Contraindications

A known history of allergy to any of the constituent medication of the 3 Mix MP paste, primary teeth nearing exfoliation, perforation of the pulpal floor, teeth with excessive coronal structure breakdown in which an adequate coronal seal is not feasible.^[20]

5. Clinical Protocol and Preparation

• Step 1: Isolation & Caries Removal

Administrative of local anesthesia; rubber dam isolation; excavation of carious tissue.

• Step 2: Access & Medication Cavity Preparation

Access coronal pulp chamber; remove coronal necrotic tissue. Enlarge canal orifices (1 mm diameter, 2 mm depth) using a No. 12 round bur.

• Step 3: Chemical Conditioning & Smear Layer Removal

Etch pulp chamber with 35% Phosphoric Acid for 1 minute; rinse and dry.

Control refractory hemorrhage using 10% NaOCl for 1 minute if required.

• Step 4: Paste Preparation & Placement

Pulverize tablets/capsules; mix 7 parts antibiotic powder with 1 part MP vehicle.

Place antibiotic paste into the medication cavities over canal orifices.

• Step 5: Hermetic Restoration

Seal cavity with Glass Ionomer Cement (GIC); restore with a Stainless Steel Crown (SSC).

6. Evidence Review: Clinical, Radiographic, and in Vitro Evaluations

Author(s) & Year	Study Type / Sample	Intervention / Groups	Key Findings & Outcomes
Takushige et al. (2004)2	Clinical (56 patients, 87 teeth)	3Mix-MP in infected primary root canals	High clinical success; rapid resolution of pain, gingival swelling, and sinus tracts.
Lin et al. (2003)42	In vitro (Bovine dentin)	Clindamycin (2%) vs. Tetracycline (2% Ledermix)	Clindamycin significantly reduced viable bacteria up to 400 µm into dentinal tubules (p < 0.01).
LeCorn et al. (2007)7	In vitro (E-test MIC)	Amoxicillin, Doxycycline, Moxifloxacin, Clindamycin, Metronidazole vs. Actinomyces	Amoxicillin, Doxycycline, and Moxifloxacin showed low MIC; Metronidazole was ineffective against Actinomyces (MIC ₉₀ > 256 µg/mL).
Bruno et al. (2007)24	Histological (in vivo dogs)	Antibiotic paste pulpotomy	Initial coronal pulp inflammation subsided over 8–10 months, demonstrating biocompatibility.
Nakornchai et al. (2010)27	Clinical trial	3Mix vs. Vitapex	100% and 96% clinical success at 6 and 12 months, respectively; both suitable for primary molars.
Pinky et al. (2011)25	Clinical trial	Group A (Cipro/Metro/Mino) vs. Group B (Cipro/Orni/Mino)	Both antibacterial drug pastes showed high clinical and radiographic success rates in primary teeth.
Agarwal et al. (2011)26	Clinical trial (12-month follow-up)	Pulpotec vs. LSTR vs. ZOE Pulpectomy	Pulpotec and LSTR showed comparable clinical outcomes to ZOE pulpectomy.

Velasco-Loera et al. (2012)28	In vitro (Disc diffusion)	Modified 3Mix vs. Ultrapex	Modified 3Mix exhibited superior bactericidal effect against anaerobic primary canal isolates compared to Ultrapex.
Trairatvorakul & Detsomboonrat (2012)29	Clinical trial (24-month follow-up)	3Mix-MP non-instrumentation endodontics	Good short-term clinical success, but low long-term radiographic success rate at 2 years.
Jaya et al. (2012)30	Clinical trial (24-month follow-up)	Metro-TAP vs. Tinidazole-TAP	Ciprofloxacin + Minocycline + Tinidazole successfully conserved primary teeth with periradicular lesions.
Burrus et al. (2014)31	Case reports & Review	LSTR in non-vital primary molars	Documented successful lesion sterilization, tissue repair, and periapical healing in non-vital teeth.
Phumpatrakom & Srisuwan (2014)32	In vitro (Cytotoxicity)	3Mix effect on human pulp and apical papilla cells	High concentration (1 mg/mL) was toxic; 0.39 µg/mL preserved cell viability and dentinogenic gene expression.
Nanda et al. (2014)33	Clinical trial (12-month follow-up)	3Mix (Metro) vs. Other Mix (Ornidazole)	Both groups had 100% clinical success; radiographic success was 81% (3Mix) vs. 92% (Other Mix).
Aminabadi et al. (2016)34	RCT	3Mixtatin vs. MTA in inflammatory root resorption	3Mixtatin showed superior clinical and radiographic healing in teeth with inflammatory resorption compared to MTA.
Doneria et al. (2017)35	Clinical trial (18-month follow-up)	ZnO-Ozonated oil vs. Modified 3Mix vs. Vitapex	ZnO-Ozonated oil and Vitapex demonstrated higher overall success than modified 3Mix paste.
Divya et al. (2019)36	Clinical trial (12-month follow-up)	Propolis-Endoflas vs. 3Mix	Propolis liquid mixed with Endoflas achieved superior outcomes over traditional 3Mix.
Parakh & Shetty (2019)37	Clinical trial (12-month follow-up)	GAM paste (Gentamicin, Amoxicillin, Metro) ± instrumentation	GAM-LSTR showed high overall success (up to 86.7%) and proved to be an effective pulpectomy alternative.
Lokade et al. (2019)14	Clinical trial	3Mix-MP (without pulp removal) vs. 3Mix-MP (with pulp removal) vs. CTZ	3Mix-MP (with/without pulp removal) performed significantly better than CTZ paste.
Thakur et al. (2021)13	RCT	3Mixtatin vs. Modified 3Mix-MP vs. Pulpectomy	Localized 3Mixtatin was effective and comparable to modified 3Mix-MP and conventional pulpectomy.
Mittal et al. (2020)45	RCT (18-month follow-up)	Minimal excavation + LSTR (TAP) vs. Traditional IPT	LSTR with TAP was as effective as traditional indirect pulp capping for deep carious lesions (p < 0.05).

Thosar & Dahake (2021)43	In vitro (MIC/ MBC)	Clindamycin vs. Metronidazole vs. Doxycycline vs. CMD	CMD combination demonstrated significantly lower MIC/MBC against key endodontic pathogens.
Ali & Raslan (2021)38	RCT	Direct pulp capping: 3Mix-MP vs. Ca(OH) ₂	Ca(OH) ₂ showed higher success (77.3%) than 3Mix-MP (54.5%), though not statistically significant.
Shankar et al. (2021)39	RCT	1 mg/mL vs. 1 g/mL MTAP in LSTR	Both concentrations demonstrated similar clinical and radiographic success rates.
Verma et al. (2022)44	RCT (12-month follow-up)	Pulpotec vs. ClinM-TAP	Pulpotec achieved superior overall success (88% clinical / 60% radio) compared to ClinM-TAP (50% clinical / 27% radio).
Qamar et al. (2023)40	Clinical trial	Ca(OH) ₂ , CHX, and TAP combinations vs. E. faecalis	TAP combined with 2% CHX gluconate exhibited the highest antimicrobial efficacy against E. faecalis.
Almarji et al. (2024)41	RCT	3Mixtatin NIET vs. Conventional Pulpectomy	3Mixtatin NIET proved to be an effective alternative to pulpectomy for preserving necrotic molars.
Dimri et al. (2024)46	RCT (18-month follow-up)	LSTR Irrigants: Propolis vs. NaOCl vs. CHX vs. Saline + 3Mix	Pre-medication irrigation with 2% Chlorhexidine yielded the highest clinical success and lowest root resorption rates.
Golla et al. (2024)47	In vitro	Herbal extracts (Ginger, Turmeric, Nutmeg) vs. MTAP	Ginger + Nutmeg combination at 12.5% concentration matched MTAP's zone of inhibition against E. faecalis.
Sharma et al. (2025)50	RCT (12-month follow-up)	1 mg/mL DAP vs. Ca(OH) ₂ -Iodoform pulpectomy	Favorable clinical success (67% DAP vs. 83% Pulpectomy), but low radiographic success (36% DAP vs. 53% Pulpectomy).
Beevi et al. (2026)49	RCT (12-month follow-up)	Conventional LSTR vs. Modified LSTR vs. Metapex Pulpectomy	Metapex pulpectomy demonstrated significantly superior overall radiographic success (p = 0.01) over LSTR.
Aşık & Önçag (2026)48	Retrospective (36 teeth)	Single-session 3Mix-MP (Clindamycin)	Overall success rate of 91.7% at 6 months; effective regardless of patient cooperation levels.

7. Advantages and Limitations of LSTR

7.1 Advantages

Relatively simple and easy when compared to conventional pulp therapy (less technique sensitive), decreased chair-time (single visit), noninstrumentation technique, economical, primary teeth which are not ideal for conventional pulpectomy treatment and those that warrant extraction can be treated using lstr (teeth with peri-radicular involvement and extensive root resorption).

7.2 Disadvantages

Systemic absorption and drug resistance of the drugs used in LSTR therapy has not been evaluated. The long-term effects of the drugs used need to be evaluated, Standardized measuring systems for

pulverizing and proportioning the antibiotics need to be formulated to avoid over use of antibiotics.[10,15] Minocycline is known to cause discoloration of the enamel.[10,44] However, this can be replaced by using clindamycin. The original 3 Mix Paste appears radiolucent in radiographs which can be overcome by addition of iodoform to the mixture. In addition to these drawbacks, the development of antibiotic resistance is alarming, and should be checked. One major cause contributing to antibiotic resistance is the use of antibiotics in an improper manner, which leads to resistant microorganisms and increases transfer of resistance genes from antibiotic-resistant to antibiotic-susceptible microorganisms.^[21]

8. CONCLUSION

Lesion Sterilization and Tissue Repair (LSTR) provides a minimally invasive alternative to conventional pulpectomy or extraction in pediatric endodontics. Its ability to disinfect complex root canal systems without mechanical instrumentation makes it useful for managing necrotic primary teeth, especially in young or uncooperative patients.

While LSTR demonstrates high clinical success rates and rapid symptom resolution, its long-term radiographic outcomes remain lower than those of traditional pulpectomies, particularly in teeth with pre-existing furcation radiolucencies. To optimize LSTR protocols, future research should focus on standardizing drug proportions, minimizing cytotoxicity, incorporating osteogenic adjuvants (such as simvastatin), and using non-staining antibiotic substitutes.

REFERENCES

1. American Academy of Pediatric Dentistry. (2015). Useful medications for oral conditions. *Pediatric Dentistry*, 37(6), 407-414.
2. Takushige, T., Cruz, E. V., Asgor Moral, A., & Hoshino, E. (2004). Endodontic treatment of primary teeth using a combination of antibacterial drugs. *International Endodontic Journal*, 37(2), 132-138.
3. Brook, I. (2003). Microbiology and management of endodontic infections in children. *The Journal of Clinical Pediatric Dentistry*, 28(1), 13-17.
4. Pazelli, L. C., Freitas, A., Ito, I. Y., Souza-Gugelmin, M. C., Medeiros, A., & Nelson-Filho, P. (2003). Prevalence of microorganisms in root canals of human deciduous teeth with necrotic pulp and chronic periapical lesions. *Pesquisa Odontológica Brasileira*, 17(4), 367-371.
5. Cogulu, D. (2008). PCR-based identification of selected pathogens associated with endodontic infections in deciduous and permanent teeth. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*, 106(3), 443-449.
6. Rana, V., Baba, S., & Pandey, A. (2009). Bacteriology of infected deciduous root canal: A review. *Endodontology*, 21(2), 43-47.
7. LeCorn, D. W., Vertucci, F. J., Rojas, M. F., Progsulke-Fox, A., & Bélanger, M. (2007). In vitro activity of amoxicillin, clindamycin, doxycycline, metronidazole, and moxifloxacin against oral *Actinomyces*. *Journal of Endodontics*, 33(5), 557-560.
8. Grossman, L. I. (1951). Polyantibiotic treatment of pulpless teeth. *The Journal of the American Dental Association*, 43(3), 265-278.
9. American Association of Endodontists. (2006). *Antibiotics and the treatment of endodontic infections*. American Association of Endodontists.
10. Anila, B., Murali, H., Cheranjeevi, J., & Kapil, R. S. (2014). Lesion sterilization and tissue repair (LSTR): A review. *Journal of Scientific Dentistry*, 4(2), 49-55.
11. Doneria, D., Thakur, S., Singhal, P., Chauhan, D., Keshav, K., & Uppal, A. (2017). In search of a novel substitute: Clinical and radiological success of lesion sterilization and tissue repair with modified 3Mix-MP antibiotic paste and conventional pulpectomy for primary molars with pulp involvement with 18 months follow-up. *Contemporary Clinical Dentistry*, 8(4), 514-521.
12. Thosar, N., & Dahake, P. (2021). In vitro evaluation of a new combination of three antibiotic paste against common endodontic pathogens. *Journal of Islamic Dental Association of IRAN*, 33(3), 58-67.
13. Thakur, S., Deep, A., Singhal, P., & Chauhan, D. (2021). A randomized control trial comparing the efficacy of 3Mixtatin and modified 3Mix-MP paste using lesion sterilization and tissue repair technique to conventional root canal treatment in primary molars of children aged 4-8 years: An in vivo study. *Dental Research Journal*, 18, Article 93.
14. Lokade, A., Thakur, S., Singhal, P., Chauhan, D., & Jayam, C. (2019). Comparative evaluation of clinical and radiographic success of three different lesion sterilization and tissue repair techniques as treatment options in primary molars requiring pulpectomy: An in vivo study. *Journal of the Indian Society of Pedodontics and Preventive Dentistry*, 37(2), 185-191.
15. Haapasalo, M., & Orstavik, D. (1987). In vitro infection and disinfection of dentinal tubules. *Journal of Dental Research*, 66(8), 1375-1379.
16. National Institute for Health and Care Excellence. (n.d.). *Tetracycline*. British National Formulary. Retrieved September 13, 2026, from <https://bnf.nice.org.uk/drug/tetracycline.html#contraindications>
17. Athanassiadis, B., Abbott, P. V., & Walsh, L. J. (2007). The use of calcium hydroxide, antibiotics and biocides as antimicrobial medicaments in endodontics. *Australian Endodontic Journal*, 33(1), 15-28.
18. Lin, S., Levin, L., Peled, M., Weiss, E. I., & Fuss, Z. (2003). Reduction of viable bacteria in dentinal tubules treated with clindamycin or tetracycline. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics*, 96(6), 751-756.
19. Gardner, D. E., Mitchell, D. F., & McDonald, R. E. (1971). Treatment of pulps of monkeys with vancomycin and calcium hydroxide. *Journal of Dental Research*, 50(5), 1273-1277.
20. Goswami, S. (2018). Lesion sterilization and tissue repair in pediatric dentistry. *SRM Journal of Research in Dental Sciences*, 9(2), 79-82.
21. ADA Council on Scientific Affairs. (1997). Antibiotic use in dentistry. *The Journal of the American Dental Association*, 128(5), 648.
22. Takushige, T., Venzon Cruz, E., Ali Asgor Moral, M., & Hoshino, E. (2008). Non-surgical treatment of pulpitis, including those with history of spontaneous pain, using a combination of antibacterial drugs. *Journal of LSTR Therapy*, 7, 1-5.
23. Triveni, M. N., Dhaval, P., & Rachappa, M. M. (2019). Lesion sterilization and tissue repair (LSTR) technique and its clinical application in primary and permanent teeth: A review. *Annals and Essences of Dentistry*, 11(4), 1e-6c.

24. Bruno, G. B., Alves, A. P., Menezes, V. A., Maia, M. C., & Bruno, J. A. (2007). Biocompatibility evaluation of an antibiotic paste after pulpotomy in dogs. *Brazilian Journal of Oral Sciences*, 6(22), 1397–1401.
25. Pinky, C., Shashibhushan, K. K., & Subbareddy, V. V. (2011). Endodontic treatment of necrosed primary teeth using two different combinations of antibacterial drugs: An in vivo study. *Journal of the Indian Society of Pedodontics and Preventive Dentistry*, 29(2), 121–127.
26. Agarwal, M., Das, U. M., & Viswanath, D. (2011). A comparative evaluation of noninstrumentation endodontic techniques with conventional ZOE pulpectomy in deciduous molars: An in vivo study. *World Journal of Dentistry*, 2(3), 187–192.
27. Nakornchai, S., Banditsing, P., & Visetratana, N. (2010). Clinical evaluation of 3Mix and Vitapex as treatment options for pulpally involved primary molars. *International Journal of Paediatric Dentistry*, 20(3), 214–221.
28. Velasco-Loera, N., De Alba-Vazquez, Y., Garrocho-Rangel, A., Gonzalez-Amaro, A. M., Flores-Reyes, H., & Pozos-Guillen, A. J. (2012). Comparison of the antibacterial effect of modified 3-mix paste versus Ultratapex over anaerobic microorganisms from infected root canals of primary teeth: An in vitro study. *The Journal of Clinical Pediatric Dentistry*, 36(3), 239–244.
29. Trairatvorakul, C., & Detsomboonrat, P. (2012). Success rates of a mixture of ciprofloxacin, metronidazole, and minocycline antibiotics used in the non-instrumentation endodontic treatment of mandibular primary molars with carious pulpal involvement. *International Journal of Paediatric Dentistry*, 22(3), 217–227.
30. Jaya, A. R., Praveen, P., Anantharaj, A., Venkataraghavan, K., & Rani, P. S. (2012). In vivo evaluation of lesion sterilization and tissue repair in primary teeth pulp therapy using two antibiotic drug combinations. *The Journal of Clinical Pediatric Dentistry*, 37(2), 189–191.
31. Burrus, D., Barbeau, L., & Hodgson, B. (2014). Treatment of abscessed primary molars utilizing lesion sterilization and tissue repair: Literature review and report of three cases. *Pediatric Dentistry*, 36(3), 240–244.
32. Phumpratrakom, P., & Srisuwan, T. (2014). Regenerative capacity of human dental pulp and apical papilla cells after treatment with a 3-antibiotic mixture. *Journal of Endodontics*, 40(3), 399–405.
33. Nanda, R., Koul, M., Srivastava, S., Upadhyay, V., & Dwivedi, R. (2014). Clinical evaluation of 3 Mix and Other Mix in non-instrumental endodontic treatment of necrosed primary teeth. *Journal of Oral Biology and Craniofacial Research*, 4(2), 114–119.
34. Aminabadi, N. A., Huang, B., Samiei, M., Agheli, S., Jamali, Z., & Shirazi, S. (2016). A randomized trial using 3Mixtatin compared to MTA in primary molars with inflammatory root resorption: A novel endodontic biomaterial. *The Journal of Clinical Pediatric Dentistry*, 40(2), 95–102.
35. Doneria, D., Thakur, S., Singhal, P., & Chauhan, D. (2017). Comparative evaluation of clinical and radiological success of zinc oxide-ozonated oil, modified 3mix-mp antibiotic paste, and vitapex as treatment options in primary molars requiring pulpectomy: An in vivo study. *Journal of the Indian Society of Pedodontics and Preventive Dentistry*, 35(4), 346–351.
36. Divya, D. V., Prasad, M. G., Radhakrishna, A. N., Sandeep, R. V., Reddy, S. P., & Santosh Kumar, K. V. K. (2019). Triple antibiotic paste versus propolis: A clinical quest for the reliable treatment of periapical lesions in primary molars. *Saudi Endodontic Journal*, 9(1), 34–39.
37. Parakh, K., & Shetty, R. M. (2019). Evaluation of paste containing gentamicin, amoxicillin and metronidazole in endodontic treatment of primary molars in vivo. *The Chinese Journal of Dental Research*, 22(1), 57–64.
38. Ali, H., & Raslan, N. (2021). Direct pulp capping (DPC) in primary molars using (3Mix-MP) and the characteristics of the carious lesion as predictor factors for its success: A randomized controlled trial. *European Archives of Paediatric Dentistry*, 22(4), 633–642.
39. Shankar, K., Ramkumar, H., Dhakshinamoorthy, S., Paulindraraj, S., Jayakaran, T. G., & Bommarreddy, C. S. (2021). Comparison of modified triple antibiotic paste in two concentrations for lesion sterilization and tissue repair in primary molars: An in vivo interventional randomized clinical trial. *International Journal of Clinical Pediatric Dentistry*, 14(3), 388–392.
40. Qamar, S., Jayanna, R., & Ahuja, V. R. (2023). Comparative evaluation of antimicrobial efficacy of calcium hydroxide, chlorhexidine, and triple antibiotic paste in different combination forms as intracanal medicaments against *Enterococcus faecalis* in primary teeth: An in vivo randomized clinical trial. *International Journal of Clinical Pediatric Dentistry*, 16(3), 448–452.
41. Almarji, W., Laflouf, M., & Tolibah, Y. A. (2024). Evaluation of the modified 3Mix-Simvastatin combination in non-instrumental endodontic therapy of necrotic primary molars: A two-arm randomized controlled trial. *Clinical and Experimental Dental Research*, 10(2), Article e860.
42. Lin, S., Levin, L., Peled, M., Weiss, E. I., & Fuss, Z. (2003). Reduction of viable bacteria in dentinal tubules treated with clindamycin or tetracycline. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics*, 96(6), 751–756.
43. Thosar, N., & Dahake, P. (2021). In vitro evaluation of a new combination of three antibiotic paste against common endodontic pathogens. *Journal of Islamic Dental Association of IRAN*, 33(3), 58–67.
44. Verma, N., Gupta, A., Garg, S., Arya, V., Dogra, S., & Dhankar, M. (2022). Is clindamycin-modified triple antibiotic paste better than iodoform-based medicament for the treatment of non-vital primary molars using LSTR technique—A randomised clinical trial. *Indian Journal of Physiology and Pharmacology*, 66(4), 276–285.
45. Mittal, M., Gupta, N., Kumar, A., Chopra, R., & Barua, M. (2020). Clinical, microbiological, and radiographic evaluation of sealed carious dentin after minimal intervention in primary molars. *Journal of the Indian Society of Pedodontics and Preventive Dentistry*, 38(4), 400–406.
46. Dimri, A., Srivastava, N., Rana, V., & Kaushik, N. (2024). Efficacy of different endodontic irrigants in the lesion sterilization and tissue repair technique in primary molars: A randomized controlled clinical trial. *Journal of the Indian Society of Pedodontics and Preventive Dentistry*, 42(4), 294–300.
47. Golla, S., Gambhir, N., Gupta, N., Singh, R., & Singh, D. (2024). A comparative evaluation of herbal extracts and triple antibiotic paste as intracanal medicament against *Enterococcus faecalis*: A microbiological study. *International Journal of Clinical Pediatric Dentistry*, 17(3), 285–290.
48. Aşık, A., & Öncag, Ö. (2026). Clinical and radiographic outcomes of lesion sterilization and tissue repair in primary molars: The role of patient cooperation in a retrospective study. *BMC Oral Health*, 26(1), Article 312.
49. Beevi, T. P. A., Ansari, A. A., Singh, R. K., & Khanna, R. (2026). Comparative evaluation of clinical and radiographic success of lesion sterilization and tissue repair (LSTR), modified LSTR with triple antibiotic paste and Metapex pulpectomy in primary molars: A randomized controlled clinical study. *International Journal of Paediatric Dentistry*, 36(2), 265–274.
50. Sharma, U., Gill, N. C., Passi, S., Verma, L., Agnihotri, A., Arora, R., Sharma, P., & Kaur, I. P. (2025). A prospective, blinded randomized, active-controlled clinical trial to evaluate the success of double antibiotic paste in pulpally infected primary molars. *International Journal of Clinical Pediatric Dentistry*, 18(6), 653–659.