Review Article

Efficacy of Zinc Oxide-Ozonated Oil as an Obturating Material in Primary Teeth: A Narrative Review

Dr. Kamesh Bhamare[1], Dr. Mahesh Dadpe[2], Dr. Yogesh Kale[3], Dr. Prasanna Dahake[4], Dr. Shrikant Kendre[5]

[1]Postgraduate Student, Department of Pediatric and Preventive Dentistry, MIDSR Dental College, Latur

[2]HOD & Professor, Department of Pediatric and Preventive Dentistry, MIDSR Dental College, Latur

[3,4]Professor & PG Guide, Department of Pediatric and Preventive Dentistry, MIDSR Dental College, Latur

[5]Reader, Department of Pediatric and Preventive Dentistry, MIDSR Dental College, Latur

Abstract:

In order to save carious primary teeth until their natural exfoliation and retain the structure and function of the arch, pulpectomy is still a fundamental treatment in Pediatric dentistry. The mechanical and biological characteristics of the obturating substance utilized have a significant impact on the pulpectomy's long-term success. The conventional option of zinc oxide-eugenol (ZOE) has drawbacks such cytotoxicity and delayed resorption. The powerful antibacterial, anti-inflammatory, and healing-promoting qualities of zinc oxide-ozonated oil (ZnO-OO) have drawn attention recently. This review compares the performance of ZnO-OO with both established and novel materials, combining the recent data from four important in vivo investigations. ZnO-OO is an appealing option for juvenile endodontics because of its high clinical and radiographic success, remarkable biocompatibility, and exceptional handling qualities, as shown by consistent results.

Keywords: Narrative Review, Obturating Material, Pediatric Dentistry, Pulpectomy, Zinc Oxide Ozonated Oil

Corresponding Author: Dr. Kamesh Bhamare, Postgraduate Student, Department of Pediatric and Preventive Dentistry, MIDSR Dental College, Latur, Email – kameshbhamare@gmail.com

INTRODUCTION:

Mastication, phonation, aesthetics, and directing the emergence of permanent teeth are all critical functions of primary teeth. It is crucial to keep these teeth intact until their natural exfoliation, particularly if pulp diseases are present. Pulpectomy is recommended when primary teeth exhibit permanent pulpitis or necrosis. This procedure entails total debridement and obturation of the root canal system. The optimal obturating material should be radiopaque, biocompatible, resorbable, antibacterial, and easy to apply without interfering with succeeding eruption.

Because of its antibacterial properties and track record of dependability, zinc oxide-eugenol (ZOE) has been utilized extensively. Nevertheless, it may not resorb as quickly as primary roots and may remain in the periapical area, which may interfere with the permanent successors' eruptive route and result in periapical inflammation1. Furthermore, at high doses, the eugenol component is cytotoxic2,3,4. Alternative materials like calcium hydroxide, iodoform-based pastes (like Vitapex), herbal formulations, and biologically inspired combinations like 3Mix have been investigated as a result. Because of its biological qualities, which include antibacterial activity, debriding impact, angiogenesis promotion,

anti-inflammatory and analgesic effects, and immunological response enhancement, ozone, -a strong oxidizing agent, has been hailed as promising.5 Among these, zinc oxide-ozonated oil (ZnO-OO) has emerged as a novel and promising option, combining the mechanical properties of ZnO with the biological efficacy of ozone.

Mechanism and Rationale of Zinc Oxide-Ozonated Oil

Ozonated vegetable oils, including ozonated olive or sesame oil, are mixed with zinc oxide powder to create ZnO-OO, a thick, malleable paste. Ozone is stabilized by the ozonated oil as ozonides and peroxides, which over time gradually release reactive oxygen species (ROS) like singlet oxygen and nascent oxygen.6,7 These substances have broad-spectrum antibacterial properties because they break down microbial cell walls, obstruct DNA synthesis, and suppress protein metabolism.

Furthermore, ozone promotes collagen synthesis, fibroblast proliferation, oxygen supply, and local blood flow, all of which hasten the healing of periapical tissues.8 The oil base facilitates simple insertion into the root canal with few voids and guarantees long-lasting antibacterial activity. Thus, the oil basis, which serves as an antibacterial vehicle, and ozone, which encourages healing, can combine to provide the perfect obturating material for primary teeth.

Clinical Evidence Overview

This review analyzes four in vivo studies that provide substantial clinical and radiographic data on ZnO-OO:

El-Desouky et al., 2023[3]

- **Design:** Randomized controlled trial (90 molars, 3 groups)
- **Materials:** ZnO-OO, ZnO with olive oil, ZOE
- **Follow-up:** at 3, 6, 12 months
- **Results:** ZnO-OO had a 92.6% clinical success rate and superior furcation bone healing. ZOE had lower success (82.1%) and more postoperative complications.
- **Conclusion:** ZnO-OO showed improved biocompatibility and healing.

Doneria et al., 2017[4]

- **Design:** In vivo comparative study (64 molars)
- **Materials:** ZnO-OO, modified 3Mix-MP, Vitapex
- **Results:** ZnO-OO and Vitapex achieved 100% clinical and radiographic success; 3Mix was inferior (95.8% and 79.2%, respectively).
- **Conclusion:** ZnO-OO demonstrated reliable outcomes with minimal internal resorption.

Vachhani et al., 2022[6]

- **Design:** Randomized controlled trial (90 molars)
- **Materials:** ZnO-OO, ZnO-Ocimum sanctum, ZOE
- **Results:** ZnO-OO: 95.7% clinical, 91.3% radiographic success; outperformed ZOE and herbal alternatives.
- **Conclusion:** Ozonated oil's unique properties enhance healing and reduce cytotoxicity.

Arora et al., 2024[7]

- **Design:** In vivo comparative study (120 molars)
- **Materials:** ZnO-OO, ZOE, Probiotic mix, Antioxidant mix
- **Results:** ZnO-OO showed highest success and lowest postoperative discomfort.
- **Conclusion:** ZnO-OO surpassed other novel obturating alternatives.

Summary of Study Outcomes

Study Groups Compared Best Performing Material Clinical Success (%) Radiographic Success (%)

Study	Groups Compared	Best Performing Material	Clinical Success (%)	Radiographic Success (%)

Study	Groups Compared	Best Performing Material	Clinical Success (%)	Radiographic Success (%)
El-Desouky et al. 2023	ZnO-OO, ZOE, ZnO-Olive	ZnO-OO	92.6	Significantly higher
Doneria et al. 2017	ZnO-OO, 3Mix, Vitapex	ZnO-OO = Vitapex	100	100
Vachhani et al. 2022	ZnO-OO, ZOE, Ocimum	ZnO-OO	95.7	91.3
Arora et al. 2024	ZnO-OO, ZOE, Probiotic, Antioxidant	ZnO-OO	88.9	96.3

DISCUSSION

Compared to ZOE, ZnO-OO exhibits significantly lower cytotoxicity, especially because eugenol is not present. Research validates safe resorption patterns and a low inflammatory response (pain, abscess, movement, discomfort on percussion, and lymphadenopathy).4,6

Ozone offers a potent, non-antibiotic antimicrobial strategy, effective against bacteria, fungi, and viruses. It avoids the development of resistance and is suitable for Pediatric patients7,9. Ozone can be successfully incorporated to dental materials by using it in a variety of formulations, such as ozonated oils or gels. Ozonated oil can be a perfect obturating agent when mixed with an appropriate base, such as zinc oxide. The oil base aids in transport and sealing qualities, while the ozone enhances antimicrobial activity. When combined, they create a biocompatible substance that complements the primary teeth's physiological resorption rate and keeps the treatment intact until the exfoliation process happens naturally.

All studies report reduced interradicular radiolucencies and increased bone density at follow-up intervals, reflecting active tissue regeneration and periapical repair3,6. At subsequent follow-up intervals, every study consistently reports a discernible improvement in bone density and a discernible decrease in interradicular radiolucencies. These radiography results show a positive healing response, indicating that the obturating material supports the biological processes required for periapical repair in addition to maintaining an aseptic environment within the root canal system. The progressive disappearance of radiolucencies suggests that infection and inflammation have been successfully eradicated, enabling the restoration of normal bone remodeling. Active tissue regeneration is highlighted by the concurrent increase in radiopacity in previously impacted areas, which indicates the production of new bone.

The ZnO-OO paste is simple to prepare, flows easily in canals, and sets under moist conditions, meeting key criteria for Pediatric endodontic materials6,7. It has useful benefits that make it especially

appropriate for usage in Pediatric endodontics. It is easier to use in standard clinical settings because it is simple to prepare, needing few steps and no complicated equipment. After preparation, the paste has outstanding flow characteristics that enable it to conform effectively to the complex structure of primary root canals, guaranteeing complete filling without applying undue pressure. Given the prevalence of narrow canals and anatomical heterogeneity in Pediatric dentistry, this trait is extremely beneficial.

Long-term effectiveness is maintained by ZnO-OO without leading to issues such as internal resorption, over-retention, or interference with successor eruption. It is better than biologics and herbals because of its predictability.

The integration of ozone into zinc oxide not only enhances the antimicrobial efficacy of the obturating material but also contributes to its exceptional biocompatibility, making it an ideal material for primary teeth. The absence of eugenol reduces cytotoxic effects, while the natural resorption compatibility ensures minimal interference with physiological processes. The consistent reduction in interradicular radiolucencies and increased bone density across studies strongly supports its regenerative potential. ZnO-OO's ease of preparation, flow properties, and moisture-setting capability align perfectly with the anatomical and clinical demands of pediatric endodontics. Unlike some biologic or herbal alternatives, ZnO-OO provides predictable outcomes with minimal complications such as internal resorption or delayed exfoliation. Collectively, these properties position ZnO-OO as a superior, next-generation obturating material that not only treats infection but also promotes healing and tissue restoration in primary teeth.

CONCLUSION

Zinc oxide-ozonated oil (ZnO-OO) is a novel obturating material in pediatric endodontics that exhibits superior clinical and radiographic performance, enhanced biocompatibility, and ease of application when compared to conventional materials like ZOE, Vitapex, 3Mix, and herbal agents. Its notable antimicrobial activity and regenerative potential make it a compelling candidate for routine use in pulpectomy procedures for primary teeth. These properties suggest it could improve treatment outcomes and reduce failure rates associated with traditional materials.

Although current evidence is promising, widespread clinical adoption should follow only after further validation through multicentric randomized trials, long-term follow-up studies, and detailed histological assessments.

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