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Review Article

Zinc Oxide Eugenol as an Obturation Material in Primary Dentition

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Abstract

Maintaining the deciduous teeth in a functional state until its shedding time is the main aim of Pediatric Dentistry. Primary tooth is the best and natural space maintainer which helps to maintain the arch integrity, arch length and guides the permanent tooth eruption. If the deciduous teeth are damaged irreversibly it can be managed by root canal therapy which was first advocated in 1932 in order to serve its function till exfoliation. One of the key factors for the success of pulp therapy is selecting a suitable obturation material. Even though various obturation materials are existing in practice, Zinc Oxide Eugenol (ZOE) remains as the Gold standard material. This review article presents an overview of Zinc Oxide Eugenol as an obturating material.

Keywords: Obturating Material; Pulpectomy; Primary Teeth; Zinc Oxide Eugenol; ZOE

Abbreviations

ZOE: Zinc Oxide Eugenol; MAPK: Mitogen Activated Protein Kinase; ZO: Zinc Oxide; ATP: Adenosine Triphosphate; ZOP: Zinc Oxide Propolis

Introduction

Preservation and maintenance of teeth are the ultimate goal of dentistry. Once broken; a tooth can be mended by the art of dentistry. Depending on the extent of the damage or pathological involvement of pulp tissue treatment varies from indirect pulp therapy, direct pulp capping, pulpotomy, and pulpectomy. Pulpectomy is indicated when inflammation of the pulpal tissue involves the radicular pulp or when non-vital pulp tissue or traumatic injuries are diagnosed to maintain the affected tooth until normal exfoliation [1].

The important aim of pulpectomy treatment is to remove microorganism completely from the root canal and the shaping followed by canal space obturation. For the past fifty years, the goal of obturation remained same i.e. to gain compact seal along the length of the root from the coronal to the apex [2].

Obturation material is one of the key factors for the success of pulpectomy treatment. Zinc oxide eugenol is the first introduced obturating material for primary dentition which is still the most acceptable and popularly used material to date. The purpose of this review is to provide an overview of the properties of Zinc Oxide Eugenol as an obturation material.

Materials and Methods

Literature search of electronic databases (Pub Med, EBSCO Host and Google Scholar) various journals (publication years 1978-2019) using medical subject headings were conducted. In the search, there were no filters activated and no language restrictions. Included references assessed the various obturation material (1-Systematic review, 4 -Review, 19-*In-vivo* study, 10- *In-vitro* study, and 2 - retrospective study, 2- Animal study) and the articles were reviewed by 2 reviewers (both part of the authorship team).

Discussion

Zinc oxide eugenol has been the most widely used obturating material in primary dentition. ZOE was discovered by Bonastre in 1837 and Chisholm introduced ZOE (1876) in dentistry. It was recommended as a root canal filling material in primary teeth for the first time by Sweet (1930) [2]. ZOE is composed of powder - Zinc oxide – 69.0%, White rosin – 29.3%, Zinc acetate - 1.0%, Zinc Stearate - 0.7% and the liquid is composed of Eugenol-85%, Olive oil-15%. Eugenol is said to have an anti-inflammatory and analgesic property. These properties are related to the amount of eugenol released in periapical area, which has a synergistic effect in pulpectomy treatment [3].

Several authors have evaluated the various properties of ZOE and attempted to overcome its drawbacks with many combinations.

Biocompatibility

ZOE has demonstrated less biocompatibility when compared with other obturating materials like KRI paste, as it causes foreign body reaction when extruded periapically leading to granulation tissue formation [4,5]. When it is combined with FC it was toxic to U2OS (Human osteosarcoma cells) which will affect the JNK pathway - a mitogen-activated protein kinase (MAPK) regulates cell growth, division, differentiation and cell death, leading to cell apoptosis [6]. When ZOE alone was used resulted in mild to moderate edema in periapical region. This was countered by replacing eugenol with Calen which is a non-tissue irritant and when compared to ZOE it demonstrated nearly normal periapical cells, absence of inflammatory cell, no resorption of cementum and dentine [7].

Antimicrobial property

The clinical effectiveness of the material is assessed by its antimicrobial efficacy. ZOE has a wide range of antimicrobial activity which includes action against aerobic and anaerobic bacteria, black-pigmented *Bacilli, Streptococci,* Gram-negative aerobic rods and *Staph aureus* [8]. When Zinc oxide (ZO) is mixed with formaldehyde, its action on the cell wall of the organism exhibits a bactericidal effect against *E. coli, Staph aureus* [9,10].

When the natural extract of Aloe Vera is combined with ZO it exhibited a strong inhibitory effect on the micro-organism because of its antimicrobial components like anthraquinones dihydroxyanthraquinones, barbaloin, aloemodin, aloetic acid, ester of cinnamonic acid, saponins, aloin, anthranol, chrysophanic acid, anthracin ethereal oil, isobarbaloin and resistannol [11].

ZOE demonstrated increased inhibitory action when compared with KRI paste [5], MTA, Super EBA, Amalgam [12], Metapex, chitra HAP fill [8]. Few materials exhibited equal inhibitory effect as ZOE when the Zinc oxide is mixed with Calen [13], Eucalyptus oil [14], Peppermint oil [15], and Thyme oil [16]. Eucalyptus antimicrobial property due to its constituents i. e 1,8- cineole, citronellol, citronellyl acetate, eucamalol, limonene, linalool, p-cymene, γ-terpinene, αterpinol, β- pinene, aromadendrene, and alloocimene [14]. Peppermint oil demonstrates antimicrobial action due to its constituent menthol a hydrophobe, which gets absorbed into the cell membrane and disrupts the cytoplasmic cell membrane [15], Thyme oil exhibit antibacterial property by initiating leakage of intercellular content and by decreasing ATP [16].

Resorption

The extruded ZOE material gets retained for a longer duration when compared with other materials like calcium hydroxide at 3 months [17,18], Vitapex at 6 months [19], Endoflas at 9 and 24 months [20,21], Endoflas and metapex at 12 months [22], ZOP 12 months [23]. ZOE stays for longer period time in rodents (Erasquin., *et al*.) due to the formation of a fibrous capsule around the extruded ZOE material which slows down the resorption of material.

To overcome longer retention, nano-hydroxyapatite was added which showed retention rates similar to that of primary roots [23]. The resorption rate of ZOE within the canal was similar to that of primary roots [19,21] and delayed when extruded [20].

Barrier to eruption

The resorption rate of an optimum obturating material must coincide with the primary root resorption and when extruded it should resorb faster. This requirement has been the major setback for ZOE. The extruded ZOE remains without resorption as long as

16 months [24] delaying the eruption of its successor by acting as a barrier [25-27] leading to the failure of the pulpectomy procedure [28].

The extruded ZOE resulted in deflection of the permanent successor when extruded periapically [19,24,26,27,29]. To overcome this, Calcium hydroxide has been suggested as an alternative obturating material [27].

Success rate

In contrast to many authors [20,22,24,30-32], Pramila., *et al*. and Doneria., *et al*. observed the success rate of ZOE both clinically and radiographically which was similar to that of RC-Fill, vitapex, Pulpodent [33], and 3Mix-MP [33].

The highest clinical success rate recorded for ZOE was 100% in 18 months follow up period [34], 97% in a 30 month follow up period [33] and even in necrotic teeth it demonstrated 93.4% success rate [35].

Conclusion

The selection of appropriate obturation material is the primary requisite for the success of the pulpectomy procedure. Despite ZOE's success rate, it has few limitations such as delayed resorption of extruded material, deflected or ectopic eruption of a permanent tooth, anterior cross bite, and palatal eruption. Although various obturating material have been mentioned in literature and use, there is need of a better material that fulfills the ideal requirements of obturation material.

Conflict of Interest

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