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## Obturing Materials Used in Primary Teeth: A Review



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### ABSTRACT

Pulp therapy for pulpy involved primary teeth continues to be a challenge to clinicians. One of the major areas of continued research is in the area of finding obturating materials to suit the specific properties of these teeth. Zinc Oxide Eugenol cement (ZOE) has long been used as a root canal filling material for deciduous teeth but cannot be considered the ideal root canal filling material because as it presents limited antimicrobial action and slow rate of resorption. Concerns about these shortcomings of ZOE and the need for materials that resorb at the same rate as that of the deciduous teeth led to the search for alternative root canal filling material for deciduous teeth. The present article reviews the materials used in pulpectomy and provides an overview of the newer material trials of obturation in pediatric dentistry.



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## INTRODUCTION

Obturation of root canal system is the most important step in successful root canal treatment. It is defined as “The three dimensional filling of the entire root canal system as close to the cementodentinal junction as possible”. According to American Association of Endodontists: “ Obturation is the method used to fill and seal a cleaned and shaped root canal using A root canal sealer and core filling material ”The primary objective is to achieve a fluid tight seal at apical, lateral and coronal sections of root canal system<sup>1</sup>.

## PROPERTIES OF IDEAL ROOT CANAL FILLING MATERIAL:

“Grossman’s Criteria”<sup>2</sup> for ideal root canal filling materials are the following:-

It should be easily introduced into the canal, It should seal the canal laterally as well as apically, It should not shrink after being inserted, It should be impervious to moisture, It should be bacteriostatic or at least not encourage bacterial growth, It should be radiopaque, It should not stain tooth structure, It should not irritate periapical tissue, It should be sterile, or quickly and easily sterilized before insertion, It should be easily removed from the root canal if necessary.

Sundqvist and fidgor<sup>3</sup> in 1998 assigned three primary functions to the root filling. They are sealing against ingrowth of bacteria from oral cavity, Entombment of remaining microorganisms and Complete obturation at a microscopic level to prevent stagnant fluid from accumulating and serving as nutrients for bacteria from any source.

## Criteria for an ideal pulpectomy obturants (Rifkin)<sup>4</sup>:

Resorbability, Antiseptic property, Non-inflammatory and nonirritating to the underlying permanent tooth germ, Radio-opacity for visualization on radiographs and Ease of insertion and ease of removal.

## HISTORY

Before 1800 root canal filling, when done, was limited to gold. Subsequent obturations with various metals, oxychloride of zinc, paraffin, and amalgam resulted in varying degrees of success and satisfaction<sup>5</sup>. In 1847, Hill developed the first gutta-percha root canal filling material known as “HILL’S STOPPING”.<sup>6</sup>The preparation, which consisted principally of

bleached guttapercha and carbonate of lime and quartz, was patented in 1848 and introduced to dental profession. In 1867, Bowman made claim (before the st. Louis dental society) of the first use of guttapercha for canal filling in an extracted first molar. In 1883, Perry claimed that he had been using pointed gold wire, wrapped with some soft guttapercha. In 1887, the SS white company began to manufacture guttapercha points. In 1893, Rollins introduced a new type of guttapercha to which he added vermilion. The softening and dissolution of the guttapercha to serve as the cementing agent, through the use of rosins, was introduced by Callahan in 1914.<sup>5</sup>

### **ZINC OXIDE EUGENOL**

Bonastre (1837) discovered zinc oxide eugenol and it was subsequently used in dentistry by Chisholm (1876). Zinc oxide eugenol paste was the first root canal filling material to be recommended for primary teeth, as described by Sweet in 1930. It was the only material explicitly recommended in the clinical guidelines developed by the AAPD until 2008.<sup>7</sup>

Success rates were reported after obturating with Zinc Oxide Eugenol cement by various authors as follows – Coll et al.<sup>8</sup> in 1985 reported a 77.7% success rate. Nadkarni and Damie<sup>9</sup> in 2000 reported an 89% success rate. Yacobi et al.<sup>10</sup> in 2014 reported an 84% success rate with ZOE primary molar root canal therapy after a follow-up time of 12 months.

### **Enamel defects of succedaneous teeth following ZOE pulpectomies:**

Coll and Sadrian<sup>11</sup> in 1996 stated that there is no relationship between primary teeth pulpectomy and enamel hypoplasia. Incidence of enamel defects was not related to the retention of ZOE filler, length of ZOE fill, or history of trauma or caries. Holan<sup>12</sup> in 2011 reported that Succedaneous incisors that replace traumatized primary Incisors treated with ZOE pulpectomies have 2-3 times higher incidence of enamel defects when compared to normal teeth.

**Advantages of zinc oxide eugenol includes:-**Excellent antibacterial & analgesic effects (in lower concentrations), Radiopaque for good radiographic visibility, Easy to manipulate & fill in the canals, Insoluble in tissue fluids, Easily available, Cost effective and absence of tooth discolouration.<sup>7</sup>

**Disadvantages includes:-** Rate of resorption of material does not coincide with that of root ie, is slower in resorption when pushed beyond the canals, It irritates the periapical tissue is said to show foreign body reaction in contact with periapical tissue (necrosis of bone & cementum), the excessive material is retained for years even after exfoliation of the primary tooth & is shown to harm the permanent tooth bud, forms a fibrous capsule & alters the path of eruption.<sup>7</sup>

**Some Authors and their observations for zinc oxide eugenol:**

Author	Observation
Spedding <sup>13</sup> in 1973	Stated that the extruded zinc oxide eugenol resisted resorption and took months or even years to resorb
Coll and sadrian <sup>11</sup> 1996	Pulpectomized teeth rarely exfoliate later than normal and timing of exfoliation was not related to retention of paste
Hashieh <sup>14</sup> in 1999	The amount of eugenol released in the periapical zone immediately after placement was 10 <sup>-4</sup> and falls to 10 <sup>-6</sup> after 24 hrs, reaching zero after one month. Within these concentrations, eugenol is said to have anti-inflammatory and analgesic properties that are very useful after a pulpectomy procedure.

**CALCIUM HYDROXIDE**

Calcium hydroxide is widely used as a liner for deep restorations, a temporary intracanal dressing and apexification procedures in permanent teeth. Calcium hydroxide is also recommended as a final obturation material for root canal therapy of primary teeth. Calcium hydroxide paste used as root canal filling materials are calvital, calen paste, and L and C paste, seal apex.

Some disadvantages of calcium hydroxide are: -It tends to resorbs earlier than the physiological resorption of the root of primary teeth, This creates a "hollow tube" effect wherein tissue fluid seeps in and eventually becomes a site for infection, Inadequate seal against microorganisms, Dissolution under liquids and lack of adhesion to hard tissues.<sup>7</sup>

After a follow-up time of nine months, Nadkarni and Damie<sup>9</sup> in 2000 reported a 94% success rate after root canal therapy of 35 primary mandibular molars using a calcium hydroxide (0.2 gm powder, 0.5 gm paste) and zinc oxide eugenol (0.36 gm powder, 0.28 gm liquid) mixture.

Also, complete resorption of overfilled calcium hydroxide was observed at the three-month radiographic examination.

Calcium hydroxide when used as obturating material in hyperaemic pulp, can come in contact with some vital pulp tissue remnants and can trigger the cascade of inflammatory root resorption and when used in necrotic pulp produces superficial layer of necrosis causing damage to predentin, which in turn can lead to exposure of dentine to odontoclasts and subsequent resorption.<sup>15</sup>

### **VITAPEX/METAPEX**

Kawakami et al introduced it in 1979. Japanese researchers introduced a calcium hydroxide sealer named vitapex that contains 40% iodoform along with silicone oil. The iodoform is a known bactericide that is released from the sealer and suppresses any residual bacteria in the canal or periapical region. Vitapex is a syringe-loaded viscous pre-mixed paste composed of iodoform - 40.4%, calcium hydroxide - 30.3%, silicone oil- 22.4% and others – 6.9 (neodental chemical products co. Tokyo, Japan).

One advantage of vitapex is its resorbability. When extruded from the apex of a primary tooth, vitapex can be resorbed as early as one week to three months, without causing a foreign body reaction. Its rate of resorption from within the canals is faster than physiological root resorption. It has an easy delivery system, radio-opaque and does not set to a hard mass. It has bone regeneration potential and decreases abnormal tooth mobility and pre-existent bone radiolucency.<sup>16</sup>

Pabla et al<sup>17</sup> in 1999 evaluated the antimicrobial efficacy of zinc oxide eugenol, iodoform paste, KRI paste, Maisto paste and vitapex against intracanal microbes and found that Maisto paste had the best antibacterial activity. Iodoform paste was the second best followed by zinc oxide eugenol paste. Vitapex showed the least antibacterial activity.

Mortazavi<sup>18</sup> in 2004 found that vitapex was more effective than ZOE because it produced a greater decrease in abnormal tooth mobility and in pre-existent bone radiolucency.

Ozalp<sup>19</sup> in 2005 concluded that both ZOE and vitapex were 100% successful, but in the vitapex group, six teeth needed retreatment In the ZOE group, of the six teeth overfilled, only

two showed complete resorption of the extruded material. ZOE performed significantly better than the root canal filling material containing calcium hydroxide.

Saumyanavitet al<sup>20</sup> in 2016 conducted a study to assess the antimicrobial efficacy of different obturating materials used in pediatric dentistry. Antimicrobial activity of obturating materials according to results obtained from the present study can be summarized as follows: endoflas> ZOE >calcium hydroxide + chlorhexidine> calcium hydroxide + iodoform +distilled water ~ metapex> saline.

### **IODOFORM-BASED PASTES**

Iodoform based pastes have been advocated as root filling materials as they fulfill most of the requirements of filling material for primary teeth as they are more easily resorbed from the periapical area, cause no foreign body reaction, display potent germicidal properties. It is used either in pure form or is combined with other materials. It is a potent bactericidal, nonirritant, radiopaque, and well suited for a non-shrinking and non-soluble paste and has rate of resorption is faster than ZOE material.

Disadvantages includes: Rate of resorption of material within the canals is faster than the rate of physiological root resorption. It also has the drawback of causing yellowish-brown discoloration of the teeth<sup>10</sup>. Erasquin<sup>21</sup> in 1989 have shown that iodoform is irritating to the periapical tissues and can cause cemental necrosis.

Iodoform containing root canal filling materials are available in different formulations such as KRI paste, maisto paste, guedes-pinto paste, rifocort, endoflas, vitapex.

### **WALKHOFF PASTE**

Introduced by Walkhoff in 1928. It contains Iodoform, parachlorophenol 33-37% (disinfectant action depend on the liberation of the chlorine in the presence of phenol), camphor – 63-67% and menthol. It can be used as intracanal dressing in cases of non- vital teeth associated with large periapical lesions.<sup>10</sup>

### **KRI PASTE**

KRI, basically an iodoform paste, was introduced by volkoff as a resorbable paste suitable for root canal filling. It consists of iodoform (80.8%), camphor (4.86%), para chlorophenol

(2.025%), and menthol (1.215%). It is a radiopaque endodontic root filling. Camphor and menthol are mixed with the antimicrobial agent and para chlorophenol, to minimize coagulation with adjacent tissues. Iodoform is added as a vehicle to carry the antimicrobial agent as it is a non-irritant and radiopaque.<sup>12</sup>

According to rifkin<sup>4</sup>, it meets all criteria required from an ideal root canal filling material for primary teeth. It was also found to have long-lasting bactericidal potential. Overall success rate for KRI paste was 84% versus 65% for ZOE.

### **MAISTO'S PASTE**

Maisto introduced it in 1967. Tagger et al. used it as root canal filling material in primary teeth. It consists of zinc oxide -14 g, iodoform-42 g, thymol-2 g, chlorophenol camphor-3 cc, and lanolin – 0.5 g. Maisto's paste differs from KRI paste, in that it also contains zinc oxide, thymol and lanolin. This formulation change was made to reduce the resorption rate of the paste from within the canals of endodontically treated primary teeth. Eliyahu mass in 1989 found Maisto paste to be successful in infected posterior primary teeth and had positive healing effect on periradicular tissue.<sup>23</sup>

### **GUEDES-PINTO PASTE**

Guedes-pinto in 1981 proposed a root filling material for primary teeth named as guedes-pinto paste (GPP), Composed of rifocort, camphorated para chlorophenol and iodoform. The paste is made up of one equal part of each component, mixed on a sterilized glass plate.<sup>16</sup>

A systemetic review and meta-analysis by Najjar in 2019 concluded that Ca(OH)<sub>2</sub>/iodoform is the best filling material to be used for pulpectomy in primary teeth nearing exfoliation. Conversely, either ZOE or ZOE/iodoform combined with Ca(OH)<sub>2</sub> is the materials of choice for pulpectomy in primary teeth need long time before exfoliation. The clinical and radiographical success rates of Ca(OH)<sub>2</sub>/iodoform paste are comparable with that of ZOE in primary teeth pulpectomy up to ≥18-month follow-up.

## RECENT TRIALS IN PULPECTOMY OBTURATING MATERIALS

### Zinc oxide eugenol, calcium hydroxide, and sodium fluoride

A mixture of calcium hydroxide, zinc oxide powder, and sodium fluoride (10%) was used as an obturating material, combining the advantages of both calcium hydroxide and zinc oxide. Calcium fluoride as a reaction product added radiopacity to the root canal filling material. Addition of fluoride had given the material a resorption rate similar to the resorption rate of the roots of the primary pulpectomized teeth.

In cases of overfilled canals, the material was not seen to resorb even after two years of follow-up completely; hence care should be taken not to over push the material beyond the apex. Different concentrations of sodium fluoride as liquid was added to the mixture of zinc oxide and calcium hydroxide and was evaluated for the resorption of the root canal filling material intraarticularly, interradicularly and periapically. The mixture made by using 8% sodium fluoride showed good result.<sup>24</sup>

### Endoflas

The rationale behind incorporating three materials ZOE, CA (OH) 2 and iodoform into endoflas was probably to compensate the disadvantages of one individual material with the advantages of the other. Endoflas has the advantage of having the resorption limited to excess material, which has been extruded periapically within 7 days. Resorption of material does not occur within the canal. Thus, the material is neither resistant to resorption nor does it result in hollow tube effect.<sup>25</sup>

### Endoflas-chlorophenol-free (CF)

Radiolucent lesions following endodontic treatment of primary teeth were, maybe due to the filling material that contain phenol. Due to this endoflas CF was developed which is free of chlorophenol. Chlorophenol was eliminated from endoflas composition because it has fixation effect which may affect the osteoblast cells.<sup>26</sup>



### **Calen paste**

Pinto in 2011 in compared success rate of ZOE and calen paste thickened with zinc oxide. High success rate with calen/zo was seen as this material prevented pathologic root resorption and induced new bone formation. Addition of ZO provides better consistency to the paste.<sup>27</sup>

### **Pulpotec**

Pulpotec has antiseptic, antibacterial and anti-inflammatory properties. The main component of this product is iodoform, and due to its antiseptic properties, it acts like an antibiotic paste at the entry of the empty root canal. Pulpotec can be used in the teeth showing bone lesion and help in reduction of clinical signs of infection. The clinical and radiological results show that this procedure could be considered as an alternative to the conventional endodontic treatment for necrotic primary teeth in pediatric dentistry.<sup>28</sup>

### **Aloe vera**

Aloe vera is an herbal and naturally found material and its Properties made possible its wide usage in dentistry for various therapeutic properties. It enhances various phases of Wound healing process, such as macrophage recruitment, Collagen synthesis and wound contraction. Khairwa et al in 2014 evaluated clinical and radiographic success of zinc oxide Combined with aloe vera and showed good success rate. They reported that this material can be used as an alternative for Zinc oxide eugenol.<sup>29</sup>

### **Ozone**

Ozone is gaseous, energized form of oxygen. It is unstable and dissociates readily back into oxygen, thus liberating so called singlet oxygen, which is a strong oxidizing agent. They are responsible for remarkable bactericidal and fungicidal effects. In the study conducted by Chandra et al<sup>30</sup> in 2014, there was good clinical success rate at 12 months follow up, which was attributed to the antibacterial and excellent healing properties of ozone peroxides. ZoE had radiographic success rate less than that of ozonated oil-zoe. Accordingly, the authors have concluded that it can be considered as a good alternative for ZOE.

### **Rifocort**

It is a product formed from a corticosteroid and an antibiotic, presenting a great antimicrobial action and Recommended for the treatment of primary teeth presenting with pulpal infectious processes. The paste also presented Bactericidal action against most organisms except for *Enterococcus faecalis* and *bacillus subtilis*.<sup>10</sup>

### **Zinc oxide eugenolpropolis**

Al-ostwani AO et al<sup>26</sup> in 2014 evaluated zinc oxide and propolis (ZOP) as a new paste, endoflas-chlorophenol-free as a new paste free of chlorophenol, metapex paste and zinc oxide and eugenol (ZOE) paste as a control paste for pulpectomy of nonvital primary molars. Clinical and radiographic results were evaluated at 6, 12 months. The filling pastes achieved convergent clinical and radiographic success rates within the two observation periods without significant differences between them. The radiolucency in ZOE group remained stable without remarkable changes after 6, 12 months of observation. It was accompanied by slow resorption of ZOE paste compared with root resorption in 31.3% of cases. While resorption rate of ZOP was corresponding with root resorption in 62.5% of the cases. Both metapex and endoflas-cf were faster than root resorption in 56.3% of its cases.

### **Chitra HAP-Fil**

Jeeva and Retnakumari et al.<sup>31</sup> in 2014 observed the current trend in dentistry towards the use of biomaterials such as hydroxyapatite. In an attempt to find an appropriate root canal obturating material, they designed a new product named “chitra hap-fil”. “Chitra hap-fil” apparently satisfies all requirements of an ideal pulpectomy material. This study was carried out to investigate the cellular and microbial response of chitra hap-fil in comparison with zinc oxide eugenol and metapex by in-vitro methods and results showed that metapex is significantly least cytotoxic than chitra HAP fil which is less cytotoxic than zinc oxide eugenol. Antibacterial properties of Metapex reported by various authors.

### **CONCLUSION**

Moderate level of evidence to support the use of both ZOE and iodoform paste with calcium hydroxide as root canal filling materials for deciduous teeth. High-quality randomized controlled clinical trials with at least 12 months of follow up are necessary before a reliable

conclusion can be drawn as to the best root canal filling material for endodontically treated deciduous teeth.

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