Obturating Materials in Pediatric Dentistry: Literature Review

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Abstract
Preservation of primary teeth is essential for the space maintenance till the eruption of permanent teeth. So, endodontic treatment is done for the same purpose. Various obturating materials have been introduced for the root canal filling of primary teeth but none could match all the ideal properties of the material. The main aim of the clinician should be to fill the root canal with material which could match maximum requirements of the ideal properties.

Keywords: Calcium Hydroxide, Iodoform, Obturation, Zinc Oxide

1 | INTRODUCTION:

The goal of any procedure performed in a primary tooth is to remove acute and chronic infection from tooth or oral cavity so as to maintain tooth structure which help in maintaining arch length and preserve masticatory function. (1) Pulp therapy for pulpally involved primary teeth is a very challenging situation for clinicians due to:

• Anatomy (tortuous and ribbon shaped) of the primary teeth

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• Roots get resorbed physiologically

• In order to allow for the development of the succedaneous tooth, primary molar roots are usually curved, these curves increase the chance of perforation of the apical portion of the root or the coronal one-third of the canal into the furcation. (2)

Primarily, chemical cleansing and sterilization and secondarily, mechanical instrumentation during pulpectomy procedure are the procedures which increase the chance of success of the endodontic treatment in primary teeth due to complex anatomy. (3) Substances with antimicrobial properties are frequently used as root canal filling materials in deciduous teeth. The main objective of endodontic treatment is total elimination of microorganisms from the root canal and the prevention of subsequent reinfection which is achieved by proper cleaning and shaping followed by the complete obturation of the canal space. (4)

2 | DISCUSSION:

The ultimate goal of endodontic obturation has remained the same for the past 50 years i.e. to create a fluid-tight seal along the length of the root canal system from the coronal opening to the apical termination. (4)

Goals of obturatuion (5)

• Fill the entire root canal system & complexities completely as closely as possible with a suitable obturating materials so that no voids remain.

• Filling the root canal with a material that will resorb and give way for the eruption of the permanent tooth.

• As there is developmental, anatomical & physiological differences between primary & permanent teeth, there is difference in obturation techniques and materials from that of permanent teeth.

Criteria for an ideal pulpectomy obturant (Rifkin & Rabinowitch) (6, 7)

• Non-inflammatory and nonirritating to the underlying permanent

• Radio-opacity for visualization on radiographs

• Ease of insertion

• Resorbability

• Ease of removal

• Antiseptic property

• Stable disinfecting power

• Excess press beyond the apex should be resorbed easily

• Adhere to walls of the canal and should not shrink

• Insoluble in water

• Should not discolor the tooth

• Induce vital tissue to seal the canal with calcified or connective tissue

• Harmless to the adjacent permanent tooth germ

• Not set to a hard mass

However, presently no single material fulfill all these criterias.

Various root canal obturating materials for primary teeth (6–8)

• Zinc Oxide Eugenol

• Calcium Hydroxide

• Iodoform based pastes

• Walkhoff paste

• KRI paste

• Maisto paste

• Vitapex/Metapex
OBTURATING MATERIALS IN PEDIATRIC DENTISTRY: LITERATURE REVIEW

- Endoflas
- Endoflas-Chlorphenol-free (CF)
- Calen Paste
- Smartseal
- Guedes Pinto Paste
- Chirta HAP-Fil
- Pulpotec
- Aloe vera
- Ozone
- Rifocort
- CTZ Paste

Zinc Oxide Eugenol

![Figure 1: Zinc Oxide Eugenol](image)

Bonastre (1837) discovered ZOE and it was subsequently used in dentistry by Chisholm (1876), as one of the most widely used materials for root canal filling of primary teeth. It was first described by Sweet in 1930 (7) and until 2008, it was the only material explicitly recommended in the clinical guidelines developed by the AAPD. (9) Usually, a thin mix of ZOE is made which allow the material to flow easily but it may push the material beyond the apex. But if thick paste is used, it leads to underfilled canals (to avoid this pressure syringe technique can be used, which was introduced by Camp in 1984). ZOE without any catalyst allows a longer working time for filling of canals. (10)

Advantages (11)

- Excellent antibacterial and 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
- No tooth discoloration

Disadvantages (12)

- Slow resorption
- Irritation to the periapical tissues
- Necrosis of bone and cementum of primary tooth
- Harm the permanent tooth bud
- Forms a fibrous capsule and alters the path of eruption

ZOE and Combinations

To improve properties and success rate, zinc oxide eugenol in combination with different components like formocresol, formaldehyde and paraformaldehyde, aloe vera and cresol have been tried out, but the addition of these compounds neither increased the success rate nor any properties. (7)Khairwa A et al (2014) evaluated clinically and radiographically a mixture of zinc oxide eugenol and aloe vera as an obturating material for pulpectomy in a total of 15 primary molars for a period of 9 months. Tenderness to percussion was noted in all the patients preoperatively. At 9 months, the reduction of tenderness to percussion in 93.34% of cases and was highly
significant. Periapical radiolucency was present in all the 15 cases before the start of the study. Radiographic examination was carried out at seven days, one month, 3 months, 6 months and 9 months interval and it was observed that 11 cases (73.34%) demonstrated arrest or decrease of radiolucency. (13)

**Calcium Hydroxide**

Calcium hydroxide containing root canal filling materials can trigger inflammatory root resorption when come in contact with some vital tissue, when used in primary teeth with hyperemic pulp. (14) Also, when this paste is used in necrotic pulp, it produces a superficial layer of necrosis causing damage to dentin which, in turn can lead to exposure of dentin to odontoclasts and cause subsequent damage. (15) The alkaline property of the calcium hydroxide was said to counteract the inflammatory process by activating the alkaline phosphatase activity and acting as a local buffer, which was important for hard tissue formation. (11) Antibacterial effect is primarily due to the liberation of hydroxyl ions and inactivation of enzymes in the bacterial cytoplasmic membrane. (7)

Chawla HS et al (1998) conducted a pilot study in primary molars where Calcium Hydroxide paste was used as root canal filling material. Clinical and radiographic follow-up for 6 months was carried out at 2 months interval, revealed that the treated teeth with Ca(OH)2 as root canal filling material were successful, which show no pain and tenderness to percussion. Decrease in size of radiolucency was seen. (16)

**Iodoform Pastes**

**Iodoform**

It is a preparation of iodine obtained by action of chlorinated lime upon an alcoholic solution of potassium iodide when heated at 1040°F. No irritant action. Relieves pain and is a potent disinfectant. Better re-sorbability and disinfectant properties than ZOE. But they may produce a yellowish brown discoloration of the tooth. (7)

**Walkhoff Paste (7, 8, 11, 17)**

It consist of Iodoform, Parachlorophenol 33-37%, Camphor 63-67% and Menthol crystals 1.40-2.90%. Non-vital teeth associated with large periapical lesions can be treated with this paste.

**Parachlorophenol**

Used as antiseptic agent which dissolve albumin and therefore progressively penetrate into the canalculus of the tooth.

**Camphor**

- Treat pain
- Arrest the hemorrhage

**Menthol**

- Anodyne
- Antispasmodic
- Antiseptic
- External remedy in facial neuralgia, odontalgia, as an obtunder of sensitive dentin as a local anesthetic

**Disadvantages**

- Periapical area and root canal area get totally resorbed.

**KRI Paste**

KRI paste is basically an iodoform paste, was introduced by Volkoff as a resorbable paste suitable for root canal filling. It consists of iodoform (80.5%), camphor (4.84%), para chlorophenol (2.023%), and menthol (1.213%). KRI paste 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. (18) According to Rifkin, 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. Various components of KRI Paste and its role has been described in Table 1. (11)

Kri-1: In 1989, a procedure was published for root canal preparation and filling in necrotic primary molars with a paste made of Kri-1 and pure calcium hydroxide obtaining a high percentage of success with
remission of all symptoms. This was the first publication in which formaldehyde was mentioned as a component of root canal filling material, thus partly recovering Buckley’s formula, which contained 40% formaldehyde and glycerine. (19)

KRI-3: This liquid differs from commonly used KRI-1 paste in that, its parachlorophenol, camphor and menthol concentration are twelve times superior and hence possess greater antimicrobial properties. (7) Holan G et al (1993) found that the success rates of 84% with KRI paste group versus 65% with ZOE group. Overfills more successful KRI paste 79% versus ZOE 41%. The excess paste will resorb without causing any adverse side effects. (20)

**Maisto Paste**

An iodoform based paste developed by Maisto and used clinically for many years with good results reported. It consist of Zinc oxide -14g, Iodoform-42g, thymol-2g, Chlorophenol camphor-3 cc, lanolin – 0.5 g. It differs from KRI paste, in that it also contains Zinc oxide, thymol and lanolin. It reduces the resorption rate of the paste from within the canals of endodontically treated primary teeth. (11) Pabla T et al (1997) evaluated the antimicrobial efficacy of Zinc Oxide Eugenol, Iodoform paste, KRI paste, Maisto paste and Vitapex against aerobic and anaerobic bacteria from infected nonvital primary anterior teeth. Order of antimicrobial activity: Maisto paste > Iodoform paste> Zinc Oxide Eugenol> Vitapex. (21)

**Vitapex/Metapex**

Vitapex was introduced by Kawakami et al in 1979. Various components of Vitapex and its role has been described in Table 2 . (11)

**Advantage** (22)

- Non toxic to permanent successor tooth

| Component          | Action                                      |
|--------------------|---------------------------------------------|
| Iodoform           | Relieves pain and potent disinfectant       |
| Camphor            | Arrest hemorrhage and allays pain of wounded pulp of teeth |
| Menthol            | Anodyne, antispasmodic and antiseptic       |
| Parachlorophenol   | Disinfect root canal and treating periapical infections |

**FIGURE 2: Metapex**

- Antiseptic action
- Good adherence to the canal walls
- Non- setting to a hard mass
- Resorption faster than root, complete resorption of the excess paste is expected within 2-8 weeks.
- Applicability of the material is easier
- Radiopaque

**Disadvantage** (7)

- Rapid elimination of iodoform by the organism leaves behind empty spaces inside the root canal
- Pushed beyond the apex
- Discoloration of the teeth
TABLE 2: Composition of Vitapex

| Component     | Percentage | Action                                                                 |
|---------------|------------|------------------------------------------------------------------------|
| Iodoform      | 40.4%      | Bactericide, suppresses any residual bacteria in the canal or periapical region. |
| Calcium hydroxide | 30.3%  | Biocompatible, antibacterial activity, induction of mineralized tissue formation, activation of alkaline phosphatase and collagen synthesis and ability to produce hydrolysis of bacterial endotoxin. |
| Silicone      | 22.4%      | Oily base additive                                                     |

Doneria D et al (2017) in their study evaluate the clinical and radiographic success of zinc oxide-ozonated oil (ZnO-OO), modified 3Mix antibiotic paste and Vitapex in treatment of primary molars requiring pulpectomy. On the basis of the overall success rates of all the three medicaments, following order of performance can be inferred clinical success and radiographical success: - ZnO-OO(100%)=Vitapex(100%)> modified 3MIX-MP paste.(95.8% and 79.2%). (23)

Advantages (8)

- Hydrophilic and can be used in mildly humid canals.
- Firmly adheres to the surface of the root canals to provide a good seal.
- Disinfect dentinal tubules and difficult to reach accessory canals that cannot be disinfected or cleansed mechanically.
- Only resorbs when extruded extraradicularly, but does not wash out intra-radically

Disadvantage (8)

- Periapical irritation
- Tooth discoloration

Navit S et al (2016) evaluated the antimicrobial efficacy of obturating materials against E. faecalis, amongst all the groups Endoflas had significantly higher zone of inhibition. Antimicrobial efficacy of various materials according to this study can be summarized as follows: Endoflas > ZOE > Calcium hydroxide + Chlorhexidine > Calciumhydroxide + Iodoform +Distilled water ~ Metapex > Saline. (24)
TABLE 3: Composition of Endoflas

| Powder | Liquid |
|--------|--------|
| Iodoform, Zinc oxide (56.5%), | Eugenol |
| Calcium hydroxide (1.07%), | Paramonochlorophenol |
| Tri-iiodomethane dibutylorthocresol (40.6%), | |
| Barium sulphate (1.63%) | |

**Endoflas-Chlorophenol-free (CF)**

Following endodontic treatment of primary teeth radiolucent lesions were may be due to the filling material that contain phenol. Because of this, Endoflas CF was developed which is chlorophenol free. Chlorophenol was eliminated from endoflas as it has fixation effect which may affect the osteoblast cells. (25)

**Calen Paste**

It is a calcium hydroxide-based paste. Calen paste exhibits biocompatibility, high antimicrobial activity and satisfactory clinical, radiographic outcomes and intermediate setting time values. The mean initial pH was 6.1 and it exhibited a progressive increase until reaching a peak at the five-hour time point with mean pH value of 8.4. It has high registration levels, which indicate high radiopacity and lower solubility when compared with the other groups. (26)

Pinto DN et al (2011) 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. ZnO provides better consistency to the paste. (27)

**Smartseal (8)**

It is a root canal obturating material which is based on polymer technology. It uses a hydrophilic principle which can absorb surrounding moisture and expand which results in filling of spaces and voids. Hydrophilic nature is revealed by ProPoints, which permits infinite water volume existing in the root canal system that is engrossed by these points. This water may hydrogen bond to the existing polar locations, therefore, permitting the enlargement inside the polymeric chains.

**Advantages**

- Geometry of point can be accurately made
- Biocompatibility
- Controlled expansion

**Guedes Pinto Paste**

Introduced by Guedes Pinto in 1991. Composition of GPP has been described in Table 4 (28)

**Advantages (29)**

- Easy to apply
- Faster resorption than root
- No toxic effects on permanent successor
- Radiopaque

**Disadvantages (30)**

- Pulp obliteration due to osteogenic potential
- Induces internal resorption in primary teeth
- Lack of adhesion to the hard tissue, leading to inadequate seal against microleakage
- Can be depleted from canal
- Resorbs earlier than the physiological resorption of the roots

**Chitra HAP-Fil**

It is a hydroxyapatite nanoparticle gel based root filler material which corresponds to the bone and dentin’s mineral content. It is highly biocompatible. “Chitra HAP-Fil” satisfies all requirements of an ideal pulpectomy material. (11)

Jeeva PP et al (2014) conducted a study to investigate the microbial and cellular response of Chitra HAP-Fil in comparison with Zinc oxide eugenol...
and Metapex. They evaluated the antimicrobial and cytotoxic activity of three pulpectomy materials. It was found that the Metapex is significantly least cytotoxic than Chitra HAP Fil which is less cytotoxic than Zinc oxide eugenol. (31)

**Aloe vera**

It is a herbal material that has been founded naturally and because of its properties, it can be used widely in dentistry for various therapeutic properties. Various phases of wound healing process has been enhanced by Aloe vera such as macrophage recruitment, collagen synthesis and wound contraction. (34) The chemical constituents of it are part of the physiological functions of living flora and hence, they have better compatibility with the human body. It can be used for various preventive purposes owing to its anti-inflammatory, antifungal, moisturizing, antibacterial, antiviral and pain-relieving properties. (35)

Khairwa A et al (2014) evaluated clinical and radio-graphic 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. (13)

**Ozone**

Ozone is energized and gaseous form of oxygen. It is unstable and dissociates readily back into oxygen, thereby liberating a strong oxidizing agent i.e. Nascent oxygen which is responsible for bactericidal and fungicidal effects. (7)

Chandra SP et al (2014) conducted a study and found good clinical success rate at 12 months follow up, which was attributed to the antibacterial and excel-lent healing properties of ozone peroxides. Radio-graphic success rate of ZOE was less than that of ozonated oil-ZOE. It was concluded that Ozone can be considered as a good

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**TABLE 4: Composition of Guedes Pinto Paste**

| Components                        | Percentage          | Action                  |
|-----------------------------------|---------------------|-------------------------|
| Rifocort                          |                     | Anti-inflammatory       |
| Champhorated parachlorophenol     | 70% Parachlorophenol| Antibiotic              |
| Iodoform                          | 30% Camphor         | Vehicle                 |
|                                   |                     | Antimicrobial and Analgesic |

**FIGURE 4: Pulpotec**

It has antibacterial, antiseptic and anti-inflammatory properties. (32) Iodoform is the main component and because of its antiseptic properties, it acts like an antibiotic paste at the entry of the empty root canal. (7) It can be used in teeth with bone lesion and also help in reducing the infection clinically. Clinical and Radiolographical results show that this procedure could be considered as an alternative to the conventional endodontic treatment for the treatment of necrotic primary teeth in paediatric dentistry. (33)

Aboujaoude S et al (2015) in their study evaluate the effectiveness of a Pulpotec modified endodontic approach on primary molars presenting necrotic pulp and furcation bone loss in a cohort of healthy children. In this study 67.7% of patients showed healing of bone loss, and a significant difference in height and width of the lesion was observed (respectively 80.6%, 71%). (33)
alternative for ZOE. (36)

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. (37)

CTZ Paste
CTZ is an antibiotic paste Combination of chloramphenicol 500mg+tetracycline 500mg+zinc oxide 1000mg+ eugenol 1 drop. (38) Chloramphenicol is an antimicrobial agent that acts against a large number of aerobic, facultative anaerobe and spirochetes as well as gram +ve and gram –ve microorganisms. (39) Tetracycline is a broad spectrum antibiotic which can be bactericidal at high conc. offering excellent effectiveness against gram –ve bacteria and all anaerobes. ZOE provides analgesc properties and potent antibacterial action against staphylococcus, micrococi, bacillus and enterobacteria for more than 30 days. (40)

Advantages (38)

• Simple and easy application
• Antibacterial property
• Stabilization of bone resorption
• Does not cause tissue sensitivity
• Does not produce damage to the permanent tooth in development

Disadvantages (39)

• Pigmentation of the crown of the treated tooth

Fereira JL et al (2017) evaluate the clinical and radiographic CTZ (Chloramphenicol-Tetracycline-Zinc Eugenol Oxide) antibiotic paste in pulpotomies of primary molars. 93% and 88.4% clinically; 97.7% and 93% were radiographic at 6 and 12 months respectively. (41)

3 | CONCLUSION

Appropriate material selection for obturation is crucial in successful endodontic therapy. Although, current obturating materials clinically provide satisfactory results for primary teeth but still modification is required to suit the various clinical situations that have been encountered. Since ZOE has many drawbacks, several other materials have been investigated and various combinations tried with some degree of success. The current combinations of calcium hydroxide and iodoform seem to provide better results than ZOE cement. Recent advances in alternative root filling materials also promise better adhesion to root canal and avert the shortcomings of gutta-percha.

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