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Obturating Materials in Primary Teeth-A Review

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ABSTRACT

Treatment of pulpally inflamed primary and permanent teeth in children presents a unique challenge to the dental clinician. Although the number of children experiencing caries and pulpal pathologies has considerably lowered due to dental health education, pulpal pathologies still persists. It eventually leads to development of malocclusion. Pulp therapy in deciduous teeth differs from that of the permanent teeth, so the medicaments used and the obturation technique. Adequate cleansing by mechanical instrumentation and irrigation of the canals is difficult in deciduous teeth due to its complex and variable root canal morphology. Hence the success of the treatment in such cases would depend upon complete obturation of the canal space Various materials had developed for obturation of primary 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.

INTRODUCTION

The dental pulp in primary teeth is a highly vascularised connective tissue of mesenchymal origin. Treatment of pulpally inflamed primary and permanent teeth in children presents a unique challenge to the dental clinician. Lewis and Law succinctly stated the ultimate objective of pediatric pulp therapy as the successful treatment of the pulpally involved tooth to be retained in a healthy condition to fulfill its role as an important and useful component of the primary and young permanent dentition.

Premature loss of primary teeth is one of the most common causes of malocclusion. Early loss of primary canines or molars are more serious due to the following sequence, space loss, insufficient space for erupting permanent teeth, ectopic eruption and impaction of premolars, mesial tipping of molar adjacent to primary molars, extrusion of opposing permanent teeth, shift of midline with a possibility of cross bite, development of abnormal tongue positions. It is for this reasons that maximum attempts must be made to preserve primary teeth until normal exfoliation occurs [1].

Various materials were developed for obturation of primary 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 it presents

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limited antimicrobial action and it tends to resorb at a slower rate than the roots of the deciduous teeth [2]. Concerns about these shortcomings of ZOE led to a search for alternative root canal filling material for deciduous teeth.

Rifkin identified criteria for an ideal pulpectomy obturant that include: [3]

- Resorbability - An ideal root canal filling material must have the necessary properties of antibacterial action, resorption at the same rate as of the root. It must be readily absorbable if passed beyond the apex.
- Should have an antiseptic property.
- Non-inflammatory and nonirritating to the underlying permanent tooth germ, and harmless to the periapical tissues and successive developing tooth buds.
- Radiopacity for visualization on radiographs.
- Ease of insertion the root canal filling materials should be easy to condense into the canals, adhere to the walls, and should not shrink with setting.
- Ease of removal.
- Should not cause any discoloration of tooth.

Zinc Oxide Eugenol

It is one of the most widely used materials for root canal filling of primary teeth. Bonastre discovered Zinc oxide eugenol. Eugenol was the first essential oil proved to be a significant germicide and was first used in dentistry in 1876 by Chisholm when he added Zinc oxide to eugenol to make Zinc oxide eugenol or ZOE [4]. Composition of zinc oxide eugenol is: Zinc oxide – 69.0%, White resin – 29.3%, Zinc acetate – 1.0%, Zinc Stearate – 0.7%, Liquid (eugenol-85%, olive oil-15%). The advantages of zinc oxide eugenol as the obturating material is anti-inflammatory and analgesic properties, the greater zone of bacterial inhibition, ease of availability, radiopacity of material, cheaper/cost effective, good plasticity, insolubility in tissue fluids, easy to mix and good working time [5]. The amount of eugenol released in the periapical zone immediately after placement was 10^{-4} and falls to 10^{-6} after 24 hrs, reaching zero after one month. Within these concentrations, eugenol is said to have an anti-inflammatory and analgesic properties. The overall success rate of zinc oxide eugenol was 87.9% (29/33). Yacobi et al. reported an 84% success rate with ZOE primary molar root canal therapy after a follow-up time of 12 months. Coll et al. reported a 77.7% success rate [6]. Nadkarni and Damie reported an 89% success rate [7]. Disadvantages of Zinc oxide eugenol is that it alters the path of eruption of succedaneous teeth, causes anterior crossbite, palatal eruption and ectopic eruption of succedaneous tooth, necrosis of cementum and bone, variation in resorption rate of ZOE or slow resorption in comparison to root resorption, enamel defects in permanent successors, failure of extruded material to resorb at the periapical region due to hardening, soft tissue irritation, allergy to eugenol and exhibits cytotoxicity and neurotoxicity [8]. Colla found that zinc oxide may alter the path of eruption of succedaneous permanent. Robin studied unresorbed zinc oxide Eugenol was surrounded by several layers of condensed cellular tissues which were composed of an inner layer of tightly packed cells and an outer layer of fibroblast with chronic inflammatory cells. Segmentation of mass occurs by ingrowth of collagen and fibroblast forming septa. Within the septa sequestration of zinc oxide is seen into smaller masses [9].

To improve the properties of zinc oxide eugenol various formulations had been tried. A study was conducted in which iodoformized zinc oxide Eugenol was tested for its antibacterial effect against the aerobic and anaerobic bacteria and was found to be effective for both the aerobic and anaerobic bacteria of the root canals of deciduous teeth with maximum sustaining period of 10 days. It was found that the obturated material remained up to the apex of root canals till the beginning of physiologic root resorption. Also, the material was found to resorb at the same rate as teeth [10].

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 [11]. Calcium hydroxide paste used as root canal filling material is Calvital, Calen Paste, L and C paste, Sealapex. Calcium hydroxide is initially bactericidal then bacteriostatic, promotes healing and repair, has high alkaline pH that stimulates fibroblasts, stops internal resorption, and is inexpensive and easy to use. Carlos stated that in the interior of the root canal Calcium hydroxide pastes maintained a pH>12. This value of pH found on the external surface may be responsible for the temporary inactivation of the bacterial enzymes. The determining factor for the speed of action of Calcium hydroxide was investigated and found that the high concentration of hydroxyl ions inactivates bacterial enzyme of the cytoplasmic membrane, influences chemical transport and alters the availability of nutrients, thus causing a toxic effect on bacterial cells. This bacterial enzymatic inactivation is reflected in the growth, cellular division and metabolic activity that occur in the cytoplasmic membrane. The chemical disintegration of the membrane is related to the destruction of unsaturated fatty acids or phospholipids, due to a high concentration of hydroxyl ions that interferes with the lipidic peroxidation process and saponification reaction. Studies have reported a success rate of 80 to 90% [12].

The main disadvantage of calcium hydroxide as a root canal filling material is that it tends to resorbs earlier than the physi-

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ological 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. The other disadvantages include inadequate seal against microorganisms, dissolution under liquids and lack of adhesion to hard tissues and weak antimicrobial properties and aggressive internal resorption [13]. A combination of zinc oxide powder and calcium hydroxide paste for obturation of primary teeth has shown promise in a short-term study by Chawla. They found that the obturated material remained up to the apex of root canals till the beginning of physiologic root resorption. Also, the material was found to resorb at the same rate as teeth [14]. After a follow-up time of nine months, Nadkarni and Damie 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.

Iodoform

Iodoform-based pastes have been advocated as root filling materials as they fulfill most of the requirements of a filling material for primary teeth as they are more easily resorbed from the periapical area, cause no foreign body reaction and display potent germicidal properties. Moreover, many resorb in synchrony with primary roots, can be easily forced into the pulp canals and accessory canals, and have no undesirable effect on succedaneous teeth. Iodoform based material though is resorbable if pushed beyond the apex, the rate of resorption is faster than the root. 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. Resorbability makes it ideal for deciduous teeth obturation [15]. Disadvantages of iodoform are that the 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. Erasquin et al. have shown that Iodoform is irritating to the periapical tissues and can cause cemental necrosis [16]. 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 consists of 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 [17].

KRI Paste

KRI, basically an Iodoform paste, was introduced by Volkoff as a resorbable paste suitable for root canal filling. It consist of Iodoform (80.8%), camphor (4.86%), para chlorophenol (2.025%), Menthol (1.215%). 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 [19].

Maisto's Paste

Maisto introduced it in 1967. Tagger et al. used it as root canal filling material in primary teeth. It consist of Zinc oxide -14 g, Iodoform-42 g, thymol-2 g, Chlorophenol camphor-3 cc, 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 found Maisto paste to be successful in infected posterior primary teeth and had positive healing effect on periradicular tissue [20].

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 [21].

Endoflas

Endoflas is a resorbable paste produced containing components similar to that of Vitapex, with an addition of Zinc oxide eugenol. The powder contains triiodomethane and iodine dibutilorthocresol (40.6%), zinc oxide (56.5%), Calcium hydroxide (1.07%), Barium sulfate (1.63%) and with a liquid consisting of eugenol and Paramonochlorophenol [22]. Fuks et al. observed that Endoflas resorbed when overextended periapically, However, it did not resorb intra radicularly and reported 70% success clinically with endoflas and a 100% decrease in periapical radiolucency. High clinical and radiographic success of Endoflas shows its excellent healing capabilities and complete bone healing [19]. The high pH ensures powerful antibacterial effects that reduce periapical inflammatory processes and stimulate periapical healing with an increase of alkaline phosphatase action and periapical bone remineralization. The disadvantage of the material is its Eugenol content that can cause periapical irritation and can cause teeth discoloration.

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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 [21]. 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 (Neo Dental 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 [23]. Rate of resorption from within the canals is faster than physiological root resorption. Advantages of Vitapex are that it has an easy delivery system; It is 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. The success rates of Vitapex and ZOE were 100% and 78.5% [24]. Pabla et al. evaluated the antimicrobial efficacy of Zinc oxide eugenol, Iodoform paste, KRI paste, Maisto paste and Vitapex against intra canal 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 [25].

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 [15].

Chitra HAP-Fil

Jeeva and Retnakumari et al. observed the Current trend in dentistry towards the use of biomaterials such as hydroxy apatite. In an attempt to find an appropriate root canal obturating material, they designed a new product named “Chitra HAP-Fil”. It is a hydroxyapatite nanoparticle gel based root filler material, which exactly corresponds to the mineral content of bone and dentine, deemed to be highly biocompatible. “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 invitro methods.In Hydroxy apatite - Iodoform paste (Chitra HAP-Fil), The prime ingredient is hydroxyapatite nanoparticle gel (65%) which is the basic mineral content of human bone and pure Iodoform (32%) which imparts antibacterial property to the paste. The gelling agent (alginate) – 3% (including 0.2% surfactant) binds with the calcium ions in the hydroxyapatite. The study evaluated the cytotoxicity and antimicrobial activity of three pulpectomy materials, namely Zinc oxide eugenol, Chitra HAP-Fil and Metapex. The cellular response of three materials were evaluated and results showed that Metapex is significantly least cytotoxic than Chitra HAP Fil which is less cytotoxic than Zinc oxide eugenol [26].

Ozonated oil and zinc oxide

Chandra et al. evaluated the success rate of the mixture of ozonated oil and Zinc oxide as primary teeth root filling material. The results of clinical and radiographic evaluation suggested that teeth obturated with ozonated oil-Zinc oxide demonstrated success rate (93.3%) when compared to Zinc oxide eugenol (63.3%). They concluded that Ozonated oil-ZnO demonstrated a good clinical and radiographic success at 12 months follow-up, hence can be considered as an alternative obturating material in infected primary teeth [27].

Zinc oxide eugenol and aloe vera

Khairwa et al. 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.The incidence of pain present preoperatively reduced to 86.67% postoperatively.

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. Mobility and sinus formation was not observed in any of the patients at any time interval.

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. This was highly significant [28].

Zinc oxide eugenol propolis

Al-Ostwani AO et al. evaluated zinc oxide and propolis (ZOP) as a new paste, endoflas-chlorophenol-free as a new paste free

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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 [29].

CONCLUSION

With adherence to sound principles in case selection and techniques, pediatric pulp therapy is a major health benefit to the child. It has been found that the current obturating materials for primary teeth while providing satisfactory clinical results still need to be modified to suit the various clinical situation that are encountered. The current combinations of calcium hydroxide and iodoform seem to provide better results than zinc oxide eugenol cements. Hence, researches have to be done further to develop a root canal filling material for primary teeth that meets all the essential needs of ideal obturating materials.

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