REVIEW ARTICLE

Pediatric Obturating Materials And Techniques

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Abstract

Pulp therapy helps in preserving a pulpally involved primary tooth by eliminating bacteria and their products and ensures hermetic seal of the root canals so that the primary tooth can complete its function without harming the successor or affecting the health of the patient. A thorough understanding of the pulp morphology and root formation and resorption in primary teeth as well as different materials and techniques used is imperative for a successful pulp therapy. One of the major areas of continued research is in the area of finding obturating materials to suit the specific properties of these teeth. This article seeks to present a review of the major obturating materials and techniques with their modifications as well as their advantages and disadvantages.

Key words: Pulp therapy, Primary teeth, Obturation materials and techniques

Introduction

A dentist who provides emergency or restorative care for children will inevitably encounter a situation where a primary tooth has a pulp exposure.[1] This could be from a traumatic injury or as the result of a mechanical or a carious pulp exposure. Pulp therapy for deciduous teeth aims to preserve the child's health and to maintain deciduous teeth in a functional state until they are replaced by permanent teeth.[2] The main objective of endodontic treatment is total elimination of micro-organisms from the root canal, and the prevention of subsequent re-infection. This is achieved by careful cleaning and shaping followed by the complete obturation of the canal space.[3] However, the complex morphology of the root canal system in deciduous teeth makes it difficult to achieve proper cleansing by mechanical instrumentation and irrigation of the canals.[2] So, in order to increase the chance of success of the endodontic treatment, substances with antimicrobial properties are frequently used as root canal filling materials in deciduous teeth.[2]

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The ultimate goal of endodontic obturation has remained the same for the past 50 years: to create a fluid-tight seal along the length of the root canal system, from the coronal opening to the apical termination.[3]

Rifkin identified criteria for an ideal pulpectomy obturant that include

(1) Resorbability
(2) Antiseptic property
(3) Non-inflammatory and nonirritating to the underlying permanent tooth germ
(4) Radio-opacity for visualization on radiographs
(5) Ease of insertion and
(6) Ease of removal

However, none of the currently available obturating materials meet all of these criteria. The present review seeks to evaluate each of the presently available obturating materials and present a few of the emerging concepts related to obturation of primary teeth. Presently, the commonly used materials for primary root canal fillings are zinc oxide Eugenol, Iodoform based pastes[4] and calcium hydroxide.

Zinc oxide Eugenol is one of the most widely used materials for root canal filling of primary teeth. 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.[3]

Hashieh studied the beneficial effects of Eugenol. The amount of Eugenol released in the periapical zone immediately after placement was 10-4 and falls to 10-6 after 24 hrs, reaching 0 after 1 month. Within these

concentrations Eugenol is said to have anti-inflammatory and analgesic properties that are very useful after a pulpectomy procedure. Since 1930's zinc oxide Eugenol has been the material of choice. However, it has certain disadvantages like slow resorption, irritation to the periapical tissues, necrosis of bone and cementum and alters the path of eruption of succedaneous tooth.[5] Colla J (1985) found that zinc oxide may alter the path of eruption of succedaneous permanent.[6] Erasquin (1967) reported occurrence of necrosis of cementum, bone and inflammation of periapical tissue.[7] Robin L W studied unresorbed zinc oxide Eugenol was surrounded by several layers of condensed cellular tissues. This was composed of inner layer of tightly packed cells and 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.[8]

Research is going on in this area to improve the properties of zinc oxide Eugenol by adding antibacterial substances or by altering it with other materials.

Success rates were reported after obturating with Zinc Oxide Eugenol cement by various authors as follows - 82.3%- Barr et al[9] 82.5% - Gould[10] 86.1% Coll et al.[11]

Formocresol, Formaldehyde and Paraformaldehyde and cresol have been tried out[12] to improve the properties and success of zinc oxide Eugenol, but the addition of these compounds neither increased the success rate nor made the material more resorbable as compared to zinc oxide Eugenol alone.[13]

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.[14]

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[15]. 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. Combination of calcium hydroxide, zinc oxide, and 10% sodium fluoride solution has been tested in a clinical study. It was observed that the rate of resorption of this new root canal obturating mixture was quite similar to the rate of physiologic root resorption in primary teeth.[16]

Iodoform pastes have better resorbability and disinfectant properties[17,18,19] than ZOE, but they may produce a yellowishbrown discoloration of the tooth crowns which may compromise esthetics.[17] Different formulations of root canal filling materials containing Iodoform are available: KRI paste (iodoform, camphor, menthol, and parachlorophenol), Maisto paste (iodoform, camphor, menthol, para-chlorophenol, zinc oxide, lanolin, and thymol), Guedes-Pinto paste (iodoform, camphorated parachlorophenol, and Rifocort (Medley, Campinas/SP; prednisolone acetate and sodium rifampicin), Endoflas (Sanlor Lab, Miami/FL; iodoform, zinc oxide, calcium hydroxide, barium sulfate, Eugenol, and paramonochlorophenol), and Vitapex (Neo Dental International, Federal Way/WA; calcium hydroxide and iodoform).[16,20] Castagnola and Orley (1952) stated that KRI paste loses only 20% of its potency in 10 years.[21] Garcia Godoy (1987) found that KRI paste resorbs from the apical tissue in a week or two; it does not set to a hard mass and can be inserted and removed easily.[22] Eliyahu Mass (1989) found Maisto paste to be successful in infected posterior primary teeth and had positive healing effect on periradicular tissue.[23]

Since the introduction to dentistry of Calcium Hydroxide by Hermann (1920, 1930), this medica-ment has been identified to promote healing in many clinical situations. Calcium hydroxide has been used either as the sole root filling material for primary teeth or in association with Iodoform. It is commercially available as Vitapex and Metapex. These products resorb if inadvertently pushed beyond the apex. However, the rate of resorption of the material from within the canals is faster than the rate of physiologic root resorption.[24] Pitts studied the absorbable nature of Calcium Hydroxide, he found that significant wash out of apical plugs of Calcium Hydroxide occurred during the first month after placement. By the ninth month, plugs were virtually gone from the apical portion of the root canal. Adjacent to remaining Calcium Hydroxide particles, giant cells but no inflammatory cells were seen.[25] Poor success rates were reported due to high occurrence of internal resorption by Via[26] and Shroeder[27].

The alkaline property of the material was said to counteract the inflammatory process by acting as a local buffer and by activating the alkaline phosphatase activity, which was important for hard tissue formation. The depletion of the material from the root canals was found to be the main disadvantage of Calcium Hydroxide as root canal filling material.[28] Studies have reported a success rate of 80 to 90%.[23,28]

Japanese researchers have 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. However, several clinical and histopathological investigations of calcium hydroxide and Iodofom mixture (Vitapex, Neo Dental Chemical Products Co. Tokyo) have been published by Fuchino and Nishino (1980). This material was found to be easy to apply and resorbs at a slightly faster rate than that of the root. It has no toxic effects on permanent successor and is radio opaque. For these reasons, the calcium hydroxide Iodoform mixture can be considered to be a nearly ideal primary tooth filling material. Over filling and resorption of the paste containing Iodoform from the root canals had no effect on the success of the treatment but regarded as having a positive healing effect.[3]

Endoflas is a resorbable paste produced in South America and contains components similar to that of Vitapex, with the addition of zinc oxide Eugenol. This paste is obtained by mixing a powder containing tri-iodomethane and iodine dibutilorthocresol (40.6%), zinc oxide (56.5%), calcium hydroxide (1.07%), Barium sulphate (1.63%) and with a liquid consisting of Eugenol and Paramonochlorophenol.[3]

The material is hydrophilic and can be used in mildly humid canals. It firmly adheres to the surface of the root canals to provide a good seal. Due to its broad spectrum of antibacterial activity, Endoflas has the ability to disinfect dentinal tubules and difficult to reach accessory ca-nals that cannot be disinfected or cleansed mechanically. The components of Endoflas are biocompatible and can be removed by phagocytosis, hence making the material resorbable. Unlike other pastes, Endoflas only resorbs when extruded extra-radicularly, but does not wash out intraradicularly. The disadvantage of this material is its Eugenol content that can cause periapical irritation. It also has a drawback of causing tooth discoloration. One study showed a lower success rate of 58% when there was overfilling but 83% success in cases with flush and underfilled root canals.29 Thus, it can be concluded that the Endofloss may be successfully used for root canal treatments in primary teeth particularly if care is taken not to overfill.

Comparative studies have indicated that Zinc oxide Eugenol has better antimicrobial activity as well as lower cytotoxicity than KRI paste[30].

Pabla et al. evaluated the antimicrobial efficacy of zinc oxide Eugenol, Iodoform paste, KRI paste, Maisto paste and Vitapex® against aerobic and anaerobic bacteria obtained from infected non-vital primary anterior teeth. Maisto paste had the best antibacterial activity. Iodoform paste was the second best followed by zinc oxide Eugenol paste. Vitapex® showed the least anti-bacterial activity.[31] Zinc oxide Eugenol (ZOE), Zinc oxide-Eugenol and Formocresol (ZOE+FC), Calcium hydroxide and sterile water (CAOH+H_2O), Zinc oxide and Camphorated phenol (ZO+CP), Calcium hydroxide and Iodoform (Metapex) and Vaseline (Control), were checked for anti-microbial efficacy and ZOE+FC produced strong inhibition against most bacteria when compared to ZOE, ZO+CP and CAOH+H_2O. Metapex and Vaseline were found to be non inhibitory.[32] A mixture of calcium hydroxide, zinc oxide powder, and sodium fluoride (10%) was used, combining the advantages of both calcium hydroxide and zinc oxide. Calcium fluoride as a reaction product added radiopacity to the root canal filling material, without the need for addition of any other radiopaque material. The addition of fluoride was seen to give this material a resorption rate that matched the resorption rate of the roots of the primary pulpectomized teeth. The overfilled material was not seen to completely resorb even after 2 years of follow-up and so care should be taken not to over push the material beyond the apex. A study is already in progress to evaluate the resorption of the root canal filling material intraradicularly, interradicularly, and periapically, using mixtures of zinc oxide and calcium hydroxide along with different concentrations (2, 6, and 8%) of sodium fluoride as a liquid. The mixture made by using 8% sodium fluoride is showing good results in the mid-term evaluation.[16]

Retained primary teeth without permanent successor present a unique challenge to the dentist. These teeth are often prone to caries because of factors such as longevity of the tooth in the oral cavity, discrepancies in interproximal contact with permanent teeth and variation in enamel thickness.[33] A deciduous tooth without permanent tooth bud shows no signs of root resorption requiring different obturating material that would not undergo resorption.[34] This helps to prevent arch length discrepancy and to maintain the space without going for orthodontic or prosthetic rehabilitation.[35] So, materials like Guttapercha, Mineral Trioxide Aggregate (MTA), and Calcium Enriched Mixture (CEM), that are biocompatible and those would not be resorbed should be selected as a root canal filling material for retained primary teeth. Guttapercha is a desirable filling material because it is nontoxic, least irritating to periapical tissues, impervious to moisture. Mineral Trioxide Aggregate (MTA) is recently introduced cement. Studies have demonstrated cemental repair, formation of bone, and regeneration of the periodontal ligament when MTA is used.[36] Table I shows comparison of properties of different commonly used obturating materials.

Several techniques have been used for the filling of material into primary teeth root canals. An ideal filling technique should assure complete filling of the canal without overfill and with minimal or no voids.

Root Canal Filling With Hand Instruments

O'Riordan and Coll described a method of placing the material in bulk and pushing it into the canals with endodontic pluggers.[37] Similar method for root canal obturation was used by many authors[11,12].

Another method has been described in the literature[38], which includes filling large primary canals with a thin mix of the material coating the wall of the canals with the help of a reamer in an anti-clock wise direction while taking it out slowly followed by placement of the thicker mix which is then pushed manually. An endodontic plugger or a small amalgam condenser could be used for compacting the paste at the level of the canal orifice. For larger root canals lateral condensers were used by Coll et al.[39] Barr et al.[9] recommended Glick instrument for filling paste in root canals, where as Hartman and Pruhs[40] recommended the use of wet cotton pellet to push the filling materials into the canals of primary teeth. Paper points also been used to carry the paste down into the root canals.[41]

Most of the time material of choice for filling the root canal of a pulpectomized primary tooth is pure zinc oxide eugenol and it can be carried into the canal using Paper points, a Syringe, Jiffy tubes or a lentilspiral.[1]

Use of hand held Lentulospiral was recommended for use in obturation of primary canals [42,43,15,28]. Kopel reported that the letulospiral hand held was most effective in carrying zinc oxide Eugenol paste to working length and also produced the highest quality fill.[1]

Endodontic pressure syringe has been recommended for use in obturation of primary canals. It was developed by Greenberg[44] in 1963 and consists of a barrel and screw-in plunger and includes 13 to 30 gauge needle which correspond to the largest endodontic file used to instrument the root canal. It has been noted that the needles are very flexible and can easily be maneuvered in the tortuous canals of primary molars[45,46].

Vitapex, an iodoform calcium hydroxide based paste, is delivered by a disposable plastic needle connecting to a syringe. The syringe is introduced up to 1/5th the distance from the apex of the canal and the material is slowly injected as the syringe is withdrawn from the canal. However, due to thickness and limited flexibility of the plastic needle, it is questionable if the tip is able to reach the apex of all canals.

Root Canal Filling With Rotary Instrument

Use of rotary paste filer was mentioned by Yacobi et al.[46] They suggested that spiral root canal filer should be one size smaller than the last file used and cut with sharp scissors to half its length. They claimed that this made it easier to use in a child's mouth and also prevented the filling material being pushed through the apices of the primary tooth.

A lentulospiral mounted on the air motor hand piece has been studied for use in obturation of primary root canals. Sigurdsson et al.[47] and Kahn et al.[47] reported that the letulospiral mounted on a slow speed handpiece was most effective in carrying calcium hydroxide paste to working length and also produced the highest quality fill.

Aylard and Johnson[48] and Dandashi et al.[49] evaluated root canal obturation methods in primary teeth in vitro and reported that the lentulospiral mounted in a slow-speed handpiece was superior in filling straight and curved root canals of primary teeth. Similar success in obturating primary root canals with the use of rotary lentulospiral over other techniques has been reported by Allen[50] and Torres et al.[51]

Table I: Properties of obturation materials

PROPERTIES	ZINC OXIDE	KRI PASTE	VITAPEX
Resorption	Slow as compared to physiologic root resorption[3]	Resorbs at the same rate as the root [7,54]	Faster resorption than physiologic root resorption
Harmless	Harmful[7]	Harmless[14]	Harmless
Overfill resorption	Slow resorption and inflammatory reaction[3]	Resorbs in1-2 weeks[14]	Resorbs in 1-2 weeks[55]
Antimicrobial	Weak antibacterial	Best antibacterial	Weak antibacterial
Easily removed	Difficult to remove	Easily removed	Easily removed[3]
Radiopaque	Radiopaque on radiograph	Radiopaque on radiograph	Radiopaque on radiograph
Discolouration	No discolouration	Causes discolouration[16]	No discolouration

Bawazir and Salama[52] evaluated in vivo two different obturation techniques, lentulospiral mounted in a slow-speed handpiece and hand-held in primary teeth. The study was carried out on 24 children who had received fifty single visit zinc oxide and eugenol pulpectomies in primary molars. The authors reported 96% (21/22) clinical success rate in the group obturated by the lentulospiral mounted in a slow-speed handpiece and a 92% (23/25) clinical success rate in the group obturated by a hand-held lentulospiral at 6 months following treatment. Authors concluded that there was no statistically significant difference between the two techniques of obturation, according to the quality of the root canal filling or success rate.

Recently, a thin and flexible metal tip was introduced viz., NaviTip, in the market to deliver root canal sealer. This NaviTip comes in different lengths and a rubber stop may be adjusted to it. EndoSeal, a syringe delivered zinc oxide eugenol based canal sealer can be expressed by the NaviTip system.

Guelmann et al.[53] assessed the quality of root canal fill by using three filling systems: syringe with plastic needle (Vitapex), syringe with metal needle, and lentulo spiral. Filling quality was determined radiographically. Authors concluded that NaviTip system offered a more desirable filling quality than lentulo spiral and Vitapex syringe techniques.

There is evidence that lentulospiral used as a hand instrument and rotary lentulospiral mounted on a slow speed handpiece may be better and practical obturating techniques for primary molars.

Conclusion

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. Due to the drawbacks of Zinc oxide eugenol material 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 zinc oxide eugenol cements. Similarly several obturation techniques have been used with success, with rotary slow speed lentilospiral being most satisfactory. Even recently Navitip has been used for obturation with good success. However, further controlled studies and research is required to find the ideal obturating material and techniques for primary teeth.

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