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A Review on Obturating Materials for Primary Teeth and Recent Advancement

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Abstract

Pulpal therapy is a pediatric dental treatment used to test and preserve the natural tooth that has been affected by decay or trauma to the teeth. Researchers have attempted to combine the most effective vital pulp therapy technique with the most reliable materials. Many efforts have been made to determine the safest and most efficient method of preserving primary dental pulp and preventing pulpal pathosis. Various materials have yielded successful outcomes. Hence, this review is to present various obturating materials used in day to day clinical practice from the time of invention to novel materials used.

Keywords: Obturating, Supraeruption, Exfoliation

Introduction

Dental caries scores the highest among the dental problems of children all over the world. As many of these children do not attend the dentist on regular basis, their attendance is associated with dental pain in most of the instances. As many young individuals regardless of their race and social background are proved to be in daily need to relieve severe dental pain originated from pulp pathosis due to large cavities, the need for pulp treatment is clearly highlighted [1].

Untreated carious teeth in young children frequently lead to pain and infection, necessitating emergency visit to the dentist [2]. So early recognition and timely referral of infants and young children with dental caries is critical in preventing the unpleasant complications. Premature loss of primary tooth can cause a number of problems including loss of arch perimeter, supraeruption of opposing teeth, and changes in the patient's occlusion. Hence preservation of the primary tooth is important till the time of exfoliation[3].

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 [6].

History

The history of Endodontics begins in the 17th century. In **1687, Charles Allen**, describing the techniques of dental transplants, wrote the first English-language book devoted exclusively to the field of dentistry. At that time, necessity was the mother of invention: experimenting with new techniques, materials, and instruments, even though very rudimentary, the aim of Endodontics has been to relieve pain, maintain exposed pulp, and preserve teeth[10].

Pierre Fauchard (1678-1761), considered the founder of modern dentistry, who in his textbook **—Le chirurgien** precisely described the dental pulp and dispelled the legend of the **—** "tooth worm,"which had been considered the cause of caries and toothaches since the time of the Assyrians[4].

In **1725, Lazare Riviere** introduced the use of oil of cloves for its sedative properties.

In **1746, Pierre Fauchard** described the removal of pulp tissue.

In **1836, Shearjashub Spooner** recommended arsenic trioxide for pulp devitalization.

In **1838, Edwin Maynard of Washington, D.C**. introduced the first root canal instrument, which he created by filing a watch spring.

In **1847, Edwin Truman** introduced gutta-percha as a filling material.

In **1867, Bowman** used gutta-percha cones as the sole material for obturating root canals.

At the end of the century, prosthetic restorations, including the **Richmond or Davis crown**, became increasingly popular. Since they required the use of canal posts, they created an ever greater need for endodontic therapy[5].

Rifkin identified criteria for an ideal obturant includes :

1. It should not irritate the periapical tissues, nor coagulate any organic remnants in the canal.
2. It should have a stable disinfecting power.
3. Surplus pressed beyond the apex should be resorbed easily.
4. It should be inserted easily into the root canal, and removed easily if necessary.
5. It should adhere to the walls of the canal and should not shrink.
6. It should not be soluble in water.
7. It should not discolor the tooth.
8. It should be radiopaque.
9. It should induce vital periapical tissue to seal the canal with calcified or connective tissue.
10. It should be harmless to the adjacent tooth germ.
11. It should not set to a hard mass, which could deflect an erupting succedaneous tooth.
12. Should have proper consistency on mixing so that it can be adequately pushed into the canal.
13. Should not coagulate any organic remnants in the canal[7].

Zinc Oxide Eugenol

Zinc oxide eugenol paste was the first root canal filling material to be recommended for primary teeth, as described by **Sweet in 1930**.

The powder contains zinc oxide that has been finely sifted to enhance the flow of the cement with mixing vehicle eugenol . Limitations include slow rate of resorption of ZOE in the root canals, when forced beyond the apex, there is a risk of deflection of erupting succedaneous teeth because of its hardness, necrosis of cementum with limited antibacterial action.

Hashieh studied the beneficial effects of eugenol. The amount of eugenol released in the periapical zone immediately after placement was 10–4M and falls to 10-6M after 24 hrs, reaching zero after one month. Within these concentrations eugenol is said to have an anti-inflammatory and analgesic properties[8].

Coll et al has reported that when Zinc oxide eugenol extrudes, it develops a fibrous capsule that prevents resorption of the material[9].

ZOE was the choice of material for root canal filling for primary teeth until 2008 In 2009 , based on the studies recently published ,the AAPD guidelines began to cite Iodoform based paste as suitable alternatives to ZOE[10] .

Zinc Oxide Eugenol Sealers

Kerr Pulp Canal Sealer (Sybron Endo / Kerr; Orange, CA)-Developed in 1931 as **Rickert'S Sealer**, was introduced as KERR PULP CANAL SEALER in the early 50's (1951). It is radiopaque but has severe staining properties because of silver content, has average tissue toxicity. It is resorbed from periapical tissues over time and has rapid setting time in high heat / humid conditions

It is available in two forms :

Regular Pulp Canal Sealer – regular set

Pulp Canal Sealer EWT – extended working time (6 hours)

Grossman's Sealer: It was introduced by Grossman in 1974 and is the most widely used ideal sealer. Addition of sodium borate (anhydrous) to powder. Elimination of all ingredients except eugenol in the liquid.

Wach's Cement : It was developed by Dr. Edward Wach of the University of Illinois, introduced in 1925 and was reintroduced in 1955. It is presently sold as SEALEX EXTRA. The odour of liquid is unpleasant. It completely heals the periapical region if extruded.

Nogenol : t is a Zinc oxide – non eugenol based sealer. It was developed to overcome the irritating quality of eugenol. The product is an outgrowth of a non – eugenol periodontal pack and is less irritating to the tissue.

Calcium Hydroxide

Calcium hydroxide is a white, crystalline, slightly soluble basic salt that dissociates into calcium ions and hydroxyl ions in solution and exhibits a high alkalinity (pH 11).

Codman (1851) was the first to use calcium hydroxide in pulpal treatment. **Hermann (1930**) showed that calcium hydroxide stimulated the formation of new dentin, when placed in contact with pulp tissue.

The use of calcium hydroxide to maintain pulp vitality and promoting a bridge formation was first introduced by **Teuscher & Zander (1938)**

According to **Cvek (1989)** calcium hydroxide became more widely known in the 1930s through the pioneering work of Hermann (1936) and the introduction of this material in the United States by **Teuscher & Zander in 1938.**

Calcium hydroxide diffuses through dentinal tubules and may communicate with the periodontal ligament space to arrest external root resorption and accelerate healing. The irritant nature of the material causes cells in the immediate vicinity to be destroyed, where as cells further away are stimulated to respond with calcification[11]

According to **Goldman and Pearson,** there is a well-known "hollow-tube" effect in the lexicon of endodontics where it is thought that an unfilled root canal can be permeated with tissue fluid that becomes stagnant and eventually a nidus for infection. Calcium hydroxide despite its antiseptic and osteo inductive properties,has a tendency to get depleted from the canal searlier than the physiologic resorption of the roots[12]

Calcium Hydroxide Paste As Root Canal Filling Material

Calvital: Calvital was developed 50 years ago and contains a large proportion of calcium hydroxide and maintains its strong alkaline pH over a prolonged period in triturated form.

Calen Paste: It is a commercial calcium hydroxide and polyethylene glycol based material for use as a root canal dressing, introduced by **Leonardo & Lea 1976.**

L&C PASTE : It was introduced by **Lopes & Costa Filho (1984)**.The powder consist of calcium hydroxide(2g), hydrogenized colophony (0.05g) The liquid consist of olive oil (0.16ml).

Sealapex: Sealapex is the original non-eugenol, calcium hydroxide polymeric root canal sealant. This formulation produces rapid healing and hard tissue formation.

Vitapex/Metapex : Calcium hydroxide along with iodoform is commercially available as Vitapex, Metapex, Calplus, Diapex, Apexdent. These products resorb if inadvertently pushed beyond the apex. **HS Chawla 1998**, in his study on 5 teeth for six months found Calcium Hydroxide to show complete healing of periradicular radiolucency[13].

Nevertheless, is spite of its outstanding biological properties, some physicochemical properties of calcium hydroxide are quite unfavorable, the material being permeable to tissue fluids, resorbable at the periapical region and soluble within the root canals[14].

Endoflas

Endoflas is a resorbable paste produced in South America. **Ramar & Murgara (2010)** observed a much higher success rate with Endoflas (95%) compared to other materials, and also reported healing ability, bone regeneration characteristics and resorption of excess Endoflas without washing within the roots. 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, Endoflas has the ability to disinfect dentinal tubules and difficult to reach accessory canals that cannot be disinfected or cleansed mechanically. The components of Endoflas are biocompatible and can be removed by phagocytosis, hence making the material resorbable[16].

In order to overcome the disadvantages of zinc oxide, calcium hydroxide and iodoform, **Chawla HS et al. (2008)** evaluated a mixture of zinc oxide, calcium hydroxide, and sodium fluoride as a new root canal filling material for primary teeth. It was observed that the rate of resorption of this root canal obturating mixture was quite similar to the rate of physiologic root resorption in primary teeth. Use of iodoform containing products in dentistry is of questionable benefit because of the reports of iodine allergy, discoloration of the teeth, and even encephalopathy leading to coma[16].

Iodoform

In **1891 Walkhoff** introduced Camphorated monochlorophenol as an intracanal medicament or as a base for resorbable paste for obturating root canals. Iodoform-based pastes have been advocated as root filling, such as KRI, Walkhoff, Vitapex and Maisto‘s Pastes.

MatsuzukiK 1996 stated that Iodoform provides improved antiseptic and radio-opaque effects[17]. **Kawakami T 1987**used VITAPEX to find the fate of Calcium Hydroxide component in the root canal filling paste. They found that, water based pastes caused necrosis because of the higher alkalinity of Calcium Hydroxide, while the silicone oil based paste (VITAPEX) shows no necrotizing effect[18].

In a study **by Gupta S,Das G,** forty necrotic primary teeth in two groups of children of 4-7 years were obturated with ZOE and metapex and were followed clinically and radiographically for a period of 6 months postoperatively[19]. The overall success rate of ZOE was 85.71% and metapex aws 90.48%.It was concluded that metapex can be used safely whenever there is a doubt about patients return or follow-up[20].

KRI Paste

KRI, basically an iodoform paste, was suggested initially by Wolkhoff 72 in 1928 as a resorbable paste suitable for root canal filling consisting of Iodoform (80.8%),camphor (4.86%), parachlorophenol(2.025%),menthol (1.215%).

Garcia Godoy1987 found that KRI paste is bactericidal in the root canals, resorbs from the apical tissues in one or two weeks, is apparently harmless to permanent tooth germs, is radio opaque, does not set to a hard mass, and is easily inserted and removed[21].

Maisto's Paste

It has the same component as the KRI paste with the addition of zinc oxide, thymol and lanolin.This is a modification of **Walkhoff's paste by Maisto.**

Maisto's paste has the ability to remain in the paste form, and resorbed readily when overfilled. Over filling and resorption of the Iodoform containing paste from the root canals had no effect on the success of the treatment, but it might be regarded as a positive healing effect.

Guedes-Pinto Paste

Guedes-Pinto et al., in 1981 proposed a root filling material for primary teeth named as Guedes- Pinto Paste (GPP), composed of 0.30 Rifocort(formed from corticosteroid and antibiotic), 0.1ml of camphorated parachlorophenol, and 30g Iodoform have antibacterial action and recommended for treatment of primary teeth with pulpal infections

Colla–Cote (Synthetic Collagen)

It is a soft , white pliable biocompatible sponge obtained from bovine collagen . It can be applied to moist and bleeding canals .It is a absorbable collagen barrier which prevents or diminishes extravasation of root canal filling material during primary molar pulpectomies. Also used in endodontic therapy, it provides a scaffold for bone growth and so it can be applied on wounds[22].

Recent Advancements

New obturation materials have been introduced into the endodontic market over the last decade. Some of these are modifications of materials developed for restorative dentistry.

To improve the properties and success rate, ZnOE in combinations with different compounds like formocresol, formaldehyde, paraformaldehyde, and cresol have been tried out, but the addition of these compounds neither increased the success rate nor made the material more resorbable as compared to ZnOE alone. Moreover, the use of phenolic compounds are not advocated due to their fixative nature; they have been proven to have cytotoxic, mutagenic, and carcinogenic potential[23].

Zinc oxide ozonated oil and ZO added with aloevera can be used as alternative to ZOE. Endoflas can be recommended in daily practice as it has better antimicrobial property and resorption of only extruded materials. In case of necrotics primary teeth LSTR and pulpotec can be used to preserve the tooth[24].

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[24].

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.

Al-Ostwani AO et al. 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[26].

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[25].

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. 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[27].

Discussion

Pramila *et al*. in 2016, compared the outcome of three root canal filling materials in primary molar pulpectomies using ZOE with iodoform (RC Fill), Vitapex, and ZOE. In contrast to the other two groups, Vitapex was associated with both intraradicular resorption and resorption of the extruded filling material at the follow-up visits. The intraradicular resorption with Vitapex could be attributed to the fact that calcium hydroxide does not set to a hard mass and is hydrosoluble, hence permeable to tissue fluids and dissociable into ions. Severe preexisting pathosis could have contributed to the worsening of the radiolucencies and external root resorption that were observed in a few teeth which eventually resulted in failure. All three materials were found to be equally effective for obturating primary molars with necrotic pulps and irreversible pulpitis at the end of 30-month follow-up period.

Even though the AAPD guideline on pulp therapy states that the radiograph showing infectious process of pulpectomized teeth should resolve in 6 months, the selected studies' results agreed with previous studies[10.]

R.Wadachi, K.Araki, H.Suda 1998 found that Calcium Hydroxide has bactericidal effect as well as tissue dissolving effect and removes pulp tissue remaining in the root canal wall. Results suggest that a dressing with Calcium Hydroxide for 7 days and irrigation with NaOCl for >30 sec provides an optimal effect[13].

Mortazavi M & Mesbahi M (2004) evaluated Iodoform base materials for root canal treatment of necrotic primary teeth and compared them with traditionally used ZOE. ZOE and Vitapex were compared for root canal treatment

in 52 necrotic primary teeth in two groups of children with a mean age of 5 years and 8.4 months. All the patients were followed up clinically and radiographically 3 months and 10-16 months post-operatively. The overall success rates of Vitapex and ZOE were 100% and 78.5% respectively and the difference was statistically significant. They concluded that, Vitapex can be used more safely whenever there is a doubt about the patient‘s return for follow-up[15]

Conclusion

The current combinations of calcium hydroxide and iodoform seem to provide better results than zinc oxide eugenol cements[28].

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.

So, based on the observations from the present studies, this knowledge can be applied to our daily clinical practice and more randomized clinical trials should be conducted in the field of obturation materials in the future with larger sample sizes, such as, studies comparing traditional materials with that of novel materials and herbal derivatives with long term follow ups for sound evidence-based practice.

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