
**ISSN Print:** 2394-7489
**ISSN Online:** 2394-7497
IJADS 2018; 4(2): 320-323
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www.oraljournal.com
Received: 22-02-2018
Accepted: 26-03-2018

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# Root end filling materials: A review

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**Abstract**
The main goal of endodontic procedure is to provide a complete 3-D seal of the tooth from the periodontium. When this is not possible by othograde approach, retrograde filling needs to be done. Plethora of dental materials is available as root end filling material. This article reviews on the advantages and disadvantages of various retrograde materials as well as discusses new materials available.

**Keywords:** retrograde filling material, biocompatibility, hermetic seal, microleakage

## Introduction
Endodontic treatment is gaining popularity worldwide due to the growing awareness in people regarding the importance of saving the natural teeth. Conventional endodontic treatment has a high success rate of up to 95%, but failures have been noted in 5% to 10% of cases. The main objective of all endodontic procedures is to obtain a hermetic seal between the periodontium and root canal system. When this is not possible by orthograde approach, retrograde approach using root end filling technique with surgical intervention is required [1].
Surgical endodontic therapy involves the exposure of the involved area, preparation of the root end cavity and placement of root end filling material to seal the canal. In the past, many materials such as amalgam, zinc phosphate cement, gold foil were used as retrograde filling material. But because of their limitations like marginal leakage, lack of corrosion resistance and irritation to periapical tissues, many newer materials have been introduced for retrograde filling, the important among them are MTA, Viscosity Enhanced Root Repair Material, Biodentine and BioAggregate [1].

## Indications of retrograde filling are
- In cases where canals cannot be negotiated.
- Presence of a well-fitting post and core that might cause root fracture during removal.
- An irretrievable broken instrument.
- In cases where there is no proper apical seal, root end filling has to be done to ensure proper apical seal [2].

## Ideal requirements of retrograde filling material
- It should be well tolerated by periapical tissues.
- It should adhere (i.e. ideally bond) to the tooth structure.
- It should be dimensionally stable.
- It should be resistant to dissolution.
- It should promote cementogenesis.
- It should be bactericidal or bacteriostatic.
- It should be non-corrosive.
- It should be electrochemically inactive.
- It should not stain tooth or periradicular tissue.
- It should be readily available and easy to handle.
- It should allow adequate working time, and then set quickly.
- It should be radio opaque [3].

**Classification:**
Root canal filling materials can be broadly classified into two types.

- Orthograde filling materials
- Retrograde filling materials.

**Orthograde filling** materials are those which are used to fill the root canal during non-surgical endodontic treatment through the canal orifices of the root.

**Retrograde filling** materials are those which are used during surgical endodontic treatment to obtain good hermetic seal of the apex.

**Retrograde filling materials can be classified as**

- Metals
- Non-metals

**Metals include**
Amalgam, Gold Foil, Silver Cones, Gallium Alloys, Lead Points, Tin Foil, Titanium Post, Tin Post, Gold Screws, Silver Points etc.

**Non-metals include**
Zinc Eugenol cement, Glass Ionomer Cement, Cavit, Zinc Polycarboxylate cement, IRM, Super EBA, Zinc Phosphate cement, Composite Resins, Gutta-percha, MTA, Bio dentine, Bio Aggregate etc.

**Individual retrograde filling material**
**Amalgam:** An amalgam is an alloy of a metal that contains mercury as one of its constituents. Some of its advantages are: It is durable, less technique sensitive, easy manipulation, it has minimal placement time compared to other material and its corrosion products seal tooth-restoration interface and prevent bacterial leakage Some of its disadvantages are: it can cause local allergic reaction, there are concern about mercury toxicity and it does not bond to the tooth

**Gutta Percha:** main advantage is that a tight seal is zobtained at apical part (Woo Y R *et al* 1990). But since gutta percha does not stick to the walls; it must be used in combination with root canal cement (Oslon *et al* 1989).

**Gold Foil:** For year's gold foil was acknowledged as the premier restorative material. Some of its advantages are: it lasts for a long time, it is biocompatible, it produces a smooth surface and it has good marginal adaptability. Disadvantages include requirement of great skills and cost factor. Also there is possibility of root fracture under excessive condensation pressure.

**Silver Cones:** Silver cones cannot three dimensionally obturate the root canal space, especially in areas coronal to the apex which are likely to be exposed during resection. Silver cones cannot be burnished to "perfect" the apical seal.

**Glass Ionomer Cement:** Glass ionomer is a hybrid of the silicate and polycarboxylate cements, which bond physicochemically to dentin and enamel, and possess anti cariogenic activity. Some of its advantages are- good biocompatibility, it has tight sealing ability (Chong *et al* 1995), dentin bonding is through chemical adhesion and it has easy handling. But there has been cytotoxic effects of freshly mixed glass ionomer cement. It has a setting time of 5-10 minutes. Sometimes it causes insufficient filling and hollow spaces form between cavity wall and filling (Khoury & Staehle 1987). It is highly sensitive to moisture and drying during the first handling stage [10].

**Zinc Oxide Eugenol:** Zinc oxide eugenol which is a mixture of clove oil and zinc oxide to form a plastic mass was first described by Chisholm during the Tennessee state dental meeting in 1873.It is dimensionally stable, has good surface details, mucostatic/ mucocodisplacive and has easy manipulation [8]. Eugenol allergy in some patients has been reported. It sets quickly in thin sections. It has low strength and high solubility.

**Composite Resins:** Composite resins have received minimal attention as root-end filling materials. This is due to their cytotoxic or irritating effects on pulpal and periapical tissue. Overall, composites exhibited a poorer biocompatibility than amalgams. Some of its advantages are-good compatibility of selected products, reattachment of periodontal fibres was observed (Andreasen *et al* 1953) and good clinical long-term results of selected products (Rud *et al* 1996). But it is moisture and technique sensitive. Concerns about monomer content are always there. Initial cytotoxicity ranged from 1 month or more depending on which product was used (Bruce *et al* 1993).

**IRM (Intermediate Restorative Material):** IRM is zinc oxide eugenol cement reinforced by the addition of 20% of polymethacrylate by weight to the powder. In a retrospective study of retrograde filling materials, IRM was found to have a statistically significant higher success rate compared to amalgam. The addition of 10% and 20% hydroxyapatite to IRM produced a significantly better seal than amalgam [6]. Toxicity is strongly reduced with increasing setting of cement; long term inflammatory potential seems to be minimal. But it has condensation problems. Also radiopacity is same as gutta percha. Setting time varies depending on temperature, humidity and consistency. It must be refrigerated to delay setting time.

**Retroplast:** Retroplast is a dent in bonding composite resin system developed in 1984 specifically for use as a retrograde filling material. The formulation was changed in 1990, when the silver was replaced with Ytterbium tri-fluoride and ferric oxide. There is evidence that retroplast promotes hard tissue formation at the root apex and some have suggested that this is a form of cementum. In a limited number of case reports retroplast retrograde fillings have demonstrated regeneration of the periodontium with a cementum layer over the root end restoration [12].

**Geristore (Resin Ionomer Suspension):** It is a resin based glass ionomer which is developed in an attempt to combine the various properties of composite resins and glass ionomer [9].

**Advantages**

- Hybrid ionomer composite - Combines best properties of both types of materials
- Self-Adhesive - No need for retentive cavity design. Saves chair time and tooth structure. Speed can help ensure success with pediatric and geriatric patients
- Syringe delivery system - Easy and simple to dispense
- Bonds to all surfaces including: enamel, dentin,

cementum, precious and non-precious metal, and old set amalgam - eliminates the need for multiple products
- Low polymerization shrinkage and low coefficient of thermal expansion - excellent marginal integrity
- Resistant to marginal leakage and abrasion.
- Biocompatible - years of clinically proven safety, especially subgingivally
- Radiopaque - highly distinguishable from tooth structure in radiographs.

**Disadvantages**
- Technical difficulty of placing the geristore to the root end cavity.
- Requires light activation and resin bonding agent to bond to tooth surface.

**MTA (Mineral Trioxide Aggregate)**
It was developed in the Loma Linda University by Torabinejad. It is a powder that consists of fine hydrophilic particles that sets in the presence of moisture. MTA has the pH of 10.2 initially which rises to 12.5 after three hours of mixing. The setting time for the cement is 2 hours 45 minutes. It is least toxic of all the filling materials and has excellent biocompatibility. It is hydrophilic in nature and non-resorbable. It is reasonably radio opaque. It forms a good marginal seal and stimulates hard tissue formation (Cementum). But it is difficult to manipulate and has long setting time. It is expensive, has no antimicrobial property and dissolves in an acidic pH [5, 11].

**Viscosity enhanced root repair material (VERRM):** This is a new retrograde filling material which is formulated using Portland cement as the base material. Bismuth oxide and other compounds were added to improve the radio opacity and handling characteristics. Hut Kheng Chng *et al* showed that VERRM's physical properties are similar to MTA and is biocompatible with the periradicular tissues [7].

**Biodentine**
Biodentine™ was developed by Septodont's Research Group as a new class of dental material which could conciliate high mechanical properties with excellent biocompatibility, as well as a bioactive behavior. Biodentine™ turns out to be one of the most biocompatible of all the biomaterials in dentistry as demonstrated according to all the ISO standard tests, as well as in the different preclinical and clinical research collaborations. Moreover, reactionary dentine formation was demonstrated in rats, exhibiting high quality and quantity of protective dentine stimulation in indirect pulp capping [4].

**Active Biosilicate Technology:** In order to take up the technological challenge of combining the calcium silicate chemistry with the requirements of a formulation compatible with classical restorative and endodontic practice, Septodont developed a new technological platform called Active Biosilicate Technology™. This consists in controlling every step of the material formulation beginning with the purity of the raw materials. The Active Biosilicate Technology™ is a proprietary technology developed according to the state-of-the-art pharmaceutical background applied to the high temperate ceramic mineral chemistry. Septodont is now able to ensure the purity of the calcium silicate content of the formulation and the absence of any aluminate and calcium sulfate in the final product.
The working time of Biodentine™ is up to 6 minutes with a final set at around 10-12 minutes. Compared to well known dental materials such as Dycal® (calcium hydroxide), Biodentine™ exhibits less cytotoxicity. Moreover, when compared to Pro Root® MTA, Biodentine™ demonstrates at least equivalent biocompatibility.

**Laser**
Laser applications for dental practice have been a research interest for the past 25 years.
First laser, the Ruby laser was developed by Miaman in 1960. Clinical investigations into LASER, used for apicoectomy began with the $CO_2$ laser. Later Nd: YAG, Er: YAG and Ho: YAG lasers were used. The most promising wavelength has been the Er: YAG at 2.94 micrometers. The use of laser for apicectomy procedure has some merits, but it takes more time to perform when compared to more conventional methods.

**Bioaggregate:** Bio Aggregate® Root Canal Repair Filling Material is a fine white hydraulic powder cement mixture for dental applications. It utilizes the advanced science of nanotechnology to produce ceramic particles that, upon reaction with water produce biocompatible and aluminum-free ceramic biomaterial. The working time of BioAggregate® is atleast 5 minutes [13, 14].

**Bone Cement:** Bone cement is common in the practice of orthopedic surgery. The cement exhibits low cytotoxicity. High and Russell conducted cell culture studies and examined the cytotoxicity of amalgam compared with bone cement using an agarose diffusion method on cultured cell monolayer. Fibroblasts were completely unaffected by the bone cement, whereas amalgam caused cell lysis. Bone cements deliver high antibiotics locally but do not allow high systemic concentrations. It has also been found to be more effective than amalgam in inhibiting bacterial growth. In addition, bone cement tolerates a moist environment very well. Blood contamination of bone cement resulted in a slight decrease in shear strength and no difference in mechanical penetration of the cement interface. These characteristics potentially make it a suitable desirable retrograde filling material.

**Conclusion**
The clinician should consider using materials which provide a hermetic seal and are biocompatible. Retrograde materials should be non toxic, non- cariogenic, dimensionally stable and cost effective. Based on this review of literature, it appears that biodentin and MTA are the best root end milling materials.

**Conflict of interests**
The authors declare that there is no conflict of interests regarding the publication of this paper.

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