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Review Article

Retrograde filling materials: A review

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ABSTRACT

Surgical endodontic therapy is done when non-surgical endodontic treatment is unsuccessful. Rootend resection is the most common form of periradicular surgery. The procedure involves surgical access or osteotomy to expose the involved area, root-end preparation, root-end resection, periradicular curettage and placement of a suitable root-end filling material.

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.[1] A mandatory requirement of root canal therapy is that the obturation and restoration of the tooth must seal the root canals both apically and coronally to prevent leakage and percolation of oral fluids and to prevent recontamination of disinfected canals.Failure of non-surgical endodontic treatment or non-surgical endodontic retreatment indicates the need for endodontic surgery to save the tooth.[2]

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 .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.[1]

The real goal of endodontic surgery is to provide an impervious seal to the root canal system, eliminating bacterial contamination of the periradicular tissues and encouraging their regeneration (Torabinejad& Walton, 2009).[3]

Ideal requirements of a root end filling material :

1. Adhere and adapt to the walls of the root preparation
2. Prevent leakage of microorganisms and their products into the peri-radicular tissues
3. Be biocompatible
4. Non-resorbable
5. Unaffected by moisture
6. Easy to prepare and place
7. Radiographically visible
8. To have anti-caries activity
9. To be non-toxic, non-carcinogenic, dimensionally stable
10. It should not cause paresthesia
11. It should not cause additional pigmentation

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12. It should not corrode or be electrochemically active
13. It should have bactericidal or bacteriostatic effect
14. It should stimulate cementogenesis
15. It should be well tolerated by peri-radicular tissues with no inflammatory reactions

HISTORY:

1. In 1846, Jackson was the first to introduce sponge (crystalor crystalline) gold as a filling material.
2. In the mid-1850s, Robert Arthur introduced the adhesive gold foil by welding the pieces of sponge gold together.
3. In 1913, gold foil was introduced as a root-end filling material by Schuster.
4. In 1819, the English chemist Bell invented a mercurybased dental amalgam.
5. In1884, Farrar was the first to place amalgam as a retrograde filling followed by Rhein in 1897.
6. In 1867, Bowman was the first to introduce Gutta-perchafor obturating root canals.
7. Amagasa et al. (1989) reported a high success ratewhen GP was used as a root-end filling.
8. Hendra (1970) advocated Super-EBA as aroot-end filling material because of its good sealing ability.
9. Bondra et al. (1989) suggested that IRM could beconsidered in the clinical use as a retrograde filling when IRM exhibited significantly less leakage than amalgam.
10. Clinically,Dorn& Gartner (1990) showed that amalgam demonstrated a statistically significant reduction in success rateswhen compared with Super EBA and IRM.
11. In 1968, polycarboxylate cement was described by Smith.Theuse of polycarboxylate cement as a root-end filling has received little attention.
12. The effect of IRM as a root-end filling placed in teeth prior to replantation was observed by Pitt Ford et al in 1994.
13. Gray Mineral trioxide aggregate (MTA) was developed at Loma Linda University, California by Torabinajed & co-workers in 1993.
14. According to a clinical study done by Chong and Pitt ford in 2003 comparing MTA and IRM, the use of MTA showed a higher success rate.
15. Biodentine is a calcium silicate based material introduced in 2010 as a material for crown and root dentin repair treatment, repair of perforations, apexifications, resorption repair and root-end fillings.4

INDICATIONS OF RETROGRADE FILLING :

1. In cases where canals cannot be negotiated.
2. Presence of a well-fitting post and core that might cause root fracture during removal.
3. An irretrievable broken instrument.
4. In cases where there is no proper apical seal, root end filling has to be done to ensure proper apical seal.[1]

CLASSIFICATION:

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

1. 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.
2. 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:

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

b. 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.

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
- 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.
- it does not bond to the tooth

Gutta Percha: Use of gutta-percha as a rootend filling material is no longer recommended owing to the advent of newer materials with significantly enhanced properties.

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
- it has good marginal adaptability.

Disadvantages include :

- requirement of great skills and cost factor.
- 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
- it has easy handling.

Disadvantages:

- cytotoxic effects
- 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 .

Zinc Oxide Eugenol: It is a mixture of clove oil and zinc oxide to form a plastic mass , 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 . 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.

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.[5] Toxicity is strongly reduced with increasing setting of cement; long term inflammatory potential seems to be minimal. But it has condensation problems. Setting time varies depending on temperature, humidity and consistency.

Retroplast: It 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 .[6]

Endosequence root repair material (Brassler, USA): It is available in putty and paste forms. It is a ready-to-use, premixed bioceramic material for use as a root end filling material. It can also be used for perforation repair and pulp capping. This material shows biocompatibility similar to MTA.7

iRoot BP Plus (Innovative BioCeramix Inc., Canada): It is a synthetic water-based bioceramic cement. It is available in ready to use premixed form and has a biocompatibility similar to MTA .[8]

EndoBinder (Binderware, Brazil): It is a new cement which has calcium aluminate as the chief ingredient. During production,free magnesium oxide and calcium oxide are eliminated to avoid expansion of the material and ferric oxide which can cause tooth discolouration is also eliminated. In in vivo studies it is biocompatible .[9]

Generex A (Dentsply Tulsa dental, USA) : It is a calcium silicate based cement and is similar to MTA but the handling properties are different .Instead of water the cement is mixed with a special gel. The final consistency is similar to IRM like dough and easy to manipulate.10

Capasio (Primus ,USA): It is a new material which contains bismuth oxide, dental glass, and calcium alumino-silicate with a silica and polyvinyl acetate-based gel. According to a recent study, this material has mineralization capacity similar to MTA in vivo.It also has the capacity to penetrate dentinal tubules. This material also supports primary osteoblast growth.[11]

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.[12]

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.
- Syringe delivery system - Easy and simple to dispense
- Bonds to all surfaces including: enamel, dentin
- 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 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 nonresorbable. It is reasonably radio opaque. It forms a good marginal seal and stimulates hard tissue formation (Cementum).[13]

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.[14]

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. It turns out to be one of the most biocompatible of all the biomaterials in dentistry as demonstrated according to all the ISO standard tests. Moreover, reactionary dentine formation was demonstrated in rats, exhibiting high quality and quantity of protective dentine stimulation in indirect pulp capping . The working time of Biodentine™ is up to 6 minutes with a final set at around 10-12 minutes.[15]

Active Biosilicate Technology: 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-ofthe-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.

Laser : Clinical investigations into LASER, used for apicoectomy began with the CO2 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 aluminumfree ceramic biomaterial. The working time of BioAggregate® is atleast 5 minutes .[16,17]

Bone Cement: The cement exhibits low cytotoxicity. 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.[1]

CONCLUSION:

An ideal root-end filling material is still elusive because each of these above discussed materials have their own advantages and disadvantages .Based on this review of literature, it appears that biodentin and MTA are the best root end milling materials.

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