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Root End Filling Materials - A Review

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Review Article

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Abstract: The main objective of root end filling material is to achieve a good hermetic seal and to prevent the leakage of microbes and irrigants from the root canals. Various root end fillings have been discussed along with the recent advances and their biocompatibility, sealing ability, anti-bacterial effects and microleakage.

Keywords: Root end, filling, retrograde, microleakage.

INTRODUCTION

Hermetically sealing all the pathways of communication between the pulpal and periradicular tissues is the goal of endodontic therapy. Proper obturation and restoration of the tooth is the most important part of root canal therapy and root canals must be sealed both apically and coronally to avoid leakage of oral fluids thus preventing the recontamination of the canals. Apicoectomy (apicectomy / root-end resection) with retrograde obturation is a widely applied procedure in endodontics, when all efforts for the successful completion of orthograde endodontic therapy have failed [1].

When there is failure of non-surgical endodontic therapy or non-surgical endodontic retreatment the need for endodontic surgery is indicated to save the tooth. The root end filling materials should be biocompatible must provide an adequate seal so as to prevent leakage of irrigants and microbes from root canals. Its anti-bacterial effects and ability to stimulate regeneration of the periodontium will accelerate the healing process and reduce the incidence of failures. Root-end materials must be non-toxic, non-irritant, radio-opaque and non-corrosive.

In addition to this, it should also be dimensionally stable, and easy to handle. Many materials have been used as root-end filling materials.

These include amalgam, gutta percha, zinc-oxide eugenol cements (IRM, Super-EBA), , Glass ionomer cements, composite resins, MTA, Biodentine, EndoSequence, etc[2].

Ideal requirements of a root end filling material are[3].

- Adhere and adapt to the walls of the root preparation
- Prevent leakage of microorganisms and their products into the periradicular tissues
- Be biocompatible
- Nonresorbable
- Unaffected by moisture
- Easy to prepare and place
- Radiographically visible
- To have anticaries activity
- To be non-toxic, non-carcinogenic, dimensionally stable
- It should not cause paresthesia
- It should not cause additional pigmentation
- It should not corrode or be electrochemically active
- It should have bactericidal or bacteriostatic effect
- It should stimulate cementogenesis
- It should be well tolerated by periradicular tissues with no inflammatory reaction

AMALGAM

Amalgam is one of the oldest and commonly used root ends filling material. Farrar was the first one to place it as a root-end filling subsequent to resection. Later Rhein, Faulhaber & Neumann, Hippels and Garvin also used it for root-end fillings. High copper zinc free amalgam is preferred using. It is easy to manipulate, has self-sealing capacity, is radioopaque and insoluble in tissue fluids because of the formation of corrosion products. It remains as a standard to which other materials are compared. Clinical and histopathological studies show that amalgam adjacent to bone is well tolerated by periapical tissues[4, 5].

But studies show that freshly mixed amalgam is toxic due to the free mercury present and toxicity reduces with time as the material hardens. Scientists show concern about the free mercury and its potential toxicity. Some in vitro studies also show that amalgam has poor sealing ability. Few studies that amalgam when used in combination with Amalgabond has a better sealing ability. Due to these reasons in recent times, amalgam is not a favourite material for root end filling[6].

GUTTA PERCHA

Gutta Percha was introduced by Bowman in 1867. It is most commonly used root filling material in endodontics. It is a trans-isomer of polyisoprene, existing in alpha and beta crystalline forms. Friedman described its composition as consisting of 20% gutta-percha matrix, 60% zinc oxide filler, 11% heavy metal sulphates as radioopacifiers and 3% waxes as plasticizers. Because of the poor sealing ability of gutta percha it is always used with a sealer during obturation. Keeping in knowledge about the introduction of newer materials gutta percha is no longer used as a root end filling materials. It is nonresorbable, biocompatible and has good handling 19 properties but at the same time its moisture sensitive. Also there is a tendency for its margins to open when the canal root interface is cut, heated or burnish[7].

ZINC OXIDE EUGENOL CEMENTS

Zinc-oxide eugenol cements are among the most commonly used and recommended root-end filling materials. ZOE cements, in order to improve their physical properties was subjected to various modifications.

Super EBA

Here, there is a substitution of part of the eugenol liquid with ortho-ethoxybenzoic acid (EBA) and addition of alumina to the powder. Super-EBA was developed in the 1960's, it was originally manufactured by Staines in England. Super EBA shows high compressive strength, high tensile strength, neutral pH and low solubility. A comparative study of the solubility of some root-end filling materials done by Poggio et al in 2007 showed that IRM, SuperEBA and MTA showed no signs of solubility in water. It has also been shown to have good sealing characteristics. It adheres well to tooth structure even in moist conditions. But, super-EBA is radioluscent and technique sensitive. The eugenol content of super-EBA may be a source of irritation to the tissues[8].

IRM

IRM is zinc oxide eugenol cement modified by addition of 20% polymethyl methacrylate by weight to the powder. Eugenol in IRM may have an affinity for poly methyl methacrylate which reduces its release into the tissues, thereby reducing the cytotoxicity. Eugenol release from IRM by this leached component analysis was obviously higher than from Super-EBA because of the comparatively higher content of eugenol. IRM was shown to have a better seal than amalgam or super-EBA. IRM showed good anti-bacterial activity against S.aureus, E.faecalis, P.aeruginosa [2].

GLASS IONOMER CEMENT

The bonding of Glass ionomers to dentine is physico- chemically.These are formed by the reaction of calcium–aluminosilicate glass particles with aqueous solutions of polyacrylic acid. These cements are easy to handle and does not cause any adverse histological reaction in the periapical tissue. A study used light cure, resin reinforced GIC as a retro- grade filling material. It showed least microleakage due to less moisture sensitivity, less curing shrinkage and deeper penetration of polymer into dentin surface. It is reported that newer glass ionomer cements containing glass-metal powder have less leakage and showed no pathologic signs. One of the disadvantages of glass ionomers is the root preparation must be absolutely dry and seal is adversely affected by moisture and low pH [3].

COMPOSITE RESINS

Use of composite resins along with dentin bonding agent is also used to produce a leak-resistant seal. Rud *et al*. have shown excellent long term clinical success with Retroplast composite resin root-end fill and Gluma dentin bonding agent. But, presence of a dry field during placement is important. Conventional composite resins contain a polymerizable organic matrix, inorganic fillers and a silane coupling agent. TEGDMA, bis-GMA and UDMA have been detected in aqueous extracts[8] and formaldehyde can liberate over a long time period [9]. These components may be the reason why the material exhibits highly antibacterial effects against P.gingivalis, P.intermedia, P.endodontalis, F.nucleatum. Enamel matrix derivatives (EMD) coated on surfaces of root dentin is known to promote periodontal regeneration. Periapical biopsies of teeth with composite resin retrograde fillings have shown deposition of cementum and reformation of periodontal ligament over the resin fillings[10]. An experiment done to evaluate the adherence of enamel matrix derivatives on root-end filling materials was done to compare amalgam, IRM and Composite resin. High amounts of EMD were found to adhere to the composite resin. This could be an explanation for the periodontal regeneration seen with composite resin filling[11].

MINERAL TRIOXIDE AGGREGATE

Gray Mineral trioxide aggregate (MTA) was developed at Loma Linda University, California by Torabinajed & co-workers in 1993. MTA has shown excellent seal and hard tissue repair compared with other root-end filling materials. The main components in MTA are tricalcium silicate, tricalcium aluminate, tricalcium oxide, silicate oxide. Bismuth oxide has been added to the powder to make it radio-opaque. The powder is composed of hydrophilic particles that set in the presence of moisture. Hydration of the powder forms a colloidal gel that hardens. 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. MTA has shown promising results due to its good sealing properties, bioactivity, and potential to stimulate cementogenesis. The main advantages of MTA are its biocompatibility and its osteogenic and regenerative potential. MTA has been demonstrated to have better anti-bacterial properties against E.faecalis, S.aureus and P.aeruginosa compared to other materials. In addition, MTA has better anti-bacterial activity when used after mixing with 0.12% chlorhexidine. In a study done to compare sealing abilities of white and gray MTA when mixed with water and 0.12% chlorhexidine which showed no differences in sealing abilities.this shows that CHX does not compromise the sealing effect of MTA. The use of MTA has been shown to induce cementum formation and periodontal regeneration with induction of least amount of inflammation. A disadvantage is its slow setting and less resistance against washing out during placement[2].

ENDOSEQUENCE (ERRM)

It is a new bioceramic material consisting of calcium silicates, monobasic calcium phosphate, and zirconium oxide. Its is radioopaque, biocompatible, bioactive and its high pH contributes to its antimicrobial activity. ERRM has been shown to have negligible cytotoxicity and capability to induce cytokine expression similar to MTA.

CONCLUSION

An ideal root-end filling material should satisfy all the ideal requirements discussed above but it is still on debate because of their own advantages and disadvantages. Of all the recent root end filling materials, MTA remains to be the material of choice and is considered the gold standard for all the future root end filling materials.

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