Biomedical & Pharmacology Journal Vol. **8**(Spl. Edn.), 219-224 (Oct. 2015)

Recent Advances in Root end Filling Materials : A Review

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DOI: http://dx.doi.org/10.13005/bpj/678

(Received: August 15, 2015; accepted: September 20, 2015)

ABSTRACT

The aim of the root end filling is to prevent the leakage of irritants from the root canal into the periapical region and to enhance the apical seal provided by the non surgical endodontic treatment. Various restorative materials which have been used for coronal restorations have been tried and tested as a root end filling materials, along with development of restorative materials exclusively for use as a root end filing material.In old times amalgam was considered the material of choice for root end filling. In recent times MTA has been developed which fulfils almost all the requirements of an ideal root end filling material and has become the gold standard against which the newer materials are compared.This article reviews the conventional root end materials in endodontics and gives a bird's eye view of the recent advances in root end filling materials.

Key words: Root end filling materials, Endodontics, MTA, Root resection, Periapical surgery.

INTRODUCTION

Surgical endodontics is performed in a teeth when conventional endodontic procedure or retreatment cannot be performed or when non surgical retreatment fails to treat the infection. Endodontic surgery includes root resection, apical curettage when needed followed by restoration of the resected root end with a suitable root end filling material. The aim of the root end filling is to prevent the leakage of irritants from the root canal into the periapical region and to enhance the apical seal provided by the non surgical endodontic treatment. Various restorative materials which have been used for coronal restorations have been tried and tested as a root end filling materials, along with development of restorative materials exclusively for use as a root end filing material. The aim of this article is to have a comprehensive review of the literature for various root end materials available with an emphasis on recent advances in root end materials.

Ideal requirements of a root end filling material

Ideal requirements of a root end filling material are (1)

1. The most important requirement of a root end material is that it should be biocompatible and non-toxic, as it placed in direct contact with vital soft tissue.
2. It should provide a biological seal. i.e. It should promote cementum deposition on the cut root surface.
3. It should adhere to tooth structure.
4. It should be insoluble in tissue fluids.
5. It should be dimensionally stable.
6. It should be non resorbable.
7. It should be radio opaque.

Amalgam

Rhein in 1897 used amalgam to seal the pulp canal after complete root resection.Amalgam has been first material of choice for a root end filling for several years, due to its workability, self sealing capacity, radio opacity and insolubility in tissue fluids. But studies show that freshly mixed amalgam is toxic due to the free mercury present (2) 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 (3). Due to these reasons in recent times, amalgam is not a favourite material for root end filling.

IRM & Super EBA

Both these materials are modifications of zinc oxide eugenol cement. Both these materials provide a better apical seal (4).IRM has better sealing than amalgam and leaks lesser than amalgam.Coleman and Kirk in 1965 first recommended the use of EBA as root end filling material. It is a non reabsorbable material. Super EBA has high compressive strength, high tensile strength, neutral pH, adheres to tooth even in moist conditions, minimal leakage and promotes good healing(5).A recent study shows that both IRM and super EBA have less biocompatibility than assumed earlier (6).

Gutta Percha

Thermoplasticized gutta percha has a better sealing ability when compared to amalgam. It absorbs moisture from the periapical region and expands initially, which is later followed by contraction. This contraction leads to poor marginal adaptation and leakage (7-8).

Glass Ionomer Cements

GIC has been tried as a root end filling material and the results are acceptable. Though the freshly mixed GIC shows signs of cytotoxicity, the cytotoxic effect reduces with time. It has good handling properties and tissue reactions are not adverse (9-10). By using acid conditioners and varnishes the adhesion and marginal adaption of GIC to tooth increases (11-12).

Light cure resin modified GIC has also been tried as a root end filling material and shows less microleakage and acceptable healing (13).

Composite resin and resin based materials

Composite resin materials have some good desirable properties and can be considered as root end filling materials. They have good sealability . They leak less than amalgam . But moisture and blood contamination reduces bond strength and increases leakage. They may have some cytotoxic potential which is directly proportional to the amount and nature of the leachable materials (14).

Retroplast [Retroplast trading, Denmark]is a dentin bonding composite resin system developed in 1984. The formulation was changed in 1990, when silver was added in the place of ytterbium triflurode and ferric oxide.It comes as a two paste form that forms a dual cure composite resin when mixed. Paste A composed of Bis - GMA/ TEGDMA in the ration of 1:1, benzoyl peroxide N,N di-(2- hydroxyethyl) p- toluidin and BHT. Paste B consists of a resin ytterbium trifluorideaerosil ferric oxide. A Gluma-based bonding agent is used to adhere to the root surface.Working time is 1-1/2 to 2 minutes. It is well tolerated and promotes good healing response. Healing shows deposition of cementum in the root surface and regeneration of periodontium including insertion of sharpy's fibers.

Geristore (Densply Tulsa dental)& Dyract (Denmat corporation) are a combination of resin and glassionomer combining various properties of both the materials. These materials require light activation and resin - dentin bonding agents to attach to the root surface. Geristore's dual curing paste/ paste formulation is a hydrophilic Bis-GMA with a long term fluoride release.Light activation is for 40 seconds and cures the material to the depth of 4mm. Geristore has the potential of regenerating periradicular tissues. Histological evidence of cellular attachment is seen (15).In vitro leakage studies of Geristore and Dyract indicates that these materials leak lesser than IRM, amalgam or Super EBA. Geristore has the leakage pattern that of MTA.

These materials are sensitive to moisture than conventional glassionomer cements. Dry environment produces strong bonds.

Mineral Trioxide Aggregate

MTA was developed as a new root-end filling material at Loma Linda University, California, USA.When MTA powder is mixed with water, hydration takes place.Hydration of the powder produces a colloidal gel that solidifies into a hard structure consisting of discrete crystals in an amorphous matrix.The crystals are composed of calcium oxide and the amorphous region composed of 33% calcium,49% phosphate,2% carbon,3% chloride and 6% silica. MTA has a long setting time of 2 hours and 45 minutes. Compressive strength is lowest at 24 hours-40 MPa, but it increases to 67MPa in 21 days after mixing.The compressive strength, radiopacity and the solubility of MTA are as those of amalgam , super EBA and IRM (16-17). But it is more radiopaque than IRM and super EBA.Initially pH is of 10.2, which raises to 2.5, three hours after mixing. pH is about 9.5 at 168 hours after mixing.Mean particle size is 10µm.Range of particle size is from 0.1 µm to 100 µm.The tricalcium oxide in MTA reacts with tissue fluid to form calcium hydroxide resulting in hard tissue formation (18). Studies in dogs have reported with less periradicular inflammation and cementum deposition immediately adjacent to the material.

Augmentation of new cementum is necessary to make the apical barrier more resistant to penetration of micro organism —biological barrier. Scanning electron microscopic analysis indicated that cementoblast could reattach and grow on MTA.In addition strong expression of osteocalcin gene was seen after application of MTA. MTA also increases the production of both proinflammatory and anti inflammatory cytokines from osteoblasts.

Newer root end filling materials

MTA like recent materials

Light cure MTA has been developed which is found to have properties similar to regular MTA but better working characteristics. But there is not literature available regarding this new material (19-21).

Another new material is Fast endodontic cement which contains portland cement in gel form along with water, barium sulphate and an emulsifier. This material has improved handling characteristics and good biocompatibility (22).

Bioaggregate is a modified version of MTA. This material contains biocompatible pure white powder composed of ceramic nano-particles and deionized water. In invitro studies Bioaggregate appeared to be biocompatible compared with WMTA (23-24).

Other new materials

Endosequence root repair material (Brassler, USA) 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.64 This material shows biocompatibility similar to MTA (25-27).

iRoot BP Plus (Innovative BioCeramix Inc., Canada) is a synthetic water-based bioceramic cement. It is available in ready to use premixed form and has a biocompatibility similar to MTA (28).

New resin cement is available a powder and liquid system. The liquid contains hydroxyethylmethacrylate, benzoyl peroxide, toluidine, and toluenesulfinate. Powder is composed of calcium oxide, calcium silicate, and triphenyl bismuth carbonate. It has a good initial biocompatibility but one study shows that it has a higher inflammatory reaction compared to MTA. It acts as a calcium reservoir which may promote mineralization of the tissues (29-30)

EndoBinder (Binderware, Brazil) is a new cement which has calcium aluminate as the chief ingredient.It has properties similar to MTA but it does not have the disadvantages of MTA. 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 (31-33).

Biodentine (Septodont, France) is a bioactive cement available in powder and liquid form.The powder contains tricalcium silicate, calcium carbonate and zirconium oxide as the radio-pacifier. The liquid contains calcium chloride as the setting accelerator and water as reducing agent.81 In in vitro studies it shows apatite formation in phosphate solution. It has better uptake of elemental calcium when compared to MTA. The biocompatibility is similar to MTA (34-36).

Generex A (Dentsply Tulsa dental, USA) 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 (37-38).

Capasio (Primus ,USA) 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.

Quick-set cement is a modified version of Capasio which shows biocompatibility similar to that of MTA (39-40).

Polymer nanocomposite resin belongs to the group of nanocomposites.A polymer nanocomposite is a common term for polymeric materials that have minimal amounts of nanoparticlesdispersed at a nanoscale eg. C-18 Amine montmorillonate (MMT) and vinylbenzyl octadecyldimethyl ammonium chloride (VODAC) MMT.Both these materials contain 2% chlorhexidine diacetate salt hydrate and have been tried as root-end filling material. In vitro studies show some amount of cytotoxicity present (41-42).

Epoxy resin and Portland cement (EPC) is made from a mixture of epoxy resin and Portland cement. In vitro studies show that it has a good radio opacity, short setting time, low microleakage, and low cytotoxicity and can be used a root end filling material (43).

Partially stabilized cement is a recent material which is manufactured so that it does not have the disadvantages of MTA. This material is based on Portland cement but the iron nitrate is replaced with a special manufacturing process. The properties are favourable for its use as a root end filling material (44).

Recently tetrasilicate cements are being considered as a good alternative root end filling material. In vitro studies show that their properties are similar to that of MTA (45).

CONCLUSION

After reviewing the various studies, of all the recent root end filling materials, MTA has more favourable properties and is considered the gold standard for all the future root end filling materials.

But the future looks promising since there are a lot of new materials under research. But since there is no sufficient literature to support these recent root end filling materials they cannot be used in clinical practice. Till then the search for the better root end filling material continues.

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