INTRODUCTION

Most endodontic failures occur as a result of leakage of irritants from pathologically involved root canals. When non-surgical attempts prove unsuccessful or are contraindicated, surgical endodontic therapy is needed to save the tooth. It is estimated that over 24 million endodontic procedures are performed annually with up to 5.5% of those procedures involving endodontic apical surgery, perforation repair and apexification treatment. Endodontic surgery is performed to resolve inflammatory processes that cannot be successfully treated with conventional techniques. Surgical procedures may be indicated for the resolutions of misadventures. Surgical treatment usually involves placement of a material designed to seal root canal contents from the periradicular tissues and repair root defects. The root-end filling material should provide an apical seal to an otherwise unobturated root canal or improve the seal of existing root canal filling material and be biocompatible with the periradicular tissues. Throughout the dental history, a wide variety of materials have been used for retrograde fillings and perforation repair. Although Gold foil, silver posts, titanium screws, tin posts, amalgam and gallium alloys are some of the solids used for retrograde fillings. Certain cements and sealers such as Zinc Oxide Eugenol, IRM, Super EBA, Cavit, Zinc polycarboxylate, Zinc phosphate, Glass ionomer cement, Bone cement and other materials like Composite, Gutta percha etc have been used as root end filling materials though none has been found that fulfils all or most of the properties for an ideal root end filling material.

An ideal endodontic repair material should adhere to tooth structure, maintain sufficient seal, and be insoluble in tissue fluid, dimensionally stable, non resorbable, radio opaque and exhibit biocompatibility if not bioactivity. Given below is the list of materials that have been or are currently being used as retrograde filling material.

AMALGAM

It is the most extensively used retro-filling material from past seven decades, but one of the first reports of placing it as a root-end filling subsequent to resection is attributed to Farrar (1884). Amalgam is easy to manipulate and has good radio opacity. It is non-soluble in tissue fluids and marginal adaptation as well as sealing improves as amalgam ages due to formation of corrosion products. High copper zinc free amalgam is preferred. Use of Amalgam bond, a 4-META bonding agent with amalgam significantly reduces the microleakage of amalgam retrofillings.

Compatibility studies have demonstrated that freshly mixed conventional silver amalgams are very cytotoxic due to unreacted mercury, with cytotoxicity decreasing rapidly as the material hardens. Amalgam has few limitations which include initial marginal leakage, corrosion, tin and mercury contamination of periapical tissues, moisture sensitivity of some alloys, need for retentive undercut preparation, staining of hard and soft tissues and technique sensitivity.

GUTTA PERCHA

Until the development of thermoplasticized gutta-percha, the placement of gutta percha as a root-end filling material was not advocated. Abdal and Retief in their study observed that heat sealed gutta-percha provides a better seal as compared to Amalgam, IRM and Super EBA. It is reported that a better seal can be obtained with thermoplasticized gutta-percha than amalgam with and without varnish. Due to it's porous nature, it absorbs moisture from surrounding periapical tissue and expands initially, which is followed by contraction at a later stage. This may result in poor marginal adaptation and increased microleakage.

EUGENOL BASED CEMENTS

The use of ZOE as a root-end sealing agent in periradicular surgery has had limited documentation. Newer modifications of ZOE compounds, such as IRM and Super EBA provide a better apical seal. Studies reveal that IRM seals better than non zinc amalgam. Super EBA is zinc oxide eugenol cement modified with ethoxybenzoic acid to alter the setting time and increase the strength of the mixture. Super EBA has much better physical properties than ZOE.

It showed high compressive strength, high tensile strength, neutral pH, and low solubility. Even in moist conditions Super EBA adheres to tooth structure. Reports showed a good healing response to super EBA with minimal chronic inflammation at the root apex. EBA demonstrates virtually no leakage. Super EBA and IRM showed less leakage as compared to silver amalgam. Super EBA provides a better seal, when
compared with amalgam as a root-end filling material.

**CAVIT**

It is a Zinc oxide based temporary filling material. Cavit is soft when placed in the tooth and subsequently undergoes a hygroscopic set after permeation with water, giving a high linear expansion (18%). This rationalizes its use as a root-end filling material. Cavit has been shown to exhibit greater leakage than IRM16. It is found to be soluble and quickly disintegrates in tissue fluids. Biocompatibility studies with Cavit are in conflict, showing it to be both toxic and nontoxic.

**GOLD FOIL**

A first report of its use as a root-end material is attributed to Schuster in 1913. It exhibits perfect marginal adaptability, surface smoothness and tissue biocompatibility. Implants of gold foil produce only mild tissue reaction. When compared to IRM, composite resin, amalgam and glass ionomer, gold foil was least toxic. Gold Foil was found to be the best apical sealing material as far as the improvement in biting force is concerned. Leakage studies in root end preparations have indicated minimal or no leakage. The routine use of gold foil as a root-end filling material does not appear practical because of the need to establish a moisture free environment, careful placement and finishing.

**POLYCARBOXYLATE CEMENT**

It was introduced by Smith in 1968. The zinc polycarboxylate cement consists of a powder having modified zinc oxide with fillers and a liquid comprising of aqueous solution of polycrylic acid which, when mixed and hardened. The pH of the cement is approximately 1.7, which rapidly increases as the cement sets. Polycarboxylates placed in root canal systems or beyond the confines of root apex show a varied periangular tissue response. Apical leakage studies have indicated that polycarboxylates, when used as root-end fillings, leak at levels significantly greater than amalgam or gutta-percha. Based on their poor sealing ability and uncertain periangular tissue response, the use of polycarboxylate as root-end filling material is highly questionable.

**GLASS IONOMER CEMENT (GIC)**

Glass ionomers are formed by the reaction of calcium–aluminosilicate glass particles with aqueous solutions of polycrylic acid. Biocompatibility studies have shown evidence of initial cytotoxicity with freshley, with decreasing toxicity as setting occurs. It is easy to handle and does not cause any adverse histological reaction in the periapical tissue. Marginal adaptation and adhesion of glass ionomer cements to dentin have been shown to improve with the use of acid conditioners and varnishes. Chong et al used Light cure, resin reinforced GIC was used as a retrograde filling material by. It showed least microleakage due to less moisture sensitivity, less curing shrinkage and deeper penetration of polymer into dentin surface. Newer glass ionomer cements containing glass-metal powder have been reported to have less leakage and showed no pathologic signs.

**COMPOSITE RESIN**

Composite resins due to their cytotoxic or irritating effects on pulp tissue have received minimal attention as root-end filling materials. The cytotoxic effects are a function of the evaluative methods employed, and, when the agents are properly used, the cytotoxic effects were substantially decreased or eliminated. McDonald and Dumsha compared composite with a dentin bonding agent, composite alone, cavit, amalgam, hot burnished gutta percha, and cold burnished gutta percha and found that composite with dentin bonding agent showed least amount of leakage followed by composite alone when both of these were placed directly on resected root surface. These findings suggest that the preparation of a root-end cavity may be obviated. Light cure composite resin showed significantly lower apical leakage than amalgam and ketac-silver. Rud et al applied Gluma in vivo to cases requiring periangular surgery and compared it to cases treated with root-end amalgam fills. Gluma exhibited complete healing in 74% of the cases as compared to amalgam which showed in only in 59% of cases.

**MINERAL TRIOXIDE AGGREGATE (MTA)**

It was developed at Loma Linda University, CA, U.S.A in 1993. This cement contains tricalcium silicate, tricalcium aluminata, tricalcium oxide, silicate oxide and other mineral oxides forming a hydrophilic powder which sets in presence of water. The resultant colloidal gel solidifies to a hard structure within 4 hours. Initially the pH is 10.2 which rises to 12.5 three hours after mixing. It is found to be more opaque than EBA and IRM. MTA provides superior seal when compared with Amalgam, IRM and Super EBA34. Adamo et al compared MTA, Super-EBA, Composite and amalgam and found statistically no significant difference in the rate of microleakage but studies of Torabinejad et al and Fischer et al proved MTA to be superior as compared to Super EBA and IRM. The marginal adaptation of MTA was better with or without finishing when compared to IRM and Super EBA. MTA, when used as a root-end filling material, showed evidence of healing of the surrounding tissue. Most characteristic tissue reaction of MTA was the presence of connective tissue after the first postoperative week. Studies have shown that osteoblasts have favorable response to MTA as compared to IRM and amalgam. With longer duration, new cementum was found on the surface of the material. In a two year follow-up study with MTA as root-end filling material resulted in a high success rate. Such studies support further development of MTA to reduce the long setting time and difficulty in manipulation for use as a root-end filling material.

**CONCLUSION**

The physical properties, sealing ability, biocompatibility, and clinical performance of potential retrograde materials have been discussed. MTA materials appear not only to demonstrate acceptable bio compatible behavior but also exhibits acceptable in vivo biologic performance when used for root-end fillings, perforationrepairs, pulp-capping and pulpotomy, and apexification treatment making them the material of choice.

But as people say that “There is always room at the top”, the short comings of mineral trioxide aggregate like its longer setting time, its cost etc need to be considered and improvement over the undesired aspects of this excellent material should be made for its successful and widespread use in endodontics.

**REFERENCES**


