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ROOT-END FILLING MATERIALS – A REVIEW

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ABSTRACT:
When non-surgical root canal treatment fails to resolve periradicular lesions of endodontic origin or if retreatment is not feasible surgical intervention is recommended. Management of root end during endodontic surgery involves apical resection,retropreparation and retrofilling to seal the root canal. Numerous materials have been suggested and the newer ones like MTA, Castor Oil Polymer and calcium phosphate have shown promising results . This article is a review of literature on the suitability of various root end filling materials based on their leakage assessment, marginal adaptation, cytotoxicity and usage tests in experimental animals and humans.

KEYWORDS: Root-end filling, Endodontic surgery, Apical resection, Retrofilling, Materials,Biocompatibility.

INTRODUCTION

The success of endodontic treatment depends on thorough debridement of the inherently complex, irregular root canal systems and sealing the portals of communication with the periapical tissues. In an examination of failed cases from the Washington study Ingle et al[1] reported that over two thirds of root canal failures were related to incomplete cleaning and obturation of root canals. If the apical seal is inadequate, the residual microorganisms can cause re-infection, thereby inhibiting healing of periapical tissues[2]as proved by Kakehashi[3], Paterson[4], and Fabricius[5].

In addition to this, other investigations have shown that the exposure of coronal parts of filled root canals to oral flora results in total contamination of filled root canals in a fewdays[6-8]. The preferred treatment for failing endodontic cases is non-surgical retreatment[9]. However, because of the complexity of root canal systems, inadequate instrumentation and presence of physical barrier (anatomical, post and core restorations, separated instruments etc) it may be difficult to achieve success with a non surgical approach. Then, endodontic surgery becomes the first alternative.

Management of root end during endodontic surgery includes apical resection, retro preparation and retro filling to seal the root canal. Periradicular curettage only eliminates the effect of leakage and not the cause thereby necessitating apical root resection[10]. Massimo Gagliani et al evaluated the influence of apical root resection on the apical seal and reported that increasing the slope of the bevel from a horizontal plane of 90^0- 45^0 the dye penetration was greater. Therefore, a root apex resected perpendicular to the long axis of the root is preferred[11].

The ideal root end preparation should be parallel to the long axis of root, 3mm deep and centered as supported by Peter Gilheany et al[12]. As the depth increases the leakage decreases because of the occlusion of apical dentinal tubules by the retro filling material. Ultrasonics used for retro preparation offers improved access, alignment, depth and quality of seal[13, 14].

Apical resection and retro preparation opens up the root canal system to the periapical region, thereby necessitating the placement of a retro filling material. According to Gartner and Dorn[15], an ideal retro filling material should prevent leakage of microorganisms and their byproducts in to the Periradicular tissues, non toxic, non carcinogenic, insoluble in tissue fluids, dimensionally stable, easy to use, radiopaque and biocompatible to the host tissues.

The various materials in use are guttapercha, amalgam, glass ionomer cements, reinforced zinc oxide eugenol cements, composites, titanium screws and the more recent ones like mineral trioxide aggregate, bone cement, lasers, calcium phosphates and castor oil polymer. Although a plethora of materials are available the quest for the best still continues.

This article reviews the suitability of various root end filling materials from past to present.

COMPARATIVE EVALUATION OF VARIOUS RETROFILLING MATERIALS

Amalgam

One of the oldest materials used with reasonable success. Zinc free admixed amalgam shows less leakage compared to zinc free spherical amalgam[15]. Satoshi Inoue et al, have reported that application of cavity varnish over amalgam significantly decreased apical leakage[17].Though amalgam is easy to manipulate, readily available, well tolerated by soft tissues and radio opaque, its inherent shortcomings are slow setting time, staining of overlying soft tissues and it eventually leaks from corrosion[16]. Major problem in long term follow up is related to the fact that the root tip undergoes continuous resorption and apposition of cementum, which alters marginal integrity resulting in loss of seal.

Reinforced zinc oxide eugenol cements

As early as 1962, Nicholls showed preference for zinc oxide eugenol cements. But these cements showed increased solubility and tissue irritation. To overcome these problems Intermediate Restorative Material (IRM) and Super EBA was introduced. These cements showed better tissue compatibility and close adaptation to cavity walls with reduced solubility[18, 19]. Bondra et al[20], in their study reported that IRM provided a better seal than Amalgam or Super EBA. On clinical and radiographic examination in a clinical retrospective study a success rate of 75%- Amalgam, 91%-IRM and 95%-Super EBA was documented[21].

Glass ionomer cements

Provides better apical seal than amalgam. Easy to handle, chemically bonds with tooth structure and does not cause adverse histological reaction in the periapical tissues. But Mac Neal and Beatty[22] demonstrated that the apical seal of glass ionomer cements is adversely affected by moisture. In a study by Chong et al[23] Light cure, resin reinforced glass ionomer cements showed decreased microleakage to moisture sensitivity and curing shrinkage. Their usage warrants further evaluation.

Composites

Composites have received less attention because of their cytotoxic effects. The cytotoxic effects are a function of the evaluative methods employed. 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[24].Light cure composites have shown significantly lower apical leakage than Amalgam and Ketac silver[25]. The proper use of dentin bonding agents and composite resins play a significant role in enhancing the root end filling[26].

Newer materials

Bone cement

This is used in orthopaedics to cement artificial joint on to the socket as it exhibits decreased cytotoxicity. Bone cement has shown to permit tissue reattachment, wherein the outer cement layer is progressively incorporated in to the new tissue by an in growth of small blood vessels accompanied by macrophages, multinucleated giant cells and fibroblasts. Antibiotics can be incorporated in to these cements and they are not affected by moisture. Dental literature available on this material is relatively scarce. However, studies by Gary Mathew Holt and Thom C Dumsha have reported no statistically significant difference in dye leakage between Composite and Super EBA when compared with Bone cement. Thereby, indicating that it could be used as a retrofilling material[27]. Cell culture studies have shown that fibroblasts are unaffected by Bone cement whereas, Amalgam caused cell lysis[28]. Further research needs to be done to evaluate their efficacy as root end filling material.

Mineral trixoide aggregate (MTA)

Developed in 1993 at Loma Linda University, CA, USA, this cement is a hydrophilic powder which sets in the presence of moisture. It contains tricalcium silicate, tricalcium aluminate, tricalcium oxide, silicate oxide and other mineral oxides. After mixing, the initial ph is 10.2 which rises to 12.5 in 3 hours. Various studies have reported that MTA actively promotes hard tissue formation by inducing osteogenesis and cementogenesis[29]. MTA has proved to be biocompatible, dimensionally stable and insensitive to moisture with good sealing ability. Till date, no material has shown as much promise as MTA.

Calcium phosphate cements

Commonly known as Hydroxyapatite cement, it is a mixture of 2 calcium phosphate compounds in which one is acidic and the other basic. Primarily, consists of tetracalcium phosphate and dicalcium phosphate reactants. These compounds, when mixed with water, react isothermally to form a solid implant composed of carbonated hydroxyapatite. Calcium phosphate cements demonstrate excellent biocompatibility and have an osteoconductive effect[1].Promising as a retrograde filling material but it is yet to get approval from the United States Food and Drug Administration.

Laser

Weilcham introduced application of lasers in endodontics in 1971.The effect of lasers is dependent on wavelength specificity and energy density. CO_2, Nd:YAG, Er:YAG and Ho:YAG have been used of which Er:YAG has shown to be superior[30]. Clinically, lasers have shown improved healing and diminished post operative discomfort. When used for root end resection lasers cause ablation of dentinal tubules which decreases microleakage, eliminates microorganisms and increases resistance to root resorption[31, 32]. But the resected surfaces were rough and cause difficulty in burnishing retrofill material smoothly to the tooth surface. A study done by John Sullivan et al[33], has shown that root ends resected with lasers without placement of retrofill material shows increased leakage than when a retrofill material is placed.

Castor oil polymer [cop]

Obtained from a common tropical plant Riccinus Communis, it is widely used in medicine for prostheses to replace bone because it is biocompatible, non-toxic and easy to handle. This biopolymer presents a chain of fatty acids whose molecular structures are also present in lipids of human body. Giovana Ribeiro de Martins et al[34], in their study comparing sealing ability of Mineral Trioxide Aggregate,Castor Oil Polymer and Glass Ionomer Cement as root end filling material have reported that the COP group showed decreased dye penetration than MTA and GIC when the depth of retropreparation was 1.5mm. However,further in vivo research is warranted to evaluate the physical and biological properties of COP. It is a relatively new and promising material to be used as a root end filling material.

CONCLUSION

Based on the review of literature, it appears that no existing retrofilling material possesses all the ideal characteristics of a retrofill material. MTA and COP have shown promising results. Biological and clinical studies are required to evaluate these materials. Newer materials require more in vivo testing and clinical follow-up.

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