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RESIN BASED ROOT CANAL SEALERS: AN OVERVIEW

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ABSTRACT

Although, methacrylate resin-based sealer's were introduced in the beginning of the 21st century to support the introduction of bondable root canal filling material its effective use has only been possible in the recent times with advancements in the self-etching adhesive technology. Since then commercially four generation's of methacrylate resin-based sealers have been made available, and during the last five years, three of those were introduced when the concept of simultaneous bonding of the root canal sealer to the root filling material and dentin was popularized. In this article, an overview of the methacrylate resin-based sealers is presented with the objectives of clarifying the behavior of these materials, their limitations in clinical application and cytotoxicity. Compared to conventional root canal sealer's which lack bonding, the resin based sealer's have superior sealing ability. With the incorporation of the self-etching technology the newer resin-based sealers have also overcome the multiple step procedure of bonding. However, other limitations such as technique sensitivity and the difficulty to remove resin based sealers during retreatment have still to be overcome for greater acceptance than the conventional root canal sealer.

Keywords: Methacrylate resin based sealer, Cytotoxicity, polymerization shrinkage-resin based sealer, monoblock.

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INTRODUCTION

The success of an ideal root canal treatment depends on various factors such as proper biomechanical preparation, obturation and post endodontic treatment. The aim of root canal treatment is to eliminate the microbial entity and to prevent re-infection in future. In order to achieve this, proper seal is required to prevent any chance of proliferation of bacteria. Hermetic seal is created by sealer along with obturating material [1],[2]. Although favorable results have been reported with gutta percha and zinc oxide sealer [3],[4], they have certain disadvantages like inability to adhere to dentin, microleakage and solubility of the sealer. Research continues to explore alternative materials that may seal better and mechanically reinforce the roots by forming monoblock, which has been suggested to reduce bacterial ingress and strengthen the root to certain extent.[5][6][7] Several new resin cement sealants have been developed, which possess greater bond strength as compared to conventional root canal sealer and thus improve the root canal seal.[8],[9] Just as the introduction of self priming and self etching/adhesive resin luting techniques led to a revolution in adhesive restorative dentistry; the use of low viscosity methacrylate root canal sealer in endodontics have heralded a new era in the field of endodontics with superior sealing ability .

Table: 1: METHACRYLATE RESIN BASED ROOT CANAL SEALER

Sl No	ROOT CANAL SEALER	COMPOSITION OF SEALER	Advantages	Disadvantages
1	**Hydron** [Hydron technologies]	Bisphenol-A-glycidylmethacrylate	easy to use, non-irritating, highly adaptable to the canal walls, anti –bacterial in nature.[10][11]	severe inflammatory reaction, leakage, as well as water sorption.[12],[13]
2	**EndoREZ** [Ultradent, South Jordan, UT]	Ethoxylated BisGMA, UDMA, and hydrophilic difunctional methacrylates.	Increased intratubular penetration compared to Endo CPM-sealer[14],[15] Well tolerated by bone tissue and connective tissue[16]	Poor adaptation of the sealer with lack of resin tag formation when used with gutta percha into a dried canal.[17]
3	**Epiphany** [SybronEndo] **Fibrefill** [Penetron Clinical techonologies]	Calcium hydroxide, barium sulfate, barium glass, and silica A self etchant primer	Good sealing and adhesive properties to radicular dentin was reported with fiberfill R.C.S[18] Epiphany sealer showed significantly lesser apical leakage in comparison to Endorez sealer and Guttaflow sealer[19]	Real seal is sensible to enzymatic and alkaline hydrolysis, has the quiescent to cause tooth staining[20] Removal of epiphany from the accessory canal, canal isthmus is very difficult, as epiphany is obscure in the solvents commonly used.[21] Epiphany showed moderate to severe cytotoxic effect.[22],[23]

4	**METAseal** [CT Sybron endo Wallingford,]	Hydroxy-ethylmethacrylate (HEMA), Water and initiator	The combination of an etchant, a primer, and a sealer into an all-in-one selfetching, self-adhesive sealer is advantageous in that it reduces the application time and the errors that might occur during each bonding step[24]	As compared to Epiphany and EndoREZ, METAseal was found to be the most cytotoxic.[25] Lack of polymerization, decreased dentin thickness significant increase the cytotoxicityof HEMA.[26]

Need for Resin-based Sealers:

Resin based sealer have the desirable property of creating monoblock in the root canal. Several strategies have been used to create root canal monoblock. Coating gutta percha with poly butadiene-di-isocynate-methacrylate adhesive[27] which has a hydrophilic portion which is compatible with methacrylate resin and hydrophobic portion compatible with polyisoprene substrate of gutta percha leading to strong union between gutta percha and resin adhesive leading to formation of the root canal monoblock to achieve total bond and hence a total seal of the canal space. Use of a polycaprolactone and dimethacrylate-containing resin blend to form a filled thermoplastic composite (Resilon) that can be used an alternative root filling material instead of gutta percha.[28]

MONOBLOCK CONCEPT:

The term monoblock refers to the condition where the root canal space becomes perfectly filled with a solid mass that consists of different materials and interfaces, with the advantages of improving the seal and fracture resistance of the filled canals.[29],[30]

Primary monoblock- only one interface that extend circumfrentially between the material and root canal wall e.g. Orthograde obturation with mineral trioxide aggregate as an apexification material represents a primary monoblock.[31]

Secondary monoblock- two circumfrential interface one between the cement and dentine and other between the cement and core material e.g. Resilon is applied using a methacrylate-based sealer to self-etching primer treated root dentin, it contains two interfaces, one between the sealer and primed dentin and the other between the sealer and Resilon, and hence may be classified as a type of secondary monoblock.[31]

Tertiary monoblock – three circumferential interfaces between bonding substrate and the abutment material. e.g. Surface coating of conventional gutta-percha cones with glass ionomer fillers represents an example of a part of the components of a tertiary endodontic monoblock, in which these filler-coated gutta-percha cones **.**[31]

Limitations of Resin-based Sealers:

1) **Polymerization shrinkage**:

During polymerization of resin sealers there is the shrinkage stresses created on the root canal walls.[32],[33],[34] There are several factors for the inferior sealing properties of methacrylate resin–based sealers inside root canals. Polymerization shrinkage of the sealer might create gaps along the sealer-dentin interface because of pulling of resin sealer tags out of the tubules during polymerization shrinkage.[35] The partially polymerized sealer when manipulated during compaction of the root filling materials might disrupt the developing bonds between a self-etching primer and radicular dentin.[36]Light-curing the coronal part of the root filling to create a coronal seal might also limit flow of resin sealer.[37]

2) **Leakage of methacrylate resin based sealer**:

It was reported that Resilon/Epiphany system provide an immediate coronal seal after light curing of the dual-cured sealer at the canal orifices which is clinically advantageous because the filled root canals might be exposed to the oral environment and bacterial recontamination in some situation.[38] However, these findings was in contrast as it is known through physical and chemical processes polymers degrade overtime .[39]Interfacial leakage increases as the bond degrades, which resembles in vivo aging.[40],[41] Resilon is also susceptible to alkaline[42] and enzymatic hydrolysis.[43] Therefore endodontically relevant bacteria might occur in the event of apical or coronal leakage because of biodegradation of Resilon by bacterial/salivary enzymes [44], further negotiate the seal achieved after root canal treatment.

3**)** The EndoREZ system, gaps were identified between the gutta-percha resin coating and the EndoREZ sealer, even though a thin layer of hybridized dentin created by EDTA demineralization could be identified together with long resin tags.[45] The only truly bondable interface in this system, the interface between the gutta-percha resin coating and the resin sealer, but this interface is a weak link that failed during polymerization shrinkage of the sealer. The chemical union between the polyisoprene component of the gutta-percha and the polybutadiene end of the resin coating molecule appears to be stronger than the coupling between the methacrylate end of the molecule to the resin sealer. During packaging removal of oxygen inhibition layer[46] from the surface of resin-coated gutta-percha cones was the reason for their weak adhesion to the methacrylate resin–based root canal sealer, resulting in their frequent delamination from the sealer after root canal obturation.

Epiphany resin–based sealer adhesive strength to the Resilon was 4–5 times lower than the bond strength of a composite resin to the same sealer[47] , suggesting that the coupling is very weak between the methacrylate resin–based sealers to Resilon. This may be because within a continuous polycaprolactone phase there is phase separation of the emulsified dimethacrylate phase.[48]

Detailed information on adhesive properties of the fourth generation self-adhesive type root canal sealers to root filling materials is limited. For the 4-META containing sealer (METAseal), a hybrid layer-like structure along the gutta-percha–sealer interface has been reported.[49] However, no data are currently available on the adhesive strength of MetaSEAL to gutta-percha via this hybrid layer-like interface.

4) **Methacrylate resin based sealer absorbs water and leach:**

Introduction of hydrophilic methacrylate resin based sealers, the water absorption became a primary concern because the resin matrix via water absorption leach out resin components.[50] This was demonstrated by the Donnelly et al, [51] who observed methacrylate resin based sealer show significantly higher solubility (3%–8%). According to ADA specification less then 3percent solubility of root canal sealer is required.[52] Most of the methacrylate root canal sealer donot meet this criteria. The unreacted monomer leach through apical foramen after water sorption and swelling causes harmful detrimental effect on periodontal ligament tissue.[53]There is deterioration of physical properties of resin[54] specially the durability of resin-dentine bond by hydrolysis and micro crack formation[55] as a result of diffusion of water into resin matrices .

5) **Cytotoxicity of resin based sealer**

Cytotoxicity of the resin sealer is by release of bisphenol-A-diglycidyl ether which is a mutagenic component and cytotoxic.[56] Endorez reduce the fibroblast viability by 49 percent.[57] Endorez consists of UDMA (urethane dimethacrylate) which is responsible for the cytotoxicity[58] as UDMA cause cell damage by decreasing the intracellular glutathione level.[59] Epiphany resin matrix consists of a mixture of bis-GMA(bisglycidyl dimethacrylate), UDMA, and difunctional methacrylates.[60] The residual monomer released from the cured sealer may contribute to high level of cytotoxicity observed with epiphany.[61] Epiphany consists of total filler content by 70percent which might leach as a result of degradation resulting in cytotoxicity.[62] HEMA (hydroxyl ethyl methacrylate) one of the components of MetaSeal which is cytotoxic[63] diffuses through the dentin in sufficient concentration and cause cellular damage. HEMA inhibit cell growth, glutathione reduction and reactive oxygen species production[64]

CONCLUSION

In the age of adhesive endodontics, cogitate has most often been directed to gutta-percha substitutes. The primary function of these gutta-percha substitutes is to occupy space, with the more important issue being the sealer and its properties. Very few limited clinical outcome studies have included a control group to support the advantages of these new materials over conventional nonbonding materials. Under the conditions of well-executed cleaning and shaping and the provision of adequate coronal restorations, it is doubtful whether the merits of adhesive methacrylate resin–based sealers might be revealed in future

prospective clinical trials particularly when more demanding strict attention to rules and procedure criteria for evaluating success are used.

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