

EMERGING ROOT CANAL SEALERS



Medical Science

KEYWORDS : root canal sealer, fluid tight seal, monoblock, silicon based sealers

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ABSTRACT

In Endodontics, the success of root canal therapy mainly depend on achieving a compact fluid tight seal of the apical end of the root canal, so as to prevent the ingress and accumulation of irritants causing biological breakdown of attachment apparatus leading to failure. Root canal sealers along with solid core material play a major role in achieving the fluid tight seal. Although gutta-percha has been the standard obturating material, is not able to achieve an impervious seal along the dentinal walls of the root canal. Gutta-percha does not form a monoblock even with the use of a resin-based sealers such as AH Plus because the sealer does not bind to gutta-percha. While Resilon can bind with dentinal walls when used along with Resin sealer and bonding agent/prime. New silicone-based sealers like Roekoseal automix and the most recent GuttaFlow have some affirmative results regarding solubility and biocompatibility, as compared to other sealers. Methacrylate resin-based sealers and mineral trioxide aggregate (MTA)-based sealers have opened a new horizon for sealers.

INTRODUCTION

Endodontic obturation comprises complete three-dimensional filling of the root canal system with materials that exhibit satisfactory physical and biological properties.[1,2]

Gutta Percha has universally been accepted as the gold standard for root canal filling materials as it appears to be the least toxic and tissue irritating root canal filling material available. However, Gutta Percha does not adhere to the dentinal walls and consequently a sealing agent is required [3,4]

The quality of the seal obtained with gutta-percha and conventional zinc oxide eugenol sealers is quite far from being perfect. [5,6] Also, despite its multiple strong points, GP and conventional sealer combination still has its own shortcomings, like its inability to strengthen root, as it does not adhere to dentin, inability to control microleakage, and the solubility of sealer makes prognosis dilemmatic and un-assuring.

Several new resin cement sealants have been developed to be used instead of ZOE, thereby improving the root canal seal and imparting it more strength as compared to the conventional materials.[5,6] These include silicon-based sealers which are well tolerated by tissues, have low water sorption, and have a potential of forming monoblock, thus reinforcing root canal,[7] epoxy resin-based sealers with the possibility of adhesion to dentin and with lower rates of water solubility,[7,8] and mineral trioxide aggregate (MTA)-based sealers which have the predilection toward mineralization along with all the viable properties of orthodox sealers.

The use of bioceramic-based sealers with their features- osseointegrativity, hydrophilicity, adhesiveness and chemical bonding to root canal dentinal walls — appears to be an effective approach to eliminate on long term, the microspace, otherwise remaining between the root canal walls and the materials filling

the root canal.

RESIN BASED SEALERS:

Resin bonded root canal filling materials have been suggested as an alternative to the traditional Gutta Percha based system to obtain a better seal. The adhesion of endodontic sealers to both the obturation material and to dentin may improve their sealing properties. Resin based sealer creates a monoblock between intraradicular dentin and the root filling material making it more resistant to both bacterial leakage and root fracture compared to similar teeth filled with conventional sealers [9,10].

Methacrylate based resin sealers are based on polymer chemistry technology, initially developed for adhesive restorative dentistry.

The two systems are:

1. EndoREZ (Ultradent Products Inc. South Jordan, UT)
2. Epiphany (Pentron Clinical, Wallingford, CT)/ Resilon

EndoREZ is a hydrophilic, two-component, chemical or dual-curing sealer and contains zinc oxide, barium sulfate, resins, and pigments in a matrix of urethane dimethacrylate. The sealer can be used with gutta-percha or with resin-coated gutta-percha, the latter with the objective of forming a monoblock.

Resilon is composed of polymer-based resin (polycaprolactone), bioactive glass, bismuth oxide, barium sulfate, and coloring agents. Epiphany contains a dual cure sealer, UDMA, PEGDMA, EBPADMA and BISGMA, barium-borosilicate, BaSO₄, bioxychloride, calcium hydroxide, photo initiators, and a thinning resin. In addition, the system comes with a self-etching primer. The premise behind the material is the formation of a “monoblock”. Methacrylate based resins sealers enable obturation in a slightly moist root canal because they are hydrophilic. This hydrophilicity, combined with advanced bonding techniques and a user-

friendly methodology (EndoREZ), encourages the formation of deep resin tags extending into the dentinal tubules from the root canals. Deep resin tags help enhance bonding and the clinical success of obturation.

GUTTA FLOW

In 1984, silicone was first introduced as a root canal sealer. A-silicones show comparatively little leakage, are virtually non-toxic, but display no antibacterial activity. GP powder with a particle size of less than 30 nm has been introduced into a silicone matrix (polydimethylsiloxane-PDMS). Silver particles have been added as preservative.[11,12] Working time is 15 min and setting time is 25-30 min. Gutta Flow is a cold, fluid obturation system that combines sealer and GP in a single material. It consists of a PDMS matrix which is highly filled with very finely ground GP. PDMS has only limited dimensional change in setting (about 0.6%-0.15%) and low water sorption. The finely ground GP powder and the silicone-based matrix are distributed homogeneously after mixing.

Gutta Flow has very promising properties because of its insolubility, biocompatibility, post-setting expansion, great fluidity, and ability for providing a thin film of sealer.[13] and hence greater adhesion with the dentinal wall.[14] Gutta Flow has nanosilver in its composition. Nanosilver is metallic silver which is distributed uniformly on the surface of the filling. It do not cause corrosion or color changes in the GuttaFlow. There is sufficient nanosilver in the material to prevent further spread of bacteria and is highly biocompatible.[15] Gutta Flow has poor wettability but showed good spreadability in the group where root dentin surface was treated with both EDTA and sodium hypochlorite. The reason for this could be the increase in the surface energy of the root dentinal wall which was free of the smear layer.[16] A GP containing silicone sealer expands slightly, and thus leakage was reported to be less than for AH26 with GP over a period of 12 months.[17] Dentin surface treated only with EDTA showed high contact angle value, suggesting the poor wettability of Gutta Flow. The high concentration of EDTA could have caused mild etching of the dentin surface leading to the exposure of collagen fibers, and the exposure of this hydrophobic moiety could have resulted in the increased contact angle.[18]

No data for systemic toxicity and allergy are available. However, based on the composition of the material, no adverse type reaction is to be expected.[12]

MTA BASED SEALERS

In 1999 study by Holland et al[19] compared glass ionomer root canal sealer (Ketac Endo) with MTA as a sealer and concluded that MTA induces closure of main canal foramen by new cementum formation with absence of inflammatory cells after 6 months. In 2007 Holland [20] examined influence of the extent of obturation on apical and periapical tissue after filling root canal with MTA and concluded that it can be used as root canal sealer. When MTA is used as root canal sealer a dentin-MTA interfacial layer forms in the presence of phosphate. This adherent interstitial layer resembles hydroxylapatite in composition and structure when examined under X-ray diffraction and SEM analysis. However, the calcium to phosphorus ratio varies slightly to actual hydroxylapatite. This interface demonstrates superior marginal adaptation. Moreover, particle size of MTA can occlude and penetrate dentinal tubules that might harbor microorganism after cleaning and shaping.

There are various advantages of MTA as Root Canal Sealer, which include:

1. They are highly biocompatible and stimulate mineralization. [21]
2. It modulates cytokinin production.[22]
3. They are bioactive, i.e. hard tissue inductive by encouraging

differentiation and migration of hard tissue producing cells. [22]

4. Forms calcium hydroxide that releases calcium ions for cell attachment and proliferation.
5. They also exhibit a higher adhesiveness to dentin than conventional zinc oxide/eugenol-based cements and sealing ability similar to epoxy resin-based cements.
6. They form a hydroxyapatite (or carbonated apatite) on the MTA surface and provide biologic seal.[23]
7. They have antimicrobial activity against *M. luteus*, *S. aureus*, *E. coli*, *P. aeruginosa*, *C. albicans* and *E.*

faecalis by its alkaline pH.[24]

Studies have demonstrated that addition of calcium chloride to MTA reduces setting time,[25] improve its sealing ability and facilitate insertion into cavities without interfering with its biocompatibility.[26] It has good antimicrobial activity (Tanomaru 2008) and satisfactory radiopacity.[29] Moreover, culture with fibroblast revealed that it is not cytotoxic.[24]

CERAMICS-BASED SEALERS

Filling of the root canal apical third must be looked upon separately from the filling of the rest of the canal having under consideration the active and constant metabolic processes occurring in the periapical area. Special attention must be paid to the interface formed between dentinal root canal walls, gutta-percha and sealer on one side and periodontium and body fluids on the other side. Long-term hermetic sealing of apical third achieved in constantly wet environment is an obligatory condition to ensure lack of microbial growth. Another extremely important factor promoting hard tissue closure of the canal is presence of osseointegrativity as sealer's feature. Perfect and lasting in wet environment hermetic seal of apical third combined with osseointegrativity of endodontic sealer ensure conditions for hard tissue closure of root canal apical orifice in time. Filling of the root canal with ceramic sealer, which due to its osseointegrativity action promotes the physiological closure of the canal by cementoid hard tissue, can be called "endodontic grafting." Such endodontic grafting can ensure the lasting root's health while it constantly remains in contact with body fluids.

when used to fill the apical third of the root canal, they guarantee adhesive hermetic seal.[27] They do not get destroyed during their hardening and afterward while being constantly in contact with the wet periapical environment. They are very stable in time. Ceramic based sealers ensure much better apical seal than IRM.

Bioceramic-based materials having nano-sized particles (BioAggregate, iRoot SP, iRoot Bp) achieve excellent adhesion to the canal's dentinal walls and, more importantly, form a chemical bond with dentin. Structure of these materials during their mixing with water allows a very good consistency to be achieved (BioAggregate) or optimal consistency is already guaranteed by manufacturer by offering premixed "ready-to-use" products (iRoot SP, iRoot BP). All ceramic-based sealers are hardening slowly. This feature gives the dentist the possibility to do corrections of the filling, if control radiography has revealed any problems. Due to their hydrophilicity and low contact angle, all ceramic-based sealers achieve extremely good hermetic seal. All ceramic-based sealers expand during the time of set. They exhibit potent antimicrobial action, too. All ceramic sealers are biocompatible and insoluble in tissue fluids. They have not demonstrated until now any antigenic or mutagenic action. When used in combination with gutta-percha cones, re-entering of the canal space is possible and a calibrated "bed" may be drilled to accommodate a fiberglass post into the canal.

Potent antibacterial activity, absolute biocompatibility, osseo-conductivity, ability to achieve excellent hermetic seal in constantly wet environment, formation of chemical bond with dentin, insolubility in tissue fluids, expansion during time of set, very good radiopacity, easy handling are the features that make bioceramic-based sealers an up-to-date alternative to current "golden" standard of multi-phase (guttapercha — epoxy sealer) warm techniques.

CONCLUSION

The evolution of sealers is from the conventional ZOE to the contemporary ones like epoxy-based resin and MRBS, and to the most recent MTA sealer and bioceramic sealer, which have the predilection to change the perception the way sealers have been used in the near future. MTA and bioceramic sealer have opened a new dimension on how apart from creating hermetic seal, a sealer can also have the propensity toward mineralization through the formation of hydroxyapatite crystals.

It is seen that in contact with a simulated body fluid, the MTA sealer and bioceramic sealer released calcium in solution and encouraged the deposition of calcium phosphate crystals, and have superior sealing ability as compared to resin-based sealer though more study needs to be done as far as retreatment and fracture resistance is concerned.

ABSTRACT

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