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BIOCERAMIC BASED ROOT CANAL SEALERS – A REVIEW

Dr. Shruthi C. Havaldar Post Graduate Student, MDS, Dept Of Conservative Dentistry And Endodontics, Nathajirao G. Halgekar institute of dental sciences and research Centre, Belagavi

Dr. V. M. Uppin* MDS, Professor, Dept Of Conservative Dentistry And Endodontics, Nathajirao G. Halgekar Institute Of Dental Sciences And Research Centre, Belagavi. *Corresponding Author

Dr. Madhu Pujar MDS, Professor and Head Of The Dept Of Conservative Dentistry And Endodontics, Nathajirao G. Halgekar Institute Of Dental Sciences And Research Centre, Belagavi.

Dr. Abhipsha Lahiri Post Graduate Student, Mds, Dept Of Conservative Dentistry And Endodontics, Nathajirao G. Halgekar Institute Of Dental Sciences And Research Centre, Belagavi.

Dr. Reshma Faras Post Graduate Student, Mds, Dept Of Conservative Dentistry And Endodontics, Nathajirao G. Halgekar Institute Of Dental Sciences And Research Centre, Belagavi.

Dr. Siddhi A. Shetye Post Graduate Student, Mds, Dept Of Conservative Dentistry And Endodontics, Nathajirao G. Halgekar Institute Of Dental Sciences And Research Centre, Belagavi.

ABSTRACT

Root canal sealers are used to attain impervious seal between the core material and root canal dentin. Most of the conventional root canal sealers have demonstrated inadequate biological activity and been cytotoxic in cultures especially when freshly mixed. Bioceramic sealers were developed to overcome these disadvantages and have been proved to show better clinical performance. They have several advantages like biocompatibility, non toxicity, dimensional stability and are bio-inert. Also during their setting, they produce Hydroxyapatite which posseses an intrinsic osteo-conductive activity and induces regenerative responses in the human body. Therefore this review aims to discuss the various bioceramic sealers and their classification, properties, advantages and disadvantages.

INTRODUCTION

The most important goal of endodontic therapy is to prevent the reinfection of the root canal by sealing it against ingress of microorganisms. Leakage of bacteria and their products from the endodontically treated and restored teeth into periapical tissues is the predominant cause of most endodontic failures. In order to prevent microleakage, root canal space after chemo-mechanical preparation is filled with gutta percha along with root canal sealers. Function of sealers is to seal off the voids, patent accessory and lateral canals and to form a bond between GP and root canal dentin.[1]

Several root canal sealers have been introduced to market by the researchers and manufactures. Unfortunately all of them have one or the other disadvantage. Recently developed are the biocermaic based root canal sealers which posses better properties and clinical performance. Bioceramics are biocompatible ceramic materials suitable for use in human body.[2] They are composed of alumina, zirconia, bioactive glass, glass ceramics, hydroxiapatite and calcium phosphate. The introduction of bioceramics dates back to 1969 when researchers found a new material called the bioglass when it was discovered that several glass components could be mixed with ceramic to create another compound that could be easily integrated into human bone.[3]

An important advantage of these materials is their ability to form hydroxyapatite and ultimately create a bond between dentin and the material.[2]Their Major disadvantage is difficulty in removal from the root canal system once they are set. Even though the advantages of these materials have contributed to their rapid spread in the dental field, nowadays, they are not widely used, and commercially available products on the market are not yet known by many dentists.[4] Therefore this article reviews the properties, advantages and disadvantages of various bioceramic based sealers.

CLINICAL PROPERTIES

Dentistry demands Bioceramic materials as they are biocompatible, chemically stable, non toxic, antibacterial and do not shrink upon setting. Several studies have shown that they do not result in an inflammatory response even if extruded periapically.[5]

Properties of the bioceramic sealers:[6]

1. The bioceramic sealers are hydrophilic.
2. When unset, they have a pH of above 12.
3. Do not shrink, but expand slightly and are insoluble in tissue fluids.
4. Excellent sealing ability

A great variety of endodontic sealers are available commercially and they are divided into different groups according to their chemical composition.

A. Calcium-silicate-phosphate based bioceramic sealers: Endosequence/ iRoot SP, iRoot BP, Bioaggregate
B. Calcium-phosphate based sealers: Apatite Root Canal Sealer, Bioseal, Capseal I, Capseal II
C. MTA based sealers: Endo-CPM-Sealer, MTA Obtura, ProRoot Endo Sealer, MTA fillapex

CALCIUM-SILICATE-PHOSPHATE BASED BIOCERAMIC SEALERS: Endosequence/iRoot_SP

According to the manufactures, these sealers have the ability to form hydroxyapatite during the setting process and ultimately bond chemically to the root canal dentin. iRoot_SP is the same as EndoSequence BC sealer which is composed of zirconium oxide (radiopacifier), tricalcium-silicate, dicalcium-silicate, colloidal-silica, calcium-silicate, monobasic calcium-phosphate, calcium hydroxide, fillers and plasticizers.[7]

These are insoluble, ready-to-use, injectable white cement pastes that are radioopaque and aluminium free calcium-silicate based materials. "iRoot_SP" uses water from dentin to initiate and complete its setting reaction. It exhibits potent antimicrobial action, excellent biocompatibility, and significant stimulation of

periodontal regeneration and is osteoconductive.[8]

iRoot BP and iRoot BP Plus

These sealers are insoluble, ready to use, aluminium free and radio-opaque, and are different from each other in terms of consistency. The iRoot BP is an injectable white paste but iRoot BP Plus has a putty-like consistency.[9] iRoot BP does not shrink during setting and demonstrates excellent physical properties.[7]

BioAggregate Root Canal Repair Filling Material

BioAggregate is a product of Innovative BioCeramix Inc., (Vancouver, Canada), a new generation root filling material produced using nano-technology. It is a fine white hydraulic powder cement mixture having poor radiopacity.[10] It produces biocompatible and aluminum-free ceramic biomaterial on reaction with water. Powder promotes a complicated set of reactions upon mixing with BioA Liquid leading to the formation of a nano-composite network of gel-like calcium-silicate-hydrate intimately mixed with hydroxyapatite, and forms a hermetic seal when applied inside the root canal.[9] It has excellent handling characteristics after mixing with liquid, convenient setting and hardening time, easy workability. These properties make it an ideal root canal repair filling material.[7]major drawback of this material is its poor radiopacity.

CALCIUM PHOSPHATE BASED SEALERS:

Calcium phosphate cement has been developed to treat sensitive teeth. Browne in 1983 showed that this cement penetrated and occluded the radicular dentinal tubules and enhanced hydroxyapatite formation. Wefel in 1984 found that it effectively plugged the apical foramen and penetrated the dentinal tubules upto 10µm. It is well known that it has a high biocompatibility because of its composition, almost identical to that of tooth and bone mineral.[11] Therefore, it has been suggested as root canal sealer. There are four types of calcium phosphate based sealers: Apatite Root sealer, Bioseal, Capseal I and II.

Apatite Root Canal Sealer:

Sankin apatitie root canal sealer I, II and III came into market with little modifications in composition. The poly acrylic acid in Apatite Root Sealers (ARS) has a low pH and may leak gradually to the surrounding tissue during the setting process causing inflammation. Powder component of type I ARS contains Tricalcium-phosphate, Hydroxyapatite and Liquid has Polyacrylic-acid.[12] 30% iodoform is added to Type II Powder in to improve antibacterial property. But inflammation is more severe due to the presence of iodoform. Type III Powder has 5% Iodoform and 1% Bismuth subcarbonate. Inflammatory response to this sealer is reduced because of the reduction in iodoform concentration.

Bioseal (Ogna Lab Farma, Italy)

It is a Hydroxyapatite containing eugenol sealer. Powder has Hydroxyapatite, Barium sulphate, Iodothymol and Resin and liquid has eugenol. Powder is supplied in capsules. Hydroxyapatite has no adverse effect on sealing ability. These sealers have favourable tissue responses, acceptable biocompatibility and good sealing abilities.

Capseal I and Capseal II

Bae et al. reported that Capseal I and II have superior mineralization potential than other sealers. These sealers produced pH and calcium ion release higher than or equal to those of Sealapex and Appetite root sealer.[13] Jin-Su Kim et al in 2004 showed that Capseal I and Capseal II were more biocompatible than Apatite Root Sealers.

MINERAL TRIOXIDE AGGREGATE (MTA)-BASED SEALERS

Some researchers believe that MTA in its original form is a classic bioceramic, with some added heavy metals. The primary formulation of MTA was introduced by M. Torabinajed in the 1990s and marketed by the Dentsply International (Dentsply Tulsa Dental,USA).[9] In 2007 Holland et al. 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.[14] MTA is a mixture of dicalcium silicate, tricalcium silicate, tricalcium aluminate, gypsum, tetracalcium aluminoferrite and 20% bismuth oxide, which is added as radiopacifier to change the physical properties of MTA.[9]

When MTA is used as root canal sealer and is compacted against dentin, a dentin MTA interfacial layer forms in the presence of phosphate. This adherent interstitial layer resembles hydroxyapatite in composition and structure.[14]The excellent biological properties of MTA are attributed to its alkaline pH and calcium ion release capacity. The setting time of a sealer is important to allow adequate working time and proper consistency to permit complete filling of the root canal system.[13] Drawback of these sealers is the discoloration potential due to release of ferrous ions and longer setting time about 2 hours 45 minutes.

MTA-based root canal sealers are:[14]

1. ProRoot Endo Sealer (Dentsply).
2. Fillapex (Angelus).
3. CPM Sealer (EGEO SRL, MTM Argentina SA, Argentina).
4. MTA Obtura (Angelus,Brazil).
5. MTAS experimental sealer MTAS
6. F-doped MTA cements.

Endo-CPM

CPM sealer was developed to combine the sealing and physiochemical properties of root canal sealer with biological properties of MTA.[14] It is a powder/ liquid sealer and presents basically the same composition of MTA.[13] The powder consists of fine hydrophilic particles that form a colloidal gel in presence of moisture. Its most significant difference is the presence of a large amount of calcium carbonate, which intends to increase the release of calcium ions and thus offers good sealing properties, adhesion to dentinal canal walls, Adequate flow rate, Biocompatibility. It becomes solid and forms a hard sealer in 1 hour.

MTA Fillapex

MTA Fillapex is a new MTA based endodontic sealer launched commercially in 2010. It is supplied as a double paste system. Apart from the basic composition of MTA, it consists of resins, bismuth oxide, silica nanoparticles and pigments.[13] MTA Fillapex was created in an attempt to combine the physico-chemical properties of a resin-based root canal sealer with the biological properties of MTA. According to the manufacturer, MTA Fillapex has an adequate working time, high radiopacity, and is easy to handle.[2]

In MTA Fillapex, the hydration reaction does not occur and therefore no calcium hydroxide is leached to the surrounding tissues. It contains microsilica, which affects the hydration of Portland cement. It reacts with the calcium hydroxide produced during hydration and forms more calcium silicate hydrate in the long term and improves the material properties.[15] It delivers easily and without waste and exhibits excellent handling properties with an efficient setting time.[14]

ProRoot Endo Sealer

It is an experimental calcium silicate-based root canal sealer that is designed to be used in conjunction with a root filling material. The major components of the powder component are tricalcium silicate and dicalcium silicate, with the inclusion of calcium sulphate as a setting retardant, bismuth oxide as a radiopacifier and a small amount of tricalcium-aluminate. The liquid component consists of a viscous aqueous solution of a water soluble polymer that has more fluidity and thus increases the flow.[8] The rapid adsorption of polymer molecule on to cement particles and the dispersion effect increase the surface area of cement grains to react with water. It does not alter the hydration characteristics of MTA. The addition of polymer did not seem to affect biocompatibility of material.[14]

MTA Obtura

This sealer was developed by replacing saline with a liquid resin as cure initiator. The composition of the powder is similar to gray MTA Angelus. The composition of the powder in this cement is similar to gray MTA Angelus, consisting of Portland cement clinker and bismuth oxide. It was developed to combine the biological and sealing properties of MTA. This sealer presented very stable

leakage values at 15 and 30 days, as expected for an MTA-based material. Its performance reproduced the good sealing ability of MTA as repair material. However, at 60 days MTA Obtura exhibited a considerable increase in leakage.[14]

MTAS Experimental Sealer

It was developed by the authors at discipline of Endo Araraquara Dental School UNESP, University of Estadual Paulista, Brazil. It is composed of 80% white Portland cement, zirconium oxide as radio opacifying agent, calcium chloride as additive, and resinous vehicle. It is prepared using powder to liquid ratio of 5:3 by weight which was determined in previous pilot studies. According to Tanomaru et al. MTAS released more showed calcium than MTA and Portland cement. This may be due to incorporation of calcium chloride. The pH of MTAS sealer was significantly higher up to 48-hours similar to MTA and Portland cement suggesting that MTAS has strong capacity of release of hydroxyl ions.[14]

F-doped MTA Cements

Powder consists of White Portland cement, bismuth oxide, anhydrite, sodium fluoride. Liquid consist of Alphacaine SP solution. Sodium-fluoride was included in FMTA as an expansive and retardant agent. It has been recently demonstrated that Portland-based cement containing fluorine had a significant expansion in water and in PBS. The expansion of Portland-based cements is a water-dependent mechanism because of water uptake because when immersed in hexadecane oil, no expansion occurred.[14]

CONCLUSION

Properly performed endodontic therapy is the cornerstone of dentistry, success rate of which is directly proportional to a clinician's knowledge of the root canal anatomy and the techniques and materials selected to seal it. One of the main goals of endodontic treatment is to three dimensionally seal the root canal system, thereby ensuring its success. Thus, several endodontic sealers have been recommended for use in conjunction with obturating materials. Bioceramic-based root canal sealers have shown to possess better properties than other sealers. However, few studies reveal that these sealers do not fulfil all of the requirements demanded of the ideal root sealer. Further studies are required to clarify the clinical outcomes associated with the use of these sealers.

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