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Applications Of Bioceramic Root Canal Sealers In Endodontics – A Review

Bioceramic Sealers

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ABSTRACT: Bioceramics are materials which contain zirconia, Alumina, bioactive glass, Glass ceramics, hydroxyapatite and resorbable calcium phosphates. They are widely used in dentistry for patching up bony defects,apical fill materials, sealing of perforations and in regenerative endodontics. The advantages of bioceramics are biocompatibility, dimensional stability, non-toxic, and most importantly being bio inert in endodontic applications. They can be broadly classified in endodontics into calcium phosphate/tricalcium/ hydroxyapatite based and mixtures of calcium silicate and phosphates. This article focuses about the overview in bioceramics, classification, advantages and also about the recently used bioceramic materials in endodontics.

Keywords: Bioceramics, Bioactive glass, calcium phosphate, calcium silicate, hydroxyapatite

1. INTRODUCTION

The field of endodontics is exhibiting a constant change with the introduction of new techniques and advances. Bio-Ceramics are materials which are recently introduced has showed a significant change in the field of endodontics. [1] Ceramics are non-metallic inorganic materials that are made my heating raw materials at high temperatures. [2] Bio ceramics are metal oxides or biocompatible materials with enhanced sealing abilities along with antibacterial and antifungal activity applied for use in medicine and dentistry. They have the ability to resorb and encourage regeneration of natural tissues. Bioceramics include titanium, zirconia, bioactive glass, glass ceramics, calcium silicate, hydroxyapatite, resorbable calcium phosphate and radiotherapy glasses. [1] Classifications of bioceramics were given based on composition, setting reaction and consistency. They are classified as follows.[3]

Bio inert: Non interactive with biological systems Eg: Alumina, Zirconia

Bio active: Tissues that can undergo interfacial interactions with surrounding tissue Eg: bioactive glasses, bioactive glass ceramics, calcium silicates and hydroxyapatite.
Bio Degradable: Resorbable or soluble which is eventually incorporated into tissue Eg: Tricalcium phosphate, Bioactive glasses.

ADVANTAGES OF BIO CERAMICS

Exceptional Biocompatible properties due to their affinity with biological hydroxyapatite. Natural osteoconductive capacity due to their ability to absorb osteoinductive substances where there is a bone healing process nearby. Acts as a regenerative scaffold of resorbable lattices that provide a framework which is eventually dissolved as the body rebuilds tissue. They have the capability to achieve excellent hermetic seal, and form a chemical bond with the tooth structure and also have good radiopacity.[4]Bioceramics are porous powders containing nanocrystals with a diameter of 1–3 nm, which resist bacterial adhesion., which prevent bacterial adhesion. At times, fluoride ions are Components of apatite crystals, and the resulted nanomaterial exhibits antibacterial properties.[5]

2. CLASSIFICATION

Calcium silicate based bioceramics

Portland cement: Joseph Aspdin, in 1824licensed a product called as Portland Cement which is derived from the calcination of mixture of the limestones from Portland and silicon-argillaceous materials.[6]
Portland Cement exhibits both antibacterial and antifungal that are similar to MTA against E.Fecalis, Micrococcus luteus, Staphylococcus aureus, Pseudomonas aeruginosa and candida albicans.[1]
Sealing ability – The sealing ability of white and grey Portland cement was found to be similar to that of grey and white MTA[7] but when tested as a perforation repair material by means of protein leakage, white Portland cement showed better sealing ability when compared to white and grey MTA.
Limitations- Large amounts of Lead and arsenic released from Portland cement added to its high solubility when compared to MTA and it concerns about the safety with respect to the surrounding tissues. Uncontrolled setting expansion of Portland cement could lead to crack formation on the tooth.[8]

Mineral Trioxide aggregate (MTA)

MTA was introduced in endodontics by Torabinejad in 1993. It is biocompatible and also shows osteoconductive and osteoinductive properties. It was initially recommended as a root end filling material and in due course it has been used for pulp capping, pulpotomy, apexogenesis. Hydrated calcium silicate and calcium hydroxide which are released over time constitutes the setting reaction of MTA.[5]
Biocompatibility: MTA is non-neurotoxic, non-mutagenic material which shows no side effects on microcirculation. It is confirmed to have anti inflammatory effects on pulp tissue along with cementoconductive, cementoinductive and osteoconductive effects.[9]
Advantages: Calcium ions are released by the formation of calcium hydroxide for cell proliferation and attachment. Its alkaline pH creates an antibacterial environment by modulating cytokine production. Provides biological seal by encouraging differentiation and migration of hard tissue producing cells by forming hydroxyapatite on the MTA surface.[9]

Limitations: Prolonged setting time.[10] The solvent for this material remains unknown. Difficulty in handling. [1] Once placed, the material is very difficult to remove. [9]

Biodentine

It is a calcium silicate-based material which, in 2009 became commercially available

Antibacterial activity: During the setting phase of the material, calcium hydroxide ions are released which increases the pH to 12.5 that in turn inhibits the growth of microorganisms and can disinfect the dentin.[11]

Biocompatibility: It is a non-toxic material which has no adverse effects on cell differentiation and function. Biodentine increases Tgf 1 growth factor secretion from the pulp stem cells which causes cell differentiation, mineralization and angiogenesis.[12]

Advantages of Biodentine over MTA

Biodentine ensures improved handling characteristics that is better suited for clinical use than MTA. There is no requirement of two step procedure as in MTA. Faster setting time lowers the risk of bacterial contamination compared to MTA.[12]

Experimental Calcium alumino silicates

Endobinder: It is a new calcium aluminate based endodontic cement that was developed with the intention to preserve clinical applications and properties of MTA eradicating its negative characteristics. They are produced with significantly greater levels of purity, eliminating traces of free MgO and CaO that are responsible for the undesirable setting expansion and ferric oxide which is responsible for darkening of the tooth.[13]

Generex A: It is a new calcium silicate-based material which is somewhat similar to proroot MTA but mixed with unique gels instead of water. When compared to MTA Generex A has a very different handling property. It mixes to a dough like consistency just like IRM.[13]

Capasio

Capasio is primarily made up of bismuth oxide, dental glass and calcium alumino silicate with silica and polyvinyl acetate-based gel. A recent study showed that Capasio and MTA had mineralization capacity by promoting apatite deposition when exposed to synthetic tissue fluid. [13]

EPC-Root end filling material using epoxy resin and Portland cement

Epc is a new composite which is made from a mixture of epoxy resins and Portland cement with acceptable radiopacity, quick setting time, less microleakage and low cytotoxicity.[13]

Calcium phosphate based bioceramics

It was listed that a triple calcium phosphate compound was used in a bony defect which encouraged osteogenesis or new bone formation. Hench in 1971 developed a calcium phosphate containing glass ceramic which is termed as Bioglass. It chemically bonds with the host bone through a calcium phosphate rich layer.[14]

Limitations- Lack of strength leading to fatigue and fracture resulting in failure in load bearing situations. [14]

Mixture of calcium silicates and calcium phosphates

Bio-aggregate: They are composed of nano particle sized tricalcium silicate, tantalum pentoxide, calcium phosphate and silicone dioxide which shows improved performance when compared to MTA.

Endosequence Root Repair Material

A novel root repair material was introduced into the market which is the Endosequence Bc root repair material which are available as two forms – iRoot SP and iRoot BP

Composition- The composition given by the manufacturer are as follows

calcium silicate, monobasic calcium phosphate, zirconium oxide, tantalum oxide and filler agents. They are available both in paste and moldable putty forms.[15]

Biocompatibility: When compared to MTA, ERRM did not exhibit cytotoxic effects on human gingival fibroblasts.[16]

USES OF BIOCERAMICS

Used in prosthetics as coatings to improve the biocompatibility of metal implants.[17]

Surgical uses such as replacement of joints, patching up bony defects, augmentation of alveolar ridge, Sinus obliteration and fractures of the orbital floor.

Endodontic uses- perforation fillers, retrograde filling, pulpotomy, apexification, dentin substitute, pulp capping, regenerative endodontics. [1]

3. CONCLUSION

As MTA was the benchmark bioceramic matrial, recent advances have continuously tried to overcome disadvantages and improve its properties. Bioceramics are widely applied both in restorative dentistry and endodontics therefore a clinician must have an up-to-date knowledge of the new bio active materials which are essential to ensure the selection of the most suitable material during clinical practice.

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