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Bioceramics As Sealers In Endodontics.

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ABSTRACT

The human intellect has always had an unsatisfying urge to better itself, to one-up what it has already accomplished and to find means towards attaining a state of health. The marvels of human innovations are a spectacular achievement in a world that is fickle and demanding. Innovations in dentistry hold a special place in this vast spectacle of human advancement and the field of endodontics is no exception. The development of bio- ceramic based root canal sealers is one such innovation. Root canal sealers play an important role in sealing the root canal system thereby greatly influencing the outcome of endodontic treatment. Bioceramics with a perfect combination of sealing ability and biocompatibility and possessing favourable characteristics closer to that of an ideal root canal sealer, have shown promising results.

Keywords: bioceramics, endodontics, dentistry, root canal

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INTRODUCTION

The field of Endodontics is continuously changing due to introduction of new techniques and technological advances. Advances in endodontic sciences contribute considerably to the exponential growth in endodontics. Bio-ceramics are amongst the newly introduced materials in endodontics which have transformed the face of endodontics. Ceramics are inorganic, non-metallic materials made by the heating of raw minerals at high temperatures. Bio-ceramics are biocompatible ceramic materials or metal oxides which include alumina and zirconia, bioactive glass, glass ceramics, calcium silicates, hydroxyapatite and resorbable calcium phosphates, and radiotherapy glasses Along with superior sealing ability, antibacterial and antifungal activity, they have the ability to either function as human tissues or to resorb and encourage the regeneration of natural tissues. (1,2,3)

CLASSIFICATION: (4, 5)

- *Bioinert:* non-interactive with biological systems(Alumina, zirconia)
- *Bioactive:* durable tissues that canundergo interfacial interactions with surrounding tissue(bioactive glasses, bioactive glass ceramics, hydroxyapatite, calcium silicates)
- *Biodegradable:* soluble or resorbable, eventually replaced or incorporated into tissue (Tricalcium phosphate, Bioactive glasses).

Advantages of Bioceramics:

1. Excellent biocompatibility properties due to their similarity with biological hydroxyapatite.
2. Intrinsic osteoinductive capacity because of their ability to absorb osteo inductive substances if there isa bone healing process nearby.
3. Function as a regenerative scaffold of resorbable lattices which provide a framework that is eventually dissolved as the body rebuilds tissue.
4. Ability to achieve excellent hermetic seal, forma chemical bond with the tooth structure and havegood radiopacity (6, 7).
5. Antibacterial properties as a result of precipitation in situ after setting, a phenomenon that leads tobacterial sequestration. Bioceramics form porous powders containing nanocrystals with diameters of1-3 nm, which prevent bacterial adhesion. Sometimes, fluoride ions are constituents of apatite crystals, andthe resulted nanomaterial has antibacterial properties (8).

Uses of Bioceramics(3, 6).

1. Prosthetic uses- implants, prosthesis, prostheticdevices, coatings to improve the biocompatibility of metal implants
2. Surgical uses – joint replacements, fill surgical bonedefects, alveolar ridge augmentation, sinus obliteration, and correction of orbital floor fracture.
3. Restorative uses- Dentin substitute, pulp capping, dentin hypersensitivity, dentin remine ralization
4. Endodontic uses- sealers, obturation, perforation repair, retrograde filling, pulpotomy, resorption, apexification, regenerative endodontics.

Bioceramics in Endodontics:

In an endodontic treatment, good instrumentation and cleaning of root canal combined with perfect hermetic closure of its apical third are vital prerequisites for achieving of full closure of root canal apical orifice with cementoid tissue. Closure of the root canal ensures non-problematic and lasting function of the root in naturally wet environment surrounding it.

The “golden” standard for endodontic treatment today is warm condensation multi phase (guttapercha— sealer) techniques. In the era of adhesive techniques in dentistry we have an endodontic standard, which lacks adhesion and chemical bond between root canaldentin walls and root canal filling materials.(9) Shrinking of gutta-percha after the end of warm condensation and lack of adhesion of the root filling materials to dentinal root canal walls are factors creating enough predispositions for micro leakage. The known fact is that the human body’s immune system can easily deal with this situation when titre of

microorganisms is low. That capability of immune system is demonstrated by lack of periapical pathology and subjective complaints. This equilibrium can easily be destroyed when due to different reasons human body's reactivity is changed and existing balance is "pushed" toward appearance of pathologic periapical changes. That is why the quest for endodontic sealers that adhesively and chemically bond to root canal walls continues. Clinical use of Bis-GMA based sealers in combination with polycaprolactone made cones is a promising step ahead. (10 11) but in the area of the root canal apical third these materials are in constant contact with wet environment of periodontium and are subjected to action of enzyme systems there.(12, 13,14)

'Endodontic grafting' (15)

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 andperiodontium 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 osseoconductivity as sealer's feature. Perfect and lasting in wet environment hermetic seal of apical third combined with osseoconductivity 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 osseoconductivity 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.

Different Bioceramics Used: (16 ,17)

Calcium silicate based –Cements- Portland Cement, Mineral trioxideaggregate (MTA), Biodentine (Septodont, France)

Sealers - Endo CPM Sealer (EGO SRL, BuenosAires, Argentina), MTA Fillapex (Angelus, Brazil), BioRoot RCS (Septodont, France), TechBiosealer(Profident, Kielce, Poland).

Calcium phosphates/ tricalcium phosphate/hydroxyapatite based

Mixture of calcium silicates and calciumphosphates - iRoot BP, iRoot BP Plus,iRoot FS(Innovative Bioceramix Inc., Vancouver, Canada),Endo Sequence BC Sealer (Brasseler, Savannah, GA, USA)/ Total Fill , Bioaggregate (InnovativeBioceramix Inc., Vancouver, Canada), Tech Biosealer, Ceramicrete (developed at Argonne National Lab,Illinois, USA)

The use of bioceramic-based sealers with their features like osseoconductivity, hydrophilicity, adhesiveness, 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. Such microspace is a potential place for possible microbial growth, because of microleakage observed with other kind of sealers.

Bioceramic Sealers

A number of commercially available bioceramic-based root canal sealers are classified according to their major constituents:

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Type	Brand name	Manufacturer	Components
Calcium silicate-based	BioRoot RCS	Septodont, Saint Maurdes-Fosses, France	Powder: tricalcium silicate, zirconium dioxide, povidone Liquid: water,calcium chloride, and polycarboxylate
	Total Fill BC Sealer	FKG Dentaire, La-Chaux-de-Fonds, Switzerland	Premixed single syringe contains: calcium silicates, calcium phosphate monobasic, zirconium oxide, tantalum oxide and thickening agents
	iRoot SP	Innovative BioCeramix Inc., Vancouver,Canada	Calcium silicate, calcium phosphate, calcium hydroxide, niobium oxide and zirconium oxide
	EndoSequence BC Sealer	Brasseler USA, Savannah, GA, USA	Calcium silicate, calcium phosphate, calcium hydroxide, niobium oxide and zirconium oxide Tricalcium silicate, dicalciumsilicate, tantalum pentoxide, calcium phosphate monobasic, amorphous silicon oxide
	DiaRootBioaggregate	DiaDent Group International, Burnaby, BC, Canada	Calcium silicate, zirconium oxide, filler, and thickening agents
	Well-Root ST	Vericom, Gangwon-Do, Korea)	
MTA-based	MTA-Fillapex	Angelus Londrina, PR, Brazil	Salicylate resin, diluting resin, natural resin, bismuth trioxide, nanoparticulate silica, MTA, and pigments
	MTA Angelus	Angelus Londrina, PR, Brazil	Tricalcium silicate, dicalcium silicate, tricalcium aluminate, tetracalcium aluminoferrite, bismuth oxide, iron oxide, calcium carbonate, magnesium oxide, crystalline silica, and residues (calciumoxide, free magnesium oxide, and potassium and sodium sulphate compounds)
	Endo CPM sealer	Egeo, Buenos Aires, Argentina	Silicon dioxide, calcium carbonate, bismuth trioxide, barium sulfate, propylene glycol alginate, sodium citrate, calcium chloride, and active ingredients Powder: tricalcium silicate, dicalcium silicate, calcium sulphate, bismuth oxide, and a small amount of tricalcium aluminate
	ProRoot Endo Sealer	DENTSPLY Tulsa Dental Specialties	Liquid: viscous aqueous solution of a water-soluble polymer

Calcium phosphate-based	Sankin Apatite Root Sealer : Type ISankin Apatite Root Sealer Type IISankin Apatite Root Sealer Type III Sankin Apatite Root Sealer Capseal (I and II)	Sankin Kogyo, Tokyo, Japan Experimental	Powder:80% alpha-tricalcium phosphate(α-TCP), 20% hydroxyapatite Liquid - 25% polyacrylic acid, 75% water Powder: 56% α-TCP 14% hydroxyapatite 30% iodoform Liquid 25% polyacrylic acid 75% water Powder: 80% α-TCP 14% hydroxyapatite 5% iodoform 1% bismuth subcarbonate Liquid 25% polyacrylic acid 75% water Powder: tetracalcium phosphate (TTCP) and dicalcium phosphateanhydrous (DCPA), Portland cement (gray cement in type I and white cement in type II), zirconium oxide, and others as powder Liquid: hydroxypropyl methyl cellulose in sodium phosphate solution

Features of ceramic-based endodontic sealers (15)

1. Ceramic-based sealers are highly hydrophilic and have low contact angle. These features allow them to spread easily over the dentin walls of the root canal and to get inside and fill the lateral micro canals, too. Thus necessity to instrument the canals with 06 or higher taper becomes no longer needed. Tooth tissues are preserved, and risk of root fractures is reduced.

2. During setting, hard ceramic-based sealers expand. Expansion of BioAggregate and iRoot SP and iRoot BP issignificant — 0.20 percent. These new bioceramic sealers also form chemical bond with the canal's dentin walls. That is why no space is left between the sealer and dentin walls. This is well demonstrated by light polymerization microscopy and much better demonstrated by large magnification scanning electron microscopy.

3. Bioceramic-based sealers are capable of achieving fast alleviation of the pain syndrome in cases of acute periapical inflammation. After appropriate instrumentation and cleaning of the root canal, followed by immediate filling with iRoot SP, pain rapidly diminishes and most often is totally gone within a period of 50 minutes to few hours.

4. In cases of MTA-based materials extrusion outside the root canal is associated with severe pain felt by the patient. When bioceramic-based sealers Bio Aggregate or iRoot SP are extruded, the pain is relatively small or totally absent. Such lack of pain may be explained with the characteristics of these new materials. During hardening they "produce" hydroxyapatite and after the end of hardening process they exhibit the same features as non-resorbable hydroxyapatite-based bioceramics used for bone replacement in oral surgery. Due to the hydroxylapatite formed, they are also osseo conductive.

5. MTA-based materials and Bio Aggregate have quite poor radiopacity, different from calcium silicate based iRoot SP and iRoot BP sealers.

CONCLUSION

The evolution of sealers from the conventional ZOE to the most recent bioceramics have the predilection to change the perception the way sealers have been used in the near future. They have opened a new dimension on how apart from creating hermetic seal, a sealer can also have the propensity toward mineralization and enhancing the fracture resistance of the endodontically treated teeth 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 warm techniques.

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