Review Article

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# Bioceramics in Dentistry

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**Abstract**

Bioceramics have been used in dentistry for a long time now. The advances in bioceramics have changed the way treatment is done and. Treatment has been more conservative, and well accepted by the body. They are of different types and their applications in dentistry are many. They are highly biocompatible and an added advantage to form hydroxyapatite and ultimately create a bond between dentin and the filling material.

**Keywords:** Bioceramics; Applications as Sealers; Advantages.

## Introduction

There are numerous bioceramics currently in use in both dentistry and medicine, although more so in medicine. Alumina and zirconia are among the bioinert ceramics used for prosthetic devices. Bioactive glasses and glass ceramics are available for use in dentistry under various trade names. Additionally, porous ceramics such as calcium phosphate-based materials have been used for filling bone defects. Even some basic calcium silicates such as ProRoot MTA (Dentsply) have been used in dentistry as root repair materials and for apical retrofills [1].

*Definition of Bioceramics*

In practical sense, the term bioceramics can be referred to a group of ceramics, which are used in the field of biomedicine. These biomaterials are ceramics, which are manufactured or processed to be suitable for use in or as a medical device that comes into intimate contact with proteins, cells, tissues, organs, and organ systems [2].

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*Classification of Bioceramics [1,3]*

Based on their chemical reactivity they can be classified as:

1. Bio inert- alumina, zirconia
2. Bio active- hydroxyapatite, bioactive glasses, and glass-ceramics
3. Resorbable- tricalcium phosphate

*Requirements to be Biocompatible*

1. Chemically inert
2. No adverse effect on surrounding tissues
3. Longevity and good tolerance by the body
4. Adequate strength (inert and fatigue)
5. Must not have any adverse effect on metabolic processes

*Advantages of Bioceramics*

1. Biocompatible
2. Non–toxic
3. No shrinkage
4. Chemically stable within the biological environment. Additionally, and this is very important in endodontics, bioceramics will not result in a significant inflammatory response if an over fill occurs during the obturation process or in a root repair.
5. Ability (during the setting reaction) to form hydroxyapatite

*Types of Bioceramics -Tissue Attachment and Bioceramics Classification [4]*

| | Type of bioceramic | Example |
|---|---|---|
| 1 | Type of attachment Dense, nonporous, nearly inert ceramics attach by bone growth into surface irregularities by cementing the device into the tissues, or by press fitting into a defect (termed morphological fixation). | Al2O3 (single crystal and polycrystalline) |
| 2 | For porous inert implants bone ingrowth occurs, which mechanically metals attaches the bone to the material (termed biological fixation). Reactive ceramics, glasses, Bioactive glass-ceramics and glass-ceramics attach Hydroxyapatite directly by chemical bonding with the bone (termed bioactive fixation). | A1203 (porous polycrystalline)<br><br>Hydroxyapatite-coated porous materials |
| 3 | Dense, nonporous, surface- reactive ceramics, glasses, glass-ceramics attach directly by chemical bonding with the bone (termed bioactive fixation). | Bioactive glasses Bioactive glass-ceramics and Hydroxyapatite |
| 4 | Dense, nonporous (or porous), resorbable ceramics are designed to be slowly replaced by bone. | Calcium sulfate (plaster of Paris) Tricalcium phosphate Calcium phosphate salts |

*Present Uses of Bioceramics [6,7]*

*1. Orthopedic Load-Bearing Applications A1203 Stabilized Zirconia PE-HA Composite*

- Coatings for chemical bonding (orthopedic, dental, and maxillofacial prosthetics) HA Bioactive glasses Bioactive glass-ceramics
- Dental implants AI2O3,
- HA
- Bioactive glasses

*2. Alveolar Ridge Augmentations*

- A1203
- HA
- HA-autogenous bone composite
- HA-PLA composite
- Bioactive glasses

*3. Otolaryngological*

- AI2O3
- HA
- Bioactive glasses
- Bioactive glass-ceramics

*4. Artificial Tendon and Ligament*

- PLA-carbon-f iber composite

*5. Artificial Heart Valves Pyrolytic Carbon Coatings*

*6. Coatings for Tissue Ingrowth (Cardiovascular, Orthopedic, Dental, and Rnaxillofacia1 Prosthetics)*

- AI2O3

*7. Temporary Bone Space Fillers*

- TCP

*Calcium and Phosphate Salts*

*8. Periodontal Pocket Obliteration*

- HA
- HA-PLA composite
- TCP
- Calcium and phosphate salts
- Bioactive glasses

*9. Maxillofacial Reconstruction*

- A1203
- HA
- HA-PLA composite
- Bioactive glasses

*10. Percutaneous Access Devices Bioactive Glass-Ceramics Bioactive Glasses HA*

*11. Orthopedic Fixation Devices*

- PLA-carbon fibers PLA-calcium phosphate-based
- glass fibers

*12. Spinal Surgery*

- Bioactive glass-ceramic
- HA

*Bioceramic Sealers [8]:*

1. High Ph 12.8 during the initial 24 hours of setting

(strongly antibacterial)

2. Hydrophillinc
3. No shrinkage
4. Don't resorb (important for a sealer)
5. Excellent sealing ability
6. Setting time (3-4hours)
7. Small particle size makes it possible to use in a syringe

The new sealer (Endosequence BC sealer) has a particle size of 2 micronmeter, it can be used with a 0.12 capillary tip.

*It's Non-Toxic Calciumsilicate Cement*

It has the advantage of simplicity in using and delivering the sealer into the canal. Also, it makes use of the water in the dentinal tubules during the setting reaction. Unlike other sealers the water in dentinal tubules aids in the formation of hydroxyapetite during the setting reaction and does not adversely affect the strength and physical properties of the sealer.

Premixed bioceramic sealer hardens only when exposed to a moist environment (such as that produced by the dentinal tubules).

*Tips for using Bioceramic Sealer [3,8]:*

1. Store at room temperature as its setting depends on moisture in dentinal tubules
2. Use a bioceramic root repair material for a single-visit direct pulp capping they are available as a sealer in a premixed syringe, as a root repair material in a premixed syringe, and as a premixed putty in a glass jar. The root repair material (particularly the putty) for direct pulp caps.

   The advantages of premixed endodontic cement (sealer) should be obvious. In addition to a significant saving of time and convenience, one of the major issues associated with the mixing of any cement, or sealer, is an insufficient and nonhomogenous mix. Such a mix may ultimately compromise the benefits associated with the material.
3. For repair of perforations: as this material is available in premixed form it is so much easier than mixing MTA or super EBA.
4. Use optimum amount of sealer. Bioceramic sealer flows much better than conventional sealers. This is due to its small particle size (less than two microns).

*Bioceramic Sealer (And Root Repair Material) Bonding Mechanism [5,9,10]*

The main component of dentin is hydroxyapatite, which has a hydroxyl group. When EndoSequence BC Sealer and/or the repair material are introduced into a root canal, they absorb water from the dentinal tubules. Then the setting reaction is initiated and it produces a composite of calcium silicate hydrogel and hydroxyapatite. The calcium silicate hydrogel will form a chemical bond with the hydroxyapatite because of the hydroxy-group. The hydroxyapatite formation in the sealer is a continuous crystal growth process (of hydroxyapatite on the dentinal walls). Therefore, both of the compounds will form strong chemical bonding with the dentin hydroxyapatite. When the smear layer is removed, the fresh hydroxyapatite structure of the dentin isin direct contact with the sealer, which creates the chemical bonding. This chemical bonding is, as well, accompanied by the micromechanical bonding of the nano-particles described.

Also, the BC Sealer will bond to a coated cone with glass ionomer particles (Activ GP). The main composition of glassionomer is calcium aluminate and calcium silicate compounds. The calcium silicates in BC Sealer hydrate with water to produce calcium silicate hyrdrate gel, which forms a chemical bond with the calcium aluminate and calcium silicate compounds on the surface of the Activ GP. This is in addition to the micromechanical bond created by the interlocking of the nanocomposite of the calcium silicate hydrate and the nanohydroxyapatite particles [3,11].

**Conclusion**

Bioceramics have transformed the way treatment is done. Its good physical properties and relatively inert nature and its ability to react in presence of moisture within the dentin make it the material of choice for the procedures which were earlier done using either MTA. It's high time we adopt it into our daily practice and provide better treatment results than conventional techniques.

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