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Bioceramics in Endodontics - A Review

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Abstract
Bioceramics are materials which include Alumina, Zirconia, Bioactive glass, Glass ceramics, Hydroxy apatite, resorbable calcium phosphate. They have been used in dentistry as root repair materials, apicall filling materials, perforation sealing, for filling up bony defects, as endodontic sealers and as aids in regeneration. They have similarity to hydroxyapatite, an intrinsic Osteo conductive activity and have an ability to induce regenerative responses in the human body. This review focuses on overview of bio ceramics, classification and their advantages. It also gives a detailed insight into individual bio ceramic materials currently used in the field of endodontics along with their properties and applications.

Keywords: Bioceramics, Bioactive glass, hydroxyapatite, Calcium Silicate, Calcium phosphate

Introduction

In the recent past, we have seen a great rush to dental implants among both general dentists and specialists. This is fine, but we want all clinicians to remember the many benefits that well-done Endodontics can bring to their patients. This desire to have dentists understand the benefits of good endodontics is critical to having the natural tooth remain the fundamental building block of restorative dentistry. New techniques and technology have been developed, which allow the majority of skilled dentists to produce stellar endodontic results. Paramount among these changes is the introduction of advanced material science. It has only been within the past decade that we have witnessed significant changes in endodontic material science. The good news is that the arena of endodontic material science is continuing to evolve and, in fact, a new day has dawned. This new horizon is the increased use of Bioceramics technology in endodontics.

Bioceramics are ceramic materials specifically designed for use in medicine and dentistry. They include alumina and zirconia, bioactive glass, glass ceramics, coatings and composites, hydroxyapatite and resorbable calcium phosphates. There are numerous Bioceramics currently in use in both dentistry and medicine, although more so in medicine[1]. Alumina and zirconia are among the bio inert 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 retro fills.

Historical Prospectus

Bioceramics are ceramic materials specifically designed for medical and dental use. During the 1960s and 1970s, these materials were developed for use in the human body such as joint replacement, bone plates, bone cement, artificial ligaments and tendons, blood vessel prostheses, heart valves, skin repair devices (artificial tissue), cochlear replacements, and contact lenses. Bioceramics are inorganic, non-metallic, biocompatible materials that include alumina and zirconia, bioactive glass, coatings and composites, hydroxyapatite and resorbable calcium phosphates, and radiotherapy glasses. They are chemically stable, non-corrosive, and interact well with organic tissue.

L.L Hench and others, in 1969, had introduced a new material called Bio glass and had observed that several glasses and ceramics could bond to living bone [1]. Since this breakthrough, significant evolution has been seen with Bioceramics technology being used in dental as well as medical practice.

Calcium phosphate was first used as Bioceramics restorative dental cement by LeGeros *et al.* However, the first documented use of Bioceramics materials as a root canal sealer was not until two years later when Krell and Wefel compared the efficacy of experimental calcium phosphate cement with Grossman's sealer in extracted teeth, finding no significant difference between both sealers in terms of apical occlusion, adaptation, dentinal tubule occlusion, adhesion, cohesion, or morphological appearance [2].

Classification

The properties associated with Bioceramics are very attractive to both medicine and dentistry. In addition to being non-toxic, Bioceramics can be classified as:

1. **Bio inert:** Non interactive with biological systems.
2. **Bioactive:** Durable tissues that can undergo interfacial interactions with surrounding tissue.
3. **Biodegradable, soluble or resorbable:** Eventually replaces or incorporated into tissue. This is particularly important with lattice frameworks.

Bioactive materials, such as glass and calcium phosphate, interact with the surrounding tissue to encourage the growth of more durable tissues. Bio inert materials, such as zirconia and alumina, produce a negligible response from the surrounding tissue, effectively having no biological or physiological effect [3]. Bioactive materials are further classified according to their stability as degradable or no degradable. Bioceramics are commonly used for Orthopaedic treatments, such as joint or tissue replacements, and for coating metal implants to improve biocompatibility. Additionally, porous ceramics, such as calcium phosphate-based materials, have been used as bone graft substitutes

Bioceramics in endodontics

Calcium silicate based –

Cements- Portland cement, Mineral trioxide aggregate (MTA), Biodentine (Septodont, France).

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

Calcium phosphates/ tricalcium phosphate/ hydroxyapatite based Mixture of calcium silicates and calcium phosphates - iRoot BP, iRoot BP Plus, iRoot FS (Innovative Bioceramics Inc., Vancouver, Canada), Endo Sequence BC Sealer (Brasseler, Savannah, GA, USA)/Total Fill, Bio aggregate (Innovative Bioceramics Inc., Vancouver, Canada), Tech Biosealer, Ceramic rete (developed at Argonne National Lab, Illinois, USA).

Product and manufacturer	Component A	Component B
AH Plus (Dentsply DeTrey, Konstanz, Germany)	Epoxy resins Calcium tungstate Zirconium oxide aerosil Iron oxide	Adamantane amine, N,N-Dibenzyl-5-oxanonane, TCD-Diamine, Calcium tungstate, Zirconium oxide, Aerosil
Fill Canal (TechNew, Campo Grande, RJ, Brazil)	Zinc oxide Hydrogen resin Bismuth subcarbonate Barium sulfate Sodium borate	Eugenol Amond oil
L&C (Dentsply Herpo, Petrópolis, RJ, Brazil)	Calcium hydroxide (65.6%) Bismuth carbonate (32.8%) Colophony (1.6%)	Purified olive oil

Fig 1: Tested materials

Composition of Bioceramics

Sealers	Compositions
AH Plus	Diepoxide, calcium tungstate, zirconium oxide, aerosol, 1-adamantane amine, diamine (3 (4),8 (9)-bis (aminomethyl) tricycle-(5.2.1.02,6)decane), dibenzyldiamine, aminoadamantane, pigments
I Root SP	Zirconium oxide, calcium silicates, calcium phosphate, calcium hydroxide filler, and thickening agents
MTA Fillapex	Salicylate resin, diluting resin, natural resin, bismuth trioxide, nanoparticulated silica, Mineral trioxide aggregate, pigments
EndoRez	30% urethane dimethacrylate, zinc oxide, barium sulfate, pigments

Mechanism of action

Bioceramic sealers use the water inherent in the dentinal tubules for the setting reaction thus beginning the hydration reaction of the material and by this reducing the setting time. The setting time is reduced [3]. Dentin is believed to contain about 20 percent water (by volume). This water is responsible for the setting of the material. These sealers are available as premixed endodontic cement and have the advantage of improved convenience. Problems that are associated with mixing of cement such as insufficient and non-homogenous mix can be prevented and also helps in saving time. Bioceramic sealers have the property of hardening only when exposed to moist environment such as dentinal tubules

Upon hydration, calcium silicate gel and calcium hydroxide are produced by the calcium silicates in the powder. The calcium hydroxide reacts with phosphate ions and produces the precipitation of hydroxyapatite and water. The hydroxyapatite that is produced can be used for reconstruction material and in bone repair as is nontoxic. The continuous interaction of calcium silicate and water leads to production of calcium silicate hydrate.

The hydration reactions (A, B) of calcium silicates and precipitation reaction (C) of calcium phosphate are:

(A) $2[3CaO.SiO2] + 6H2O \text{---->} 3CaO.2SiO2.3H2O + 3Ca(OH)2$

(B) $2[2CaO.SiO2] + 4H2O \text{---->} 3CaO.2SiO2.3H2O + Ca(OH)2$

(C) $7Ca(OH)2 + 3Ca(H2PO4)2 \text{---->} Ca10(PO4)6(OH)2 + 12H2O$

A critical factor in controlling the rate of hydration and setting reaction is the water through the setting reactions. When compared to the setting reaction of calcium hydroxide, similarity is seen and is related to its pH. It is affected by release of hydroxyl ions and their concentration. Dissociation is altered by the vehicle used. The pH of dentin also altered after by the release of hydroxyl ions when it is treated with it. There are two major advantages associated with the use of Bioceramics materials as root canal sealers. Firstly, their biocompatibility prevents rejection by the surrounding tissues. Secondly, bioceramic materials contain calcium phosphate which enhances the setting properties of bioceramics and results in a chemical composition and crystalline structure similar to tooth and bone apatite materials, thereby improving sealer-to-root dentin bonding. However, one major disadvantage of these materials is in the difficulty in removing them from the root canal once they are set for later retreatment or post-space preparation. The exact mechanism of bioceramic-based sealer bonding to root dentin is unknown; however, the following mechanisms have been suggested for calcium silicate-based sealers:

1) Diffusion of the sealer particles into the dentinal tubules (tubular diffusion) to produce mechanical interlocking bonds.
2) Infiltration of the sealer's mineral content into the intertubular dentin resulting in the establishment of a mineral infiltration zone produced after denaturing the collagen fibers with a strong alkaline sealer.
3) Partial reaction of phosphate with calcium silicate hydrogel and calcium hydroxide, produced through the reaction of calcium silicates in the presence of the dentin's moisture, resulting in the formation of hydroxyapatite along the mineral infiltration zone. While various branded bioceramic-based root canal sealers are available on the market, others are still experimental, requiring further laboratory and clinical testing to ascertain their efficacy.

Properties of Bioceramic as seal ear

Bioceramics are exceedingly biocompatible (nontoxic) and they are chemically stable within the biological environment. Also, bioceramics do not shrink upon setting. In fact, they actually expand slightly upon completion of the setting process (0.002). Furthermore (and this is very important in endodontics), bioceramics will not result in a significant inflammatory response if an overfill occurs during the obturation process or in a root repair. These are all outstanding properties for any sealer[4]. A further advantage of

the material itself is its ability (during the setting process) to form hydroxyapatite and ultimately establish a chemical bond between dentin and the appropriate filling materials in essence, a bonded restoration.
But, what is it specifically about bioceramics that make them so well-suited to act as a sealer ;From our perspective as endodontists, some of the advantages are: high pH (12.8) during the initial 24 hours of the setting process (which is strongly antibacterial) hydrophilic nature, not hydrophobic, enhanced biocompatibility, does not shrink, does not resorb (which is critical for a sealer-based technique), excellent sealing ability, sets quickly (3 to 4 hours) and its ease of use (particle size is so small it can be used in a syringe). The introduction of a bioceramic sealer (Endo Sequence BC Sealer [Brasseler USA] allows us, for the first time, to take advantage of all the benefits associated with bioceramics but to not limit its use to merely root repairs and apical retro fills. This is only possible because of recent nanotechnology developments; the particle size of BC Sealer is so fine (less than 2µm), it can actually be used with a 012 capillary tip. This material has been specifically designed as a nontoxic calcium silicate cement that is easy to use as an endodontic sealer. This is a key point. In addition to its excellent physical properties, the purpose of BC Sealer is to improve the convenience and delivery method of an excellent root canal sealer while simultaneously taking advantage of its bioactive characteristics (it utilizes the water inherent in the dentinal tubules to drive the hydration reaction of the material, thereby shortening the setting time). As we know, dentin is composed of approximately 20% (by volume) water; and it is this water that initiates the setting of the material and ultimately results in the formation of hydroxyapatite. Therefore, if any residual moisture remains in the canal after drying, it will not adversely affect the seal established by the bioceramic cement. This is very important in obturation and is a major improvement over previous sealers. Particle size, and chemical bonding to the dentin.

The biological and physical properties of bioceramic-based root canal sealers were reviewed based on the ideal root canal sealer properties as described by Grossman, as in the following list:

(1) It should be tacky when mixed to provide good adhesion between it and the canal wall when set.
(2) It should make a hermetic seal.
(3) It should be radiopaque so that it can be visualized on the radiograph.
(4) The particles of powder should be very fine so that they can mix easily with liquid.
(5) It should not shrink upon setting.
(6) It should not discolour tooth structure.
(7) It should be bacteriostatic or at least not encourage bacterial growth.
(8) It should set slowly.
(9) It should be insoluble in tissue fluids.
(10) It should be well tolerated by the periapical tissue.
(11) It should be soluble in common solvents if it is necessary to remove the root canal filling.

Clinical Properties

A premixed sealer of bioceramics (EndoSequence BC Sealer) is available in a syringe. It has a working time of approximately four hours at room temperature and is introduced immediately into the root canal [3]. It has a shelf life of two years and does not require refrigeration for storage. It can be stored at room temperature. They act by creation of a bond between the appropriate filling material and dentin and can form hydroxyapatite.
Presence of moisture in the dentinal tubules affects the setting time of the bioceramic sealer. This moisture availability in the root canal is by the dentinal tubule which is needed for the setting reaction. Thus prior to obturation addition of moisture is not required. The highly alkaline pH enhances its bactericidal properties. A very small capillary tip or a cannula can be used for its delivery owing to its small particle size.
EndoSequence BC Sealer is a premixed ready-to-use injectable bioceramic cement paste developed for permanent root canal filling and sealing applications. EndoSequence BC Sealer is an insoluble, radiopaque and aluminum-free material based on a calcium silicate composition, which requires the presence of water to set and harden. EndoSequence BC Sealer does not shrink during setting and demonstrates excellent physical properties. EndoSequence BC Sealer is packaged in a pre-loaded syringe and is supplied with disposable Intra Canal Tips.

Indications for use

- Permanent obturation of the root canal following vital pulp-extirpation.
- Permanent obturation of the root canal following removal of infected or necrotic pulp and placement of intracanal dressings.

EndoSequence BC Sealer is suitable for use in the single cone and lateral condensation technique.

Working time: No mixing is required. EndoSequence BC Sealer can be applied immediately and introduced directly into the root canal. The working time can be more than 4 hours at room temperature.

Setting Time: Setting time is 4 hours measured according to ISO 6876:2001. However, in very dry root canals, the setting time can be more than 10 hours.

Composition: Zirconium oxide, calcium silicates, calcium phosphate monobasic, calcium hydroxide, filler and thickening agents.

Standard: EndoSequence BC Sealer meets the requirements of ISO 6876:2001 for Dental Root Canal Setting Materials and ANSI/ADA Specification No. 57:2000 for Endodontic Sealing Materials.

Interaction: The setting time of EndoSequence BC Sealer is dependent upon the presence of moisture in the dentinal tubules. The amount of moisture required for the setting reaction to occur reaches the root canal by means of the dentinal tubules. Therefore, it is not necessary to add moisture in the root canal prior to performing the obturation.

Removal of root canal filling

Conventional techniques can be used for the removal of EndoSequence BC Sealer as used in combination with Gutta-Percha Points. Piezo Electric Ultrasonics (with water spray) can also be used.

Note

- Discard the Intra Canal Tips after each application. Do not re-use the tips.

- Keep the syringe cap clean and free of moisture. When not in use, keep the syringe cap in the pouch.

Directions for use

1. Prior to the application of EndoSequence BC Sealer, thoroughly prepare and irrigate the root canal using standard endodontic techniques.
2. Remove the syringe cap from the EndoSequence BC Sealer syringe. Securely attach an Intra Canal Tip with a clockwise twist to the hub of the syringe. The Intra Canal Tip is flexible and can be bent to facilitate access to the root canal.
3. Insert the tip of the syringe into the canal no deeper than the coronal one third (1/3). Gently and smoothly dispense a small amount (1-2 calibration markings) of EndoSequence BC Sealer into root canal by compressing the plunger of the syringe. Using a #15 hand file or something comparable, lightly coat the canal walls with the existing sealer in the canal. Then coat the master gutta percha cone with a thin layer of sealer and very slowly insert it into the canal. The master gutta percha cone will carry sufficient sealer to the apex.
   Note: The precise fit of the EndoSequence Gutta Percha master cone creates excellent hydraulics and for that reason it is recommended that the practitioner use a small amount of sealer. Furthermore, it is also important to insert the master cone very slowly to its final working length.
4. If desired, place additional gutta percha points into the canal using standard condensation techniques.
5. Using a heat source, burn off the gutta percha cones at the orifice, apply a slight amount of vertical condensation, and remove any excess sealer with a moist cotton ball or swab.
6. EndoSequence BC Sealer will remain part of the permanent root canal filling.
7. After each application, remove the Intra Canal Tip from the syringe with a counterclockwise twist to the hub of the syringe and discard. Clean the outside of the syringe and remove any excess paste, place the syringe cap tightly onto the syringe hub, and place the syringe into the foil pouch and ensure to seal the pouch. Store the pouch in a dry area at room temperature.

Advantages

- ✓ Excellent biocompatibility properties due to their similarity with biological hydroxyapatite.
- ✓ Intrinsic osteoinductive capacity because of their ability to absorb osteoinductive substances if there is a bone healing process nearby.
- ✓ Function as a regenerative scaffold of resorbable lattices which provide a framework that is eventually dissolved as the body rebuilds tissue.
- ✓ Ability to achieve excellent hermetic seal, form a chemical bond with the tooth structure and have good radiopacity.

Limitations

- ✓ Antibacterial properties as a result of precipitation in situ after setting, a phenomenon that leads to bacterial sequestration. Bioceramics form porous powders containing Nano crystals with diameters of 1-3 nm, which prevent bacterial adhesion. Sometimes, fluoride ions are constituents of apatite crystals, and the resulted nanomaterial has antibacterial properties Higher amount of lead and arsenic released from PC along with reports of its high solubility compared to MTA has raised questions regarding its safety with respect to the surrounding tissues
- ✓ Higher solubility may jeopardise the long term seal of the restoration.
- ✓ Excessive setting expansion with PC may lead to crack formation with the tooth
- ✓ Bio mineralization with PC is not as effective and as long term as with MTA which is critical for a bioactive material.

Tips for using Bioceramic sealer

 Do not store in a refrigerator: EndoSequence BC Sealer (Brasseler USA, Savannah, Georgia) comes premixed in a syringe, which does not have to be stored in a refrigerator. In fact, since it is the moisture inherent in the dentinal tubules that initiates the setting reaction, it is strongly recommended not to keep it refrigerated. Room temperature storage is perfectly fine.

 Don't use too much sealer: When using the premixed syringe to deliver the sealer, go slowly down into the canal no more than one-third of the way and then deliver only a modest amount of sealer.

 New users do not have to place the syringe into the tooth: Those clinicians just beginning to use BC Sealer might be wise to do a few cases where you simply syringe the material onto a glass slab, lightly coat the primary cone with the sealer, and then use the cone to deliver the sealer into the canal (lightly coating the walls with BC Sealer) [5]. BC Sealer flows better than most conventional sealers and this is due to its small particle size (less than two microns).

 Use bioceramic-coated cones: The aim of the entire EndoSequence technique is to have a cone precisely match the canal preparation and to then have this cone deliver the bioceramic sealer into the canal space, which creates the seal. Gutta percha does not create a seal; it only takes up space. The sealer is what creates the seal! To take full advantage of the bond that ispotentially created by the bioceramic glass particles, we recommend the new bioceramic-coated gutta percha cones (BC gutta percha). A glass ionomer-coated cone will work, but the bioceramic-coated cones are even better.

 Use the residual sealer material that remains in the tip: When using the premixed syringe to deliver the BC Sealer, we like to take the disposable tip off the syringe (after delivering the sealer into the canal) and then coat the master cone (with the sealer) by simply placing it into the tip. This will not only coat the master cone nicely, it will also minimize any waste of sealer.

 Use bioceramics for pulp caps: Bioceramic technology is available in the following forms: as a sealer in a premixed syringe, as a root repair material also in a premixed syringe and as premixed putty in a glass jar. We favor the root repair material (particularly the putty) for direct pulp caps.

 Do specifications with bioceramics: Specification procedures are a great indication for bioceramics. There are two methods that can work well. The first is to use the syringe able EndoSequence root repair material to fill the apical portion of the root and then, after X-ray verification continue to use this material to fill the remainder of the canal. The key is to verify how much you initially placed in the apical area to prevent a large overfill. The second method involves the use of a microscope. This technique utilizes a cone made from the root repair putty and this cone is then placed (using the microscope) in the apical third. The placement is verified with an X-ray and the remainder of the canal is backfilled with the syringe able root repair material.

 Use bioceramics as a retro filling material: Retro fills are a great indication for bioceramics. In the past, we used amalgam, super EBA and MTA. All of these materials are adequate, but each has its particular handling challenges. Now, when performing apical surgery, we have the option of using either a bioceramic root repair material that comes premixed in a syringe or a premixed putty that comes in a jar (EndoSequence RRM, Brasseler USA).

 Use bioceramics as a canal locator: This is possible because of the BC Sealer's terrific flowability and excellent radiopacity. Simply syringe the material into the space you are working in and take an X-ray to see if it has entered a canal. The bioceramic material is very easy to remove before it has set and you can verify that another canal exists.

Retreatment of Bioceramics

Bioceramic sealer cases are definitely treatable, yet the issue of retreating these cases (and all the associated misinformation) is not unlike that of glass ionomer. Historically there has been confusion about retreating glass ionomer endodontic cases (glass ionomer sealer is definitely retreatable when used as a sealer) and, similarly, there has been confusion concerning the retreat ability of bioceramics. The key is using bioceramics as a sealer, not as a complete filler. This is why endodontic synchronicity is so important and again, why the use of constant tapers makes so much Sense (it minimizes the amount of endodontic sealer thereby facilitating retreatment). The technique itself is relatively straightforward. The key in retreating bioceramic cases is to use an ultrasonic with a copious amount of water. This is particularly important at the start of the procedure in the coronal third of the tooth. Work the ultrasonic (with lots of water) down the canal to approximately half its length. At this point, add a solvent to the canal (chloroform or xylol) and switch over to an EndoSequence file (#30 or 35/0.04 taper) run at an increased rate of speed (1,000 RPM). Proceed with this file, all the way to the working length, using solvent when indicated. An alternative is to use hand files for the final 2-3 mm and then follow the gutta-percha removal with a rotary file to ensure synchronicity.

Bioceramics as a root repair material

EndoSequence Root Repair material specifically has been created as a white remixed cement for both permanent root canal repairs and apico retro fillings. As a true bioceramic cement, the advantages of this new repair material are its high pH (Ph>12.5), high resistance to washout, no shrinkage during setting, excellent biocompatibility, and superb physical properties. In fact, it has a compressive strength of 50-70 MPa, which is similar to that of current root canal repair materials, ProRoot MTA (Dentsply) and Bio Aggregate (Diadent). However, a significant upgrade with this material is its particle size, which allows the premixed material to be extruded through a syringe rather than inconsistent mixing by hand and then placement with a hand instrument. The Clinicians Report (November 2011) published findings on EndoSequence Root Repair Material. Some of its noted advantages as a root repair material were: 1. Easier to use and place than previous similar products. 2. Good dispenser (tip/syringe) for easy dispensing. 3. Radiopaque. 4. Multiple uses for a variety of clinical conditions. 5. No mixing required.

Pulp capping with Bioceramics

One of the other significant benefits of having bioceramics come premixed in a syringe (EndoSequence Root Repair Material) is the ability for all dentists to now easily treat young patients in need of pulp caps or other pulpal therapies (e.g., Pulpotomies). Hopefully, this will lead to an increased use of bioceramics in our pediatric patients and help these patients save their teeth. All dentists can benefit from this upgrade in technique. The technique itself for a direct pulp cap with the bioceramic root repair material is as follows: Isolate the tooth under a rubber dam and disinfect the exposure site with a cotton ball and NaOCl. Apply a small amount of the RRM from the syringe or, take a small amount of the RRM putty from the jar, and place this over the exposure area. Then, cover the bioceramic repair material with a compomer or glass ionomer restoration. Following the placement of this material, proceed with the final restoration, including etching if required. Single-visit direct pulp capping is now here.

Conclusion

In conclusion, based on the existing body of scientific information the technological changes governing the use of bioceramics is a crucial aspect of advancements in endodontics. There is a need for extensive research to identify new bioceramics or changing the existing one to improve their beneficial properties. As described above efforts have been directed towards amalgamating bioceramics with antimicrobial agents like silver compounds and several other formations, however, what is needed an extensive clinical research on these scientific aspects. Scholars have assessed the extent to which dentists have advanced the treatment process through the use of a biocompatible compound for different treatment procedures. The focus of the analyses has been on the level of efficiency associated with the method. Therefore, researchers have been keen to carry out commercial products studies of bioceramics as applied in endodontics.

On the other hand, the literature has pointed to some changes in market trends as well as the need for better patient outcomes as a key determinant of technological changes[6]. There is an urgent need to develop bioceramics having better anti-microbial profiles, so the patient can have better outcome subsequent to the treatment procedures.

An important avenue emerging from this review is the lack of appropriate guidelines regarding bioceramics development and their usage in endodontics. The commercial ventures manufacturing various bioceramics have complete control over this industry, and there is a need to disseminate clinical experience knowledge and the development of appropriate guidelines so the knowledge can be empirically used globally [4]. The shift from previously developed bioceramics to newly developed formulations is very slow, and there is an urgent need to boost clinical research. As the teeth are the major component of the oral cavity and healthy teeth guarantee overall human health. Bioceramics have been of use not only to endodontics but also for surgical and prosthodontics applications. Their properties help us to be more conservative during endodontic shaping by allowing us to preserve natural tooth structure. With the numerous advantages they provide, they seem to have a promising future in dental medicine. With further research, bioceramics has the potential to become the preferred materials for the various endodontic procedures. The above described future avenues identified for bioceramics research in endodontics is based on limited data available in the field. In academic institutions involved in dentistry teaching there is need to promote more scientific/clinical research in this particular field.

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