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The Advent of Bioceramics in Dentistry- A Review

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Abstract

During the past two decades, a number of major advances have been made in the field of bioactive ceramics used for endodontic treatment. This article reviews the physical, chemical and biological properties of bioceramic materials and the application of bioceramic technology to endodontics. Bioceramics, with their biocompatible nature and excellent physico-chemical properties, are widely used in endodontics. They can function as cements, root repair materials , root canal sealers and filling materials, which have the advantages of enhanced biocompatibility, potential increased root strength following obturation, antibacterial properties and sealing ability. New bioceramic materials have demonstrated the ability to overcome some of the significant limitations of earlier generations of endodontic materials. Most bioceramic materials have been shown to be biocompatible and have good characteristics, therefore having a potential use in clinical endodontics.

Keywords: Biocompatible, EndoSequence BC Sealer , EndoSequence Root Repair material.

Introduction

L.L.Hench and others, in 1969, had introduced a new material called Bioglass and had observed that several glasses and ceramics could bond to living bone.[1] Since this breakthrough, significant evolution has been seen with bioceramic technology being used in dental as well as medical practice.[2]

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 bioceramic technology in endodontics.[3]

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.[4,5,6] 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.

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 [4,7] :

• Bioinert: Non interactive with biological systems.

• Bioactive: Durable tissues that can undergo interfacial interactions with surrounding tissue.

• Biodegradable, soluble or resorbable: Eventually replace or incorporated into tissue. This is particularly important with lattice frameworks.

Properties of Bioceramics

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. 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 anti-bacterial) 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 (EndoSequence 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 retrofills. This is only possible because of recent nanotechnology developments; the particle size of BC Sealer is so fine (less than 2 μm), 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. Furthermore, its hydrophilicity, small particle size, and chemical bonding to the canals' walls make for excellent hydraulics.[8]

Endosequence BC Sealer Setting Reactions

The calcium silicates in the powder hydrate to produce a calcium silicate hydrate gel and calcium hydroxide. The calcium hydroxide reacts with the phosphate ions to precipitate hydroxyapatite and water. The water continues to react with the calcium silicates to precipitate additional gel-like calcium silicate hydrate. The water supplied through this reaction is an important factor in controlling the hydration rate and the setting time in the following equations. The hydration reactions (A, B) of calcium silicates can be approximated as follows[9]:

- $2[3CaO\text{-}SiO_2] + 6H_2O \rightarrow 3CaO\text{-}2SiO_2\text{-}3H_2O + 3Ca(OH)_2$
- $2[2CaO\text{-}SiO_2] + 4H_2O \rightarrow 3CaO\text{-}2SiO_2\text{-}3H_2O + Ca(OH)_2$

The precipitation reaction (C) of calcium phosphate apatite is as follows:

- $7Ca(OH)_2 + 3Ca(H_2PO_4)2 \rightarrow Ca10(PO_4)6(OH)_2 + 12H_2O$

Synchronized Hydraulic Condensation

The technique with this material is quite straightforward. Simply remove the syringe cap from the EndoSequence BC Sealer syringe. Then attach an Intra Canal Tip of your choice to the hub of the syringe. The Intra Canal Tip is flexible and can be bent to facilitate access to the root canal. Also, because the particle size has been milled to such a fine size (less than 2 microns), a capillary tip (such as a 0.012) can be used to place the sealer. Following this procedure, insert the tip of the syringe into the canal no deeper than the coronal one third. Slowly and smoothly dispense a small amount of EndoSequence BC Sealer into the root canal. Then remove the disposable tip from the syringe and proceed to coat the master gutta-percha cone with a thin layer of sealer. After the cone has been lightly coated, slowly insert it into the canal all the way to the final working length. The synchronized master gutta-percha cone will carry sufficient material to seal the apex.[10]

The precise fit of the EndoSequence gutta-percha master cone (in combination with a constant taper preparation) creates excellent hydraulics and, for that reason, it is recommended that the practitioner use only a small amount of sealer. Furthermore, as with all obturation techniques, it is important to insert the master cone slowly to its final working length. Moreover, the EndoSequence System is now available with bioceramic coated gutta-percha cones. So in essence, what we can now achieve with this technique is a chemical bond to the canal wall, as a result of the hydroxyapatite that is created during the setting reaction of the bioceramic material and we also have a chemical bond between the ceramic particles in the sealer and the ceramic particles on the bioceramic coated cone.

Tips for Using Bioceramic Sealer[11]

- **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). 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 is potentially 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 apexifications with bioceramics:** Apexification procedures are a great indication for bioceramics. There are two methods that can work well. The first is to use the syringeable 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 back-filled with the syringeable root repair material.
- **Use bioceramics as a retrofilling material:** Retrofills 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 flow ability and excellent radio capacity. 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 retreatable 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 retreatability of bioceramics.[12] 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 premixed cement for both permanent root canal repairs and apico retrofillings. 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 BioAggregate (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: • Easier to use and place than previous similar products. • Good dispenser (tip/syringe) for easy dispensing. • Radiopaque. • Mulitple uses for a variety of clinical conditions. • 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

Bioceramics have been of use not only to endodontics but also for surgical and prosthodontic 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.[2]

References

1. Hench LL. The story of bioglass. J Mater Sci Mater Med. 2006;17: 967–78.
2. Jain P, Ranjan M. The rise of bioceramics in endodontics: A review. Int J Pharm Bio Sci. 2015 Jan; 6(1): 416 – 22.
3. Koch K, Brave D. A new day has dawned: The increased use of bioceramics in endodontics. Dentaltown 2009:39-43.
4. Best SM , Porter AE, Thian ES , Huang J. Bioceramics: Past, present and for the future. J Eur Ceram Soc. 2008: 1319–27.
5. Dubok VA. Bioceramics ¾ Yesterday,today and tomorrow. Powder Metallurgy and Metal Ceramics. 2000;39:7-8.
6. Hench L. Bioceramics: From Concept to Clinic. J. Am. Ceram. Soc. 1991; 74(7):1487-510.
7. Hickman K. Bioceramics. Internet (Overview) April 1999 (http://www.csa.com/discoveryguides/ archives/bceramics.php)
8. Koch KA, Brave DG, Nasseh AA. Bioceramic technology: closing the endo-restorative circle, Part I. Dent Today. 2010;29:100-5.
9. Richardson IG. The calcium silicate hydrates. Cement and Concrete Research. 2008;38:137–58.
10. Koch K , Brave D. Bioceramic technology — the game changer in endodontics. Endodontic Practice US. 2009;12:7–11.
11. Koch K, Brave D. Ten tips for using bioceramics in endodontics. Dentaltown. 2010;10:94-6.
12. Friedman S , Moshonov J, Trope M. Residue of gutta percha and a glass ionomer sealer following root canal retreatment. Intl. Endo. Jour. 1993 May; 26(3):169–72.