A New Day Has Dawned

The Increased Use of Bioceramics in Endodontics

by Drs. Kenneth Koch and Dennis Brave

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.

Before we specifically address bioceramics in endodontics, we need to examine bioceramic technology itself. What are bioceramics? 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, and radiotherapy glasses.[1,2,3]

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Bioceramics are widely used for orthopedic applications (such as joint or tissue replacements), for coatings to improve the biocompatibily of metal implants, and can function as resorbable lattices which provide a framework that is eventually dissolved as the body rebuilds tissue.[4]

The properties associated with bioceramics are very attractive to both medicine and dentistry. In addition to being non-toxic, bioceramics can be classified[1-3,8] as:

- **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.

There are numerous bioceramics currently in use in both dentistry and 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.[3] Additionally, porous ceramics such as calcium-phosphate-based materials have been used for filling bone defects. Also, some calcium silicates (MTA (Tulsa Dentsply) and Bioaggregate (DiaDent) have been used in dentistry as root repair materials and for apical retrofills.

However, we must ask ourselves again, "What are the advantages of bioceramics in dental applications?" Clearly the first answer is related to physical properties. Bioceramics are exceedingly biocompatible, non-toxic, do not shrink and are chemically stable within the biological environment. Secondly (and this is very important in endodontics) bioceramics will not result in an inflammatory response if an over fill occurs during the obturation process or in a root repair. A further advantage of the material itself is its ability to form hydroxyapatite and to create a bond between dentin and the appropriate filling materials.

While the properties associated with bioceramics make them very attractive to dentistry, in general, what would be their advantage if used as an endodontic sealer? From our perspective as clinicians, some of the advantages are: enhanced biocompatibility, potential increased strength of the root following obturation, high pH (12.9) during the setting process which is strongly anti-bacterial, sealing ability, and ease of use.

The introduction of EndoSequence BC Sealer (Brasseler USA, Savannah, Georgia) 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. To better understand the use of EndoSequence BC Sealer, we need to start with the design concept.

Design Concept:

EndoSequence BC Sealer has been designed as a non-toxic hydraulic calcium silicate cement that is easy to use as an endodontic sealer. Among the attributes of BC Sealer are improved convenience and delivery, and the advantage of utilizing the water inherent in the dentinal tubules to drive the hydration reaction (of the material) thereby shortening the setting time. Dentin is composed of approximately 20 percent (by volume) water[5] and it is this water that causes the material to set.

For clinical purposes, the advantages of a premixed endodontic cement (sealer) should be obvious. In addition to saving time and added convenience, one of the major issues associated with the mixing of any cement (or sealer) is an insufficient and non-homogenous mix. Such a mix could ultimately compromise the benefits of the material. Therefore, BC Sealer has been designed as a premixed bioceramic sealer that hardens only when exposed to a moist environment such as the dentinal tubules.

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 (HAP) and water. The newly formed compound of hydroxyapatite is a non-toxic, bone repair and reconstruction material. 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 as following:

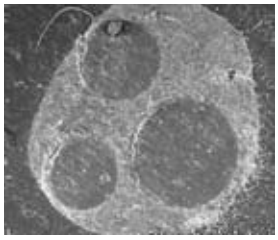
The hydration reactions (A, B) of calcium silicates can be approximated as follows:[6]

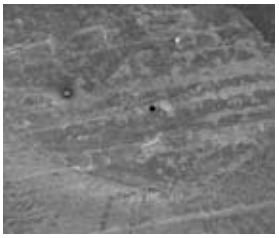
(A) $2[3CaO \cdot SiO_2]+6H_2O \rightarrow 3CaO \cdot 2SiO_2 \cdot 3H_2O+3Ca(OH)_2$

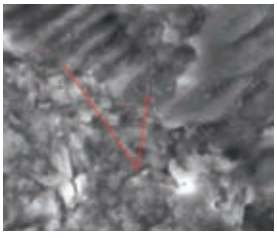
(B) $2[2CaO \cdot SiO_2]+4H_2O \rightarrow 3CaO \cdot 2SiO_2 \cdot 3H_2O+Ca(OH)_2$

The precipitation reaction (C) of calcium phosphate apatite is as follows:[7]

(C) $7Ca(OH)_2+3Ca(H_2PO_4)_2 \rightarrow Ca_{10}(PO_4)_6(OH)_2+12H_2O$







Review:

The nanocomposite structures of calcium silicate hydrate gel and hydroxyapatite in EndoSequence BC Sealer are formed by the hydration reactions of calcium silicates and the precipitation of hydroxyapatite.

Furthermore, this sealer utilizes the water that is naturally inherent in the dentinal tubules to drive the hydration reaction of the calcium silicates (after the sealer is placed into the root canal). EndoSequence BC Sealer will absorb the water from the dentinal tubules, which will speed up the hydration reaction and thereby reduce the overall setting time.

SEMs and Images:

1. Gutta percha & BC sealer
2. BC sealer only
3. Intertubular BC sealer

Clinical Properties:

Working Time:
No mixing is required as EndoSequence BC Sealer comes premixed in a syringe. It can be introduced immediately into the canal and its working time is approximately four hours at room temperature. This does not need to be stored in a refrigerator and its shelf life is two years.

Setting Time:
The setting time is four hours (according to ISO 6876:2001) but can be extended in overly dry canals.

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

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 to the root canal prior to obturation. Furthermore, the pH during the setting process is very alkaline (pH 12.9) which increases its bactericidal properties. This is a particularly important property to possess when a cement is being used an endodontic sealer and is considered an important physical property.[9]

Delivery method:
The delivery method of this system is unique. Due to its small particle size, BC Sealer can be extruded through a very small capillary tip or cannula. The delivery system is so precise that one can actually write their name, in script, with this system.

Retreatment:
Conventional retreatment techniques can be used for the removal of this sealer when used in combination with gutta percha. Piezo electric Ultrasonics (with water spray) may also be used and provide an additional benefit.

The advantage of EndoSequence BC Sealer compared to other bioceramic materials: The major advantage of BC Sealer is that its main components are calcium silicate and hyroxyapatite. Therefore, BC Sealer is not only biocompatible, it is also bioactive. Furthermore, its sealing ability and the ease of use further distinguish it from other sealers.

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Directions for Use:

1. Prior to the application of EndoSequence BC Sealer, thoroughly prepare and irrigate the root canal system 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. **Figure 1:** 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 (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 technique, it is important to insert the master cone 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 compaction, and remove any excess sealer with a moist cotton ball or swab.
6. 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 close it. Store the pouch in a dry area at room temperature.

Rationale for a new sealer:

As obturation techniques continue to evolve, we will be witness to less heated gutta percha techniques. This reasoning is straight forward as heated gutta percha shrinks when cooled. Endodontics (as a specialty) will be presented with the unique challenge of creating better obturation techniques, which are more user-friendly. If a greater number of skilled practitioners (who can perform excellent endodontics) is not established, we will likely see an increased use of dental implants in cases where the preferred treatment should be endodontic therapy.

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Summary:

EndoSequence BC Sealer is a premixed bioceramic endodontic sealer that requires no mixing. It comes in an easy to use syringe, with a tip small enough to enter the most difficult canals. Furthermore, it does not set until it is water activated. Consequently, when BC Sealer is placed in the root canal, the material absorbs water from the dentin tubules causing a hydration reaction of the dicalcium silicate and tricalcium silicate. At the same time, calcium phosphate reacts with calcium hydroxide to precipitate hydroxyapatite and water.

Fig. 1

Fig. 2

This water continues to be used for the hydration of the calcium silicates and leads to the formation of a composite network of gel-like calcium silicate hydrate, which intimately mixes with the hydroxyapatite bioceramics, and forms a hermetic seal inside the root canal. Subsequently, the water supplied through this dynamic reaction contributes to the hydration reaction, the setting of the material itself, and its final physical properties. The net result is an excellent obturation technique that is easy to use and can, in fact, be used very predictably with a single cone technique.

Figure 1: Box of EndoSequence BC Sealer

Figure 2: Curved intra canal tip entering tooth in the coronal 1/3rd

Case 1: 4 canal mandibular molar (courtesy of Dr. Ali Nasseh)

Case 2: 3 rooted bicuspid (courtesy of Dr. Ali Nasseh)

Case 3: Mandibular molar with large curve on mesial (courtesy of Dr. Ali Nasseh)

Case 4: Retreatment of BC Sealer case (courtesy of Dr. Ali Nasseh)

Case 5: Maxillary molar with palatal delta (courtesy of Dr. Alex Fleury) ■


Case 1


Case 2


Case 3


Case 4


Case 5

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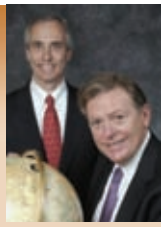
Authors' Bios



Dr. Dennis Brave is a diplomate of the American Board of Endodontics, and a member of the College of Diplomates, Dr. Brave received his DDS degree from the Baltimore College of Dental Surgery, University of Maryland and his certificate in Endodontics from the University of Pennsylvania. He is an Omicron Kappa Upsilon Scholastic Award Winner and a Gorgas Odontologic Honor Society Member. In endodontic practice for more than 25 years, he has lectured extensively throughout the world and holds multiple patents, including the VisiFrame. Formerly an associate clinical professor at the University of Pennsylvania, Dr. Brave currently holds a staff position at The Johns Hopkins Hospital. Along with having authored numerous articles on Endodontics, Dr. Brave is a co-founder of Real World Endo.

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