Bioceramic Technology: Closing the Endo-Restorative Circle, Part 2

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This is part 2 of a 2-part article series. Part 1 of Drs. Koch, Brave, and Nasseh's article was published in the February 2010 issue of Dentistry Today *and can be found in our archived articles at dentistrytoday.com. This, and all future articles that are presented in multiple parts, will now be available to our readers for review in their entirety at our Web site, dentistrytoday.com. This is being done to help those readers who may have missed a portion of any multiple-part article, and will also facilitate the ability to review a complete article in its entirety for others.*

In Part 1, we introduced the reader to the benefits of bioceramic technology in endodontics. Additionally, the physical properties of bioceramics were discussed along with a thorough description of the bonding that occurs between the bioceramic sealer (EndoSequence BC Sealer [Brasseler USA]) and the canal wall. A further case was made for establishing synchronicity between the canal preparation and the ultimate fit of a master cone. Part 1 concluded with a detailed description of how to properly use a bioceramic sealer in a one-cone obturation technique.

A "ONE-CONE" TECHNIQUE: WHAT DOES THIS REALLY MEAN?

EndoSequence BC Sealer used in combination with Activ GP cones (or the new bioceramic coated cones) creates an excellent one-cone obturation technique. But, when we talk about a true one-cone technique, what does this really mean? The easiest way to comprehend this is to compare a one-cone technique to obturator based methods. But let's begin by examining the concept of obturator-based obturation.

An endodontic obturator (Thermafil [DENTSPLY], GTX Obturators [DENTSPLY], OneFill [Guidance], RealSeal [SybronEndo]) is a plastic rod, with an attached handle (which in combination is known as a carrier) that has either gutta-percha or Resilon attached to it. The first obturator introduced and clearly the most commercially successful was Thermafil. While Thermafil received notable criticism (when introduced) from the endodontic community, it has continued to enjoy some popularity among general practitioners. It is reported that very few endodontists use or would recommend solid core obturation. In fact, in a recently published abstract in the *Journal of Endodontics* (March 2009), it was stated that, "in a survey of Board-Certified Endodontists and dental school educators, 96.4% indicated that they do *not* currently use a carrier based obturation system in their practice." Furthermore, "80% of respondents indicated that they do *not* teach carrier-based obturation to their students. Reasons for not teaching carrier-based obturation included: difficult to remove, difficult to make post space and *not predictable*."[1] However, while many of our endodontic colleagues continue to view Thermafil in a harsh light, it does have significance from a historical perspective. We believe endodontic obturators were an attempt to make endodontic obturation easier and therefore, root canal treatment more accessible to the general practitioner (Figure 1).

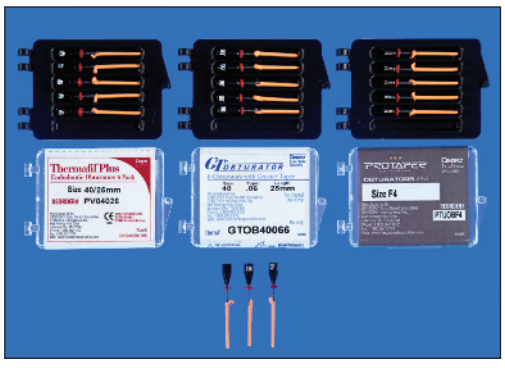

Figure 1. Various carrier-based systems.

Part of the success of a carrier-based system is that it gives the dentist something solid to "feel" during the obturation process. This "feeling" is marketed as an increased tactile awareness and therefore, greater control of the procedure. However, in reality, while the practitioner may feel in greater control, quite often he or she has no idea where the heated gutta-percha or heated Resilon is going. (Not to mention where the sealer is going that is pushed ahead of the melted core material.) Nonetheless, the idea of having something to hold and feel is noteworthy. But let's think what is actually occurring with an obturator technique. If you are using such a system, here is what you are doing. You are using a plastic carrier to deliver heated gutta-percha or heated Resilon into the root canal system. Yes, the material will flow, but when it cools, the gutta-percha will shrink.

But let us contemplate, "What actually seals a root canal?" Of course, it is the sealer, not the gutta-percha. This is why they call it sealer. What does the gutta-percha do? It takes up space and provides a mechanism to deliver the sealer. The problem has always been that we did not have dimensionally stable sealers (and the greater their bulk in the canal, the less stable they were). What if we had a sealer that was dimensionally stable (would not shrink) and was biocompatible, bioactive and antibacterial, and could be delivered into the root canal system with a room temperature gutta-percha cone that would also not shrink when placed (no heat required). Would you want to use it?

The next level of obturation is now available. Utilizing a synchronized gutta-percha cone (or a stiffer ceramic coated gutta-percha cone) to deliver a dimensionally stable bioceramic sealer (into the root canal) which is antibacterial, biocompatible, and does not resorb, is a clear advancement over solid core (plastic) obturators. But, when we talk about a true one-cone technique, let's think about what this really means. The easiest way to comprehend this is to again compare a synchronized one-cone technique to carrier based methods. Recently, many in the endodontic community have come to the conclusion that excessive coronal enlargement (of the radicular dentin) can adversely affect the long-term prognosis of a tooth. While various thermoplastic techniques have contributed to the problem of over-enlargement of the radicular dentin (and subsequent weakening of the tooth), the use of carrier-based obturation has also resulted in wider than ideal orifice enlargement. The rationale behind this is quite simple. The larger the hole at the top of the canal, the less likely it is to strip (denude) the carrier of gutta-percha (or Resilon). This has been one of the challenges associated with carrier based obturation (stripping the carrier at the orifice during insertion).[2] This is why it frequently takes multiple tries and more than one obturator to fill a canal in a posterior tooth.

As previously mentioned, one can cer-

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tainly get good obturation results with carrier-based techniques (as with other methods) if done properly, but this issue of stripping a carrier remains a significant one in endodontics. In a recent article, it has been suggested that, "The solution to this problem is not difficult, it's just technique sensitive."[3] We will ask you to be the judge of that. Let it be said again that the concept of filling a root canal with a device that you can "feel" makes sense. It is essentially the same with a synchronized cone and BC Sealer, but with a few significant differences. Again, think about what you are doing. You are, in essence, using a stiff carrier (but one that is actually a stiffer gutta-percha cone, *not* a plastic carrier) to deliver a stable, adhesive bioceramic sealer into the root canal system. So while you get the "feel" of a carrier based technique, you have the advantage of using gutta-percha as a carrier to deliver the sealer. After all, it is the sealer that creates the seal in obturation, not heated gutta-percha (which shrinks significantly when cooled).[4] A quick review of the bioceramic one-cone technique and then a comparison of some specific concepts will make the differences (and ultimately the evolution) between carrier based obturation and one-cone bioceramic technology more evident.

EndoSequence BC Sealer and gutta-percha as a synchronized, adhesive endodontic obturation technique utilizes a constant taper preparation and matching gutta-percha cones to facilitate predictable endodontic outcomes. Following cone selection (utilizing the same size master cone as the last instrument to working length), you attach a tip of choice to the bioceramic syringe, insert the tip into the canal no deeper than the coronal third and slowly dispense a small amount of the premixed sealer into the canal while simultaneously backing the syringe out of the canal. Now, using a No. 15 hand file, or something comparable (such as the master cone), proceed to lightly coat the 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 this into the canal, taking it all the way to its final working length. The precise fit of the EndoSequence master cone (gutta-percha or ceramic coated cone) in conjunction with a constant taper preparation creates excellent hydraulics that will move the nonshrinking bioceramic sealer into webs, fins, and lateral canals (Figures 2 and 3).[5] Think about what we have accomplished. The silicate components in the bioceramic sealer bond to the ceramic coated (or Activ GP) cones and, at the same time, we have created a bond to the canal wall as a result of the hydroxyapatite that is generated during the setting reaction of the bioceramic sealer. As a result of this bonded obturation, and the ease associated in achieving it, we can now state that the restoration of the endodontically treated tooth truly begins at the apex.

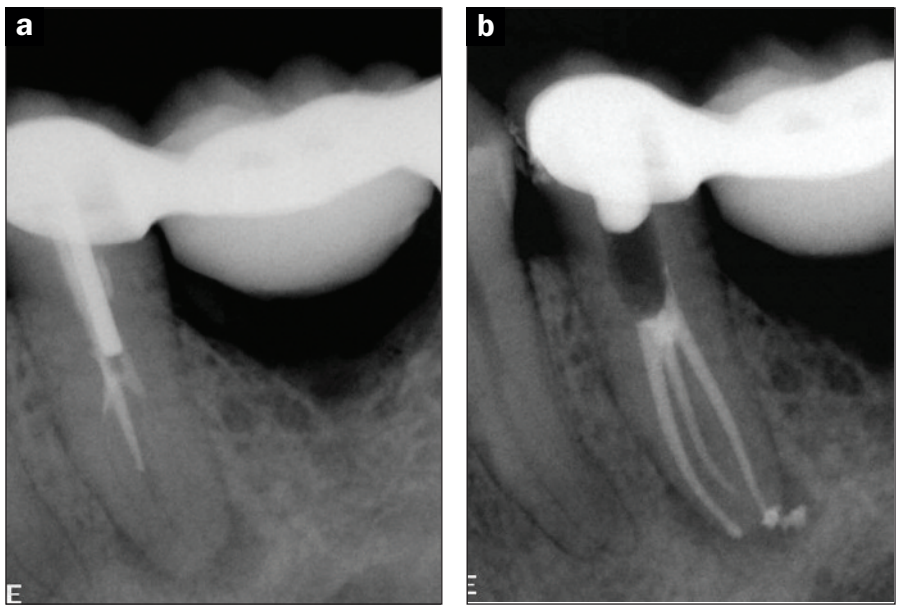

Figure 2. Conventional retreatment case completed with bioceramic obturation technique: **(a)** pre-op x-ray, and **(b)** post-op x-ray. (Case courtesy of Dr. Brad Trattner.)

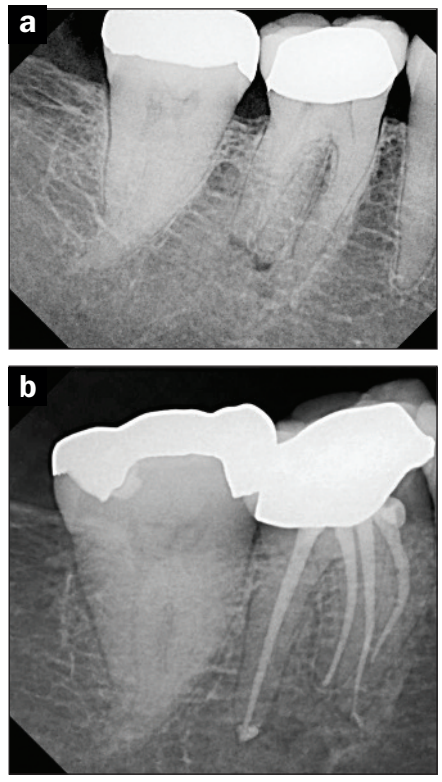

Figure 3. Conventional case completed with one cone bioceramic technique: **(a)** pre-op x-ray and **(b)** post-op x-ray.

COMPARISON OF CARRIER-BASED OBTURATION VERSUS BIOCERAMIC ONE-CONE TECHNIQUES: PLASTIC CARRIER VERSUS ONE-CONE

When filling a root canal system, utilizing an obturator-based technique, you are totally dependent upon the plastic carrier not being denuded of gutta-percha. The solid plastic carrier has the inherent risk of being stripped when inserted into the canal. This usually occurs up high, right at the orifice. This is also very difficult to determine radiographically; whether or not the plastic carrier has been stripped of gutta-percha or Resilon. A one-cone technique, on the other hand, employs a stiff gutta-percha cone or a stiff ceramic-coated gutta-percha cone. In either case, if some of the sealer accidentally gets removed during the obturation process, you still have gutta-percha remaining, not a plastic carrier. Also, when utilizing gutta-percha rather than the "medical grade" plastic associated with obturators, you do not have to overly enlarge the orifice.

The proposed benefits of obturators were that they gave dentists a seemingly easier way to fill a root canal. For this concept alone, solid core obturators need to be recognized. However, how much easier can a technique be than a room temperature, one-cone technique that utilizes an adhesive sealer?

POST PREPARATION

Post preparation with any solid core technique, such as a plastic obturator, has some very significant challenges. We really don't need to discuss the challenges, but more simply ask, "What would you rather make a post preparation in: gutta-percha or plastic?" For even those diehard obturator dentists, we recommend for those canals which will require a post, that a gutta-percha cone technique be used. As mentioned in a recent article discussing obturators and post preparation, "Finally, beware of a manufacturer's recommendation that their post drill (especially the one with an asymmetric tip) is safe to cut out carriers as they make the post space. We know several talented dentists who have used this method and have inadvertently caused a lateral root perforation with one of these drills."[3]

Additionally, we would like to mention that the EndoSequence technique has a matching post system that solves the problem inherent in the discrepancy found between the final canal shape and available post sizes (and shapes) for most post systems (Figure 4). Here is a solution: The EndoSequence rotary file creates a fully tapered preparation (.04 or .06) from orifice to apex. The corresponding paper points and gutta-percha cones are laser verified to precisely match the final canal shape (last instrument used to length). The EndoSequence post system now goes one step further and is likewise tapered (.04 or .06) to match the exact shape of the instrumented canal. Because of the synchronicity that has been established, there is no need to alter the shape of the root canal preparation to match the post. In a sense, the last rotary file taken to length is acting as a post drill. This concept has also been addressed in a recent article by Dr. Richard Trushkowsky[6] when he wrote, "The ideal post should have the same shape as the endodontic preparation, and should be noncorrosive, readily adjusted, and able to be removed without difficulty." Furthermore, since the dual-cured resin cement that is used to bond the EndoSequence post to the canal wall is also the same material used to create the buildup (EndoSequence Build-up), one can think of this technique as an intra-radicular core buildup with a rebar. Not only is this "post technique"

Figure 4. EndoSequence post system.

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easy to replicate, it is kinder to the tooth and, most importantly, it is safer.[7]

RETREATMENT OF OBTURATOR-BASED TECHNIQUES VERSUS ONE-CONE

Yes, we know you have heard from your endodontist about the difficulties of retreating obturator cases. It can be challenging! Granted, some companies are now doing a lot of marketing about "how easy" it is to retreat carrier-based obturation. However, once again, we would ask you to be the judge of that. Bioceramic sealer cases are definitely retreatable, yet the

Figure 5. EndoSequence Root Repair Material (RRM) (syringe).

Figure 6. EndoSequence RRM (putty).

issue of retreating these cases has been subject to misinformation. In actuality, retreatment of a bioceramic one-cone technique is quite easy. However, the key to facilitating retreatment is using bioceramics as a sealer, not a filler. (Gutta-percha remains a core component of the obturated root canal.) 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 expediting retreatment). The following is our recommended technique for retreating bioceramic one-cone cases.

The technique itself is straightforward. A real asset 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 half 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 (generally chloroform, although xylol is acceptable) and switch over to an EndoSequence file (No. 30 or 35 /.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 to 3 mm and then follow the gutta-percha removal with a rotary file(s), used to the working length.[2]

COST AND EASE OF USE

Cost certainly should never be the reason why you choose or choose not to use a given system or technique. That said, we want you to always employ a technique that provides great results that you can reproduce time after time (ease of use). This is the key, regardless of the cost factor. But, in case you were wondering, a bioceramic coated gutta-percha cone is about 91 cents, and a solid core obturator is...well, you tell us![8]

PEDIATRIC APPLICATIONS AND OPEN APICES CASES

One of the great benefits of new bioceramics premixed in a syringe (EndoSequence Root Repair Material [RRM]) is the ability to treat many young patients in need of pulp caps or other pulpal therapies (eg, pulpotomies). Previously, many specialists considered MTA to be the ideal material for a direct pulp cap because it did not seem to engender a significant inflammatory response in the pulp. Unfortunately, due to price concerns, this methodology was not universally accepted. However, we now have a true bioceramic material (ESRRM) that comes pre-mixed in a syringe (stored at room temperature) and costs far less per application (Figure 5). Hopefully, this will lead to an increased use of bioceramics in our pediatric patients.

The technique 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.

The bioceramic root repair material in the syringe is slightly different

Figure 7. Retrofill cone made with EndoSequence RRM putty.

from the basic BC Sealer. The RRM has a higher MPa strength and, as a result of its slightly larger particle size (2 µm), it sets more quickly (2 hours). However, this material finds many indications for use in both surgical endodontics[9] as well as open apices cases.

SURGICAL APPLICATIONS OF BIOCERAMICS IN ENDODONTICS

As previously mentioned, the bioceramic material to use in surgical cases is the RRM. The RRM is available in two different modes. There is a syringeable RRM (very similar to the basic BC Sealer in its mode of delivery) and there is also a RRM-putty that is both stronger and malleable (Figure 6). The RRM in a syringe is obviously delivered by a syringe tip, but the technique associated with the putty is different.

When using the putty, simply remove a small amount from the room temperature jar and knead it for a few seconds with a spatula or in your gloved hands. Then start to roll it into a hotdog shape. This is very similar to creating similar shapes with desiccated ZOE or SuperEBA (Bosworth). Once you have created an oblong shape, you can pick up a section of it with a sterile instrument and use this to deliver it where needed. This is an easy technique for perf repairs, resorption defects and even for apico retro fills. After placing the putty into the apical preparation (or defect), simply wipe with a moist cotton ball and finish the procedure (Figure 7).

The following surgical case demonstrates the use of bioceramics in a mandibular molar (Figure 8).

FUTURE DIRECTIONS OF BIOCERAMIC TECHNOLOGY

We can fully expect to see, in the future, the expansion of bioceramic technology into multiple aspects of endodontic treatment. Currently, we see its use in surgical endodontics as well as its use as a sealer in one-cone obturation techniques. However, we can anticipate the use of bioceramic technology to have multiple variations in obturation, whether as a sealer, as a material to be extruded from a gun-like device and (we anticipate) even a bioceramic obturator. In fact, a recently filed provisional patent application seeks the use of bioceramic technology with an obturator or carrier based device. Clearly, for bioceramic technology the challenge between its use as an obturator or as a sealer in a one cone obtuation technqiue will only intensify. The only reason (in our opinion) for a company and its advocates to promote a bioceramic obturator technique over a single cone methodology will be in one word: margin. The good news is that the final decision will be made by you, the clinician.

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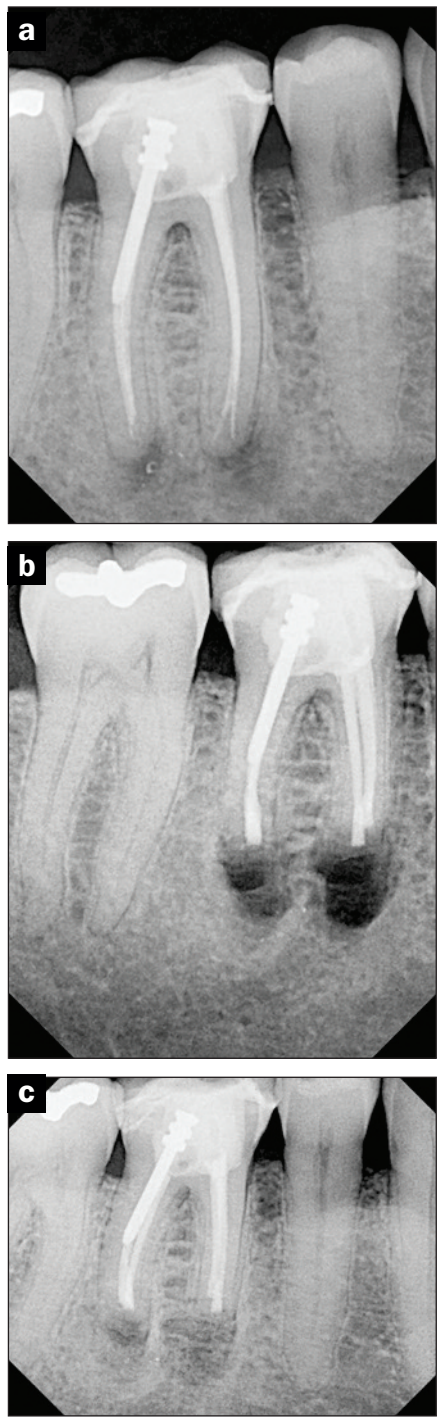

Figure 8. Surgical case demonstrating the use of bioceramic technology: **(a)** pre-op x-ray, **(b)** completed case, and **(c)** 4-month recall (incredible healing for such a short period of time). (Case courtesy of Dr. Ali Nasseh.)

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SUMMARY: HOW HAS THE USE OF BIOCERAMIC TECHNOLOGY CLOSED THE ENDO-RESTORATIVE CIRCLE?

Restoration of an endodontically treated tooth should start at the apex. True restorative materials with the ability to bond to dentin are now available to accomplish this objective. The introduction of a user-friendly, room temperature obturation technique that utilizes a constant taper preparation and laser verified gutta-percha, in concert with a new bioceramic sealer (EndoSequence BC Sealer), can be used to achieve this goal.

A one-cone obturation technique that embraces advanced material science and eliminates the need to remove excessive coronal radicular dentin has been described. Contrasts between a bioceramic one-cone technique and the use of endodontic obturators have been drawn. The restoration of the endodontically treated tooth can be further enhanced (when required) by the use of a synchronized post system. A post that matches the last rotary file used to shape the canal prevents the removal of critical radicular dentin and therefore does not weaken the treated tooth.

Endodontic shaping no longer needs to be held hostage to the limitations of cumbersome and technique-sensitive obturation systems. A minimally invasive endodontic technique that is easy to accomplish and utilizes advanced material science has been long overdue.

The game has changed with the introduction of bioceramic technology to endodontics. Saving teeth is now easier than ever before. We should be focused on the retention of the natural dentition, whenever possible, with conservative techniques that enhance the long-term prognosis of the endodontically treated tooth. Thinking once again about saving teeth and all the advantages of maintaining our patients' natural dentition should be our goal. The Endo-Restorative Circle has been closed!✦

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Disclosure: Drs. Koch and Brave are co-developers of the EndoSequence rotary file and EndoSequence BC Sealer/Root Repair Materials, Brasseler USA.

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Disclosure: Dr. Nasseh reports no conflicts of interest.

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