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roots

the international C.E. magazine of endodontics

4 2012

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Using hand files to their full capabilities

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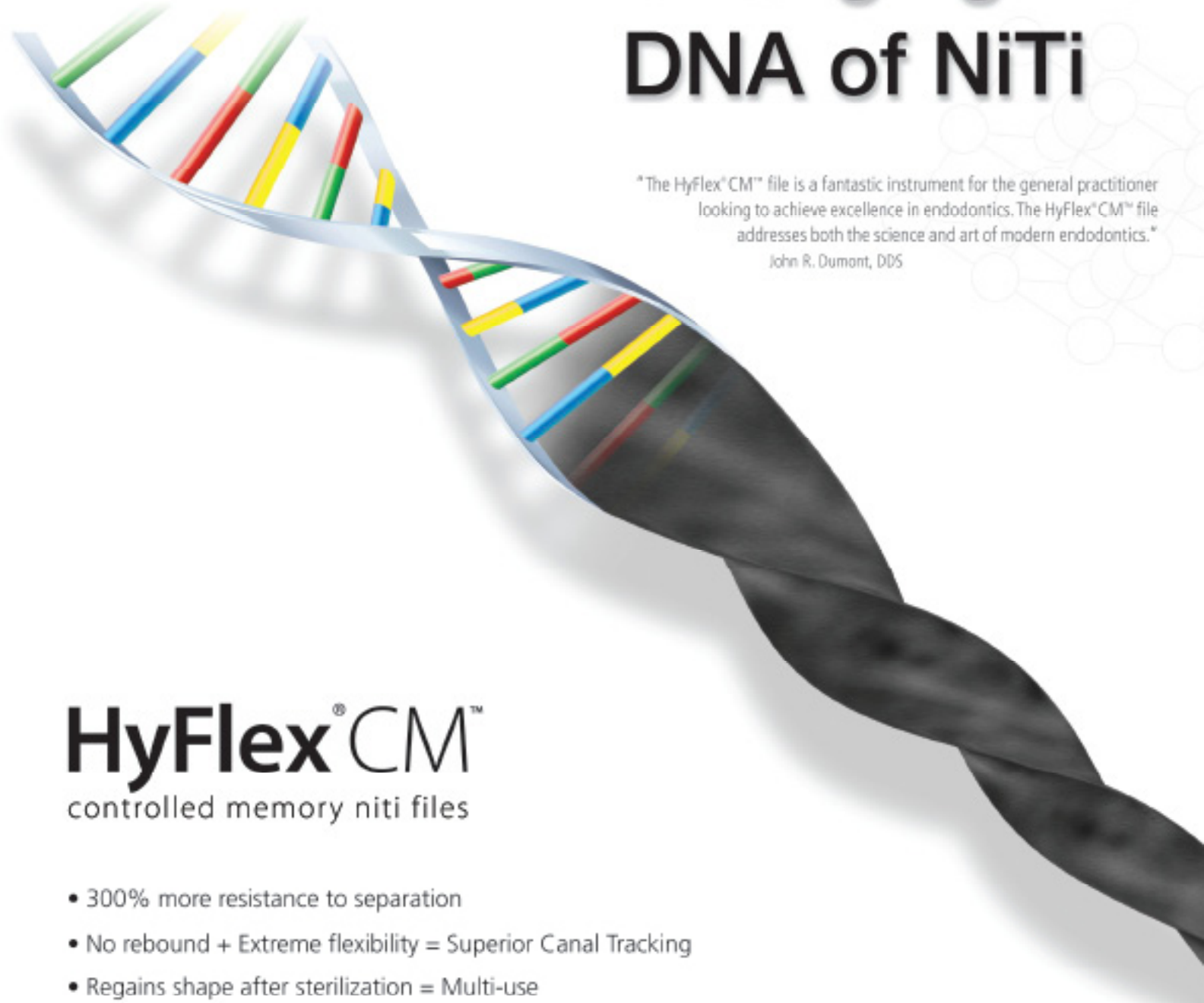

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PATENT PENDING

Stay up on the latest information with *roots*

Fred Weinstein, DMD, MRCD(C), FICD, FACD

Thanks to ever expanding technology, dental professionals are able to treat patients in new and innovative ways. But staying on the cutting edge can be a challenge. That's what makes the publication you are holding right now so valuable.

For this issue of *roots*, we've assembled a collection of articles from some of the most respected names in endodontics. These expert clinicians are sharing their knowledge and expertise with you.

Within this issue you can read reports on using hand files to their full capabilities by Dr. Rich Mounce, and the real state of endodontic instrumentation by Dr. Barry Lee Musikant. In addition, Managing Editor Fred Michmershuizen has written a report on the many offerings for endodontists that were available at the recent ADA meeting in San Francisco.

But there's even more.

Every issue of *roots* magazine also contains a C.E. component. By reading the article on bioceramic technology by Dr. Ken Koch, then taking a short online quiz about this article at *www.DTStudyClub.com*, you will gain one ADA CERP-certified C.E. credit. Keep in mind that since *roots* is a quarterly magazine, you can actually chisel four C.E. credits per year out of your already busy life without the lost revenue and time away from your practice.

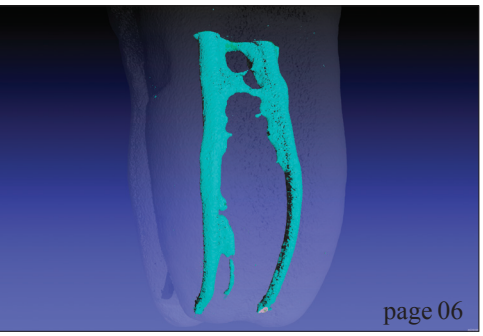
To learn more about how you can take advantage of this C.E. opportunity, visit *www.DTStudyClub.com*. Subscribers to the magazine can take this quiz for free and will be emailed an access code after the magazine's release. If you do not receive the code, please write to *support@dtstudyclub.com*. Non-subscribers may take the quiz for $20. You can access the quiz by using the QR code on page 6.

I know that taking time away from your practice to pursue C.E. credits is costly in terms of lost revenue and time, and that is another reason roots is such a valuable publication.

I hope you enjoy this issue and that you get the most out of it.

Sincerely,

Fred Weinstein, DMD, MRCD(C), FICD, FACD
Editor in Chief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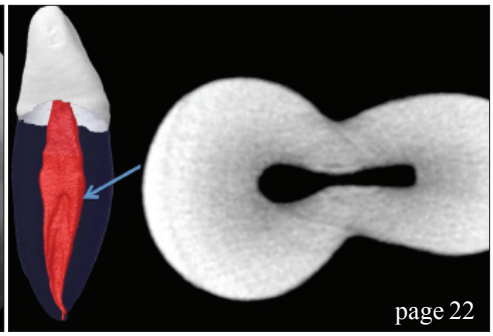
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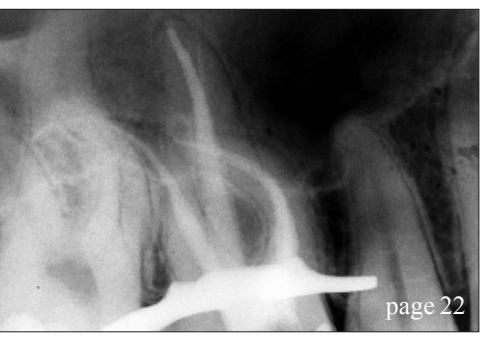
Image courtesy of Real World Endo. Research performed by Dr. Adam Lloyd.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A review of bioceramic technology in endodontics

Authors_ Ken Koch, DMD; Dennis Brave, DDS; and Allen Ali Nasseh, DDS, MMSc

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This article qualifies for C.E. credit. To take the C.E. quiz, log on to *www.dtstudyclub.com*. Subscribers to the magazine can take this quiz for free and will be emailed an access code after the magazine's release. If you do not receive the code, please write to *support@dtstudyclub.com*. Non-subscribers may take the quiz for $20. You can access the quiz by using the QR code below. The quiz will be available on Dec. 2.

_Since bioceramic technology was introduced to endodontics, the response has been exceptional. As more and more practitioners have thought through the process, they have been able to see not only the clear benefits of this technology in endodontics, but they are now asking how this technology can be applied to other aspects of dentistry. The application of bioceramic technology has not only changed endodontics both surgically and non surgically, it has also begun to change the way we treatment plan our patients. As a result of bioceramic technology, we now have the ability to save more teeth in a predictable fashion, while, in addition, improving their long-term prognosis. The option of "saving the natural dentition" is now back on the table.

However, before we investigate specific techniques, we must first ask ourselves, "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.[1,2]

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.

It is important to understand the specific advantages of bioceramics in dentistry and why they have become so popular. Clearly the first reason is related to physical properties. Bioceramics are exceedingly biocompatible, non-toxic, do not shrink, and are 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.

A further advantage of the material itself is its ability (during the setting process) to form hydroxyapatite and ultimately create a bond between dentin and the filling material. A significant component of improving this adaptation to the canal wall is the hydrophilic nature of the material. In essence, it is a bonded restoration. However, to fully appreciate the properties associated with the use of bioceramic technology, we must understand the hydration reactions involved in the setting of the material.

_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 foloows:

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

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

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

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

For clinical purposes (in endodontics), the advantages of a premixed 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 non-homogenous mix. Such a mix may ultimately compromise the benefits associated with the material. Keeping this in mind, a new premixed bioceramic sealer has been designed that hardens only when exposed to a moist environment, such as that produced by the dentinal tubules.[3]

But, what is it specifically about bioceramics that make them so well suited to act as an endodontic 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); they are hydrophilic, not hydrophobic; they have enhanced biocompatibility; they do not shrink or resorb (which is critical for a sealer-based technique); they have excellent sealing ability; they set quickly (three to four hours); and they are easy to 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 possible only because of recent nanotechnology developments; the particle size of BC Sealer is so fine (less than two microns), it can actually be delivered with a 0.012 capillary tip (Fig. 1).

This material has been specifically designed as a non-toxic 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 percent (by volume) water, and it is this water that initiates the setting of the material and ultimately results in the formation of hydroxyapatite.[4] 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 canal walls also contribute to its excellent hydraulics. But there is another aspect to sealer hydraulics. That is the shape of the prepared canal itself.

Actually, it all begins with the file. To be more specific, it all begins with the specific preparation created by the file — a constant taper preparation. When using the EndoSequence technique, we can create either a 0.04 constant taper preparation or a 0.06 taper. The real key

Fig. 1_The particle size of BC Sealer is so fine (less than two microns), it can actually be delivered with a 0.012 capillary tip. (Photos/Provided by Real World Endo)

is the constant taper preparation, because when accomplished it now gives us the ability to create predictable, reproducible shapes. A variable taper preparation is not recommended because its lack of shaping predictability (and its corresponding lack of reproducibility) will lead to a less than ideal master cone fit. This lack of endodontic synchronicity is why all variable taper preparations are associated with the overly expensive and more time consuming thermoplastic techniques.

Knowing in advance what the final shape (constant taper preparation) will be is a tremendous advantage in creating superior hydraulics. Then add in the feature of laser-verified paper points and gutta-percha cones, and we now start to develop a system where everything matches (true endodontic synchronicity).

This concept of having everything match is so important because it allows us, for the first time, to perform rotary endodontics in a truly conservative fashion and to be able to use a hydraulic condensation technique.

Furthermore, when used in conjunction with the EndoSequence filing system, this becomes a synchronized hydraulic condensation technique. This has tremendous implications for the tooth as evidenced by a recent study published in the Journal of Endodontics.[5] The purpose of this study was to evaluate and compare the fracture resistance of roots obturated with various contemporary filling systems. The investigators (Ghoneim, et al.) instrumented 40 single-canal premolars using 0.06 taper EndoSequence files. The teeth were then obturated using four different techniques. Group I used a bioceramic sealer iRoot SP (IRoot SP is BC Sealer in Europe) in combination with ActiV GP cones (Brasseler USA) while Group II used the bioceramic sealer with regular gutta-percha. Group III utilized ActiV GP sealer plus ActiV GP cones and Group IV employed ActiV G sealer with conventional gutta-percha cones. All four groups were obturated using a single cone technique. Ten teeth were left unprepared and these acted as a negative control for the study.

Following preparation and obturation, all the teeth were embedded in acrylic molds and then subjected to a fracture resistance test in which a compressive load (0.5 mm/min) was applied until fracture. Subsequently, all data was statistically analyzed using the analysis of variance model and the Turkey post hoc test.

The results generated were quite remarkable. It was demonstrated that the significantly highest fracture

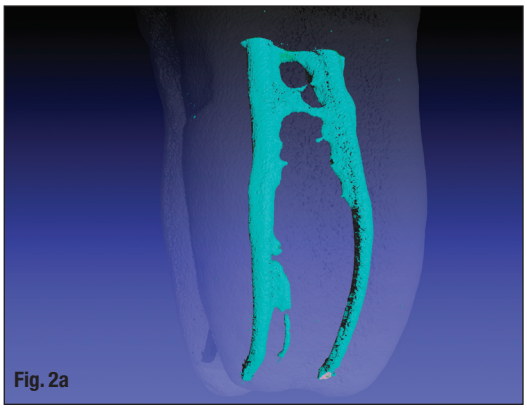

Fig. 2a

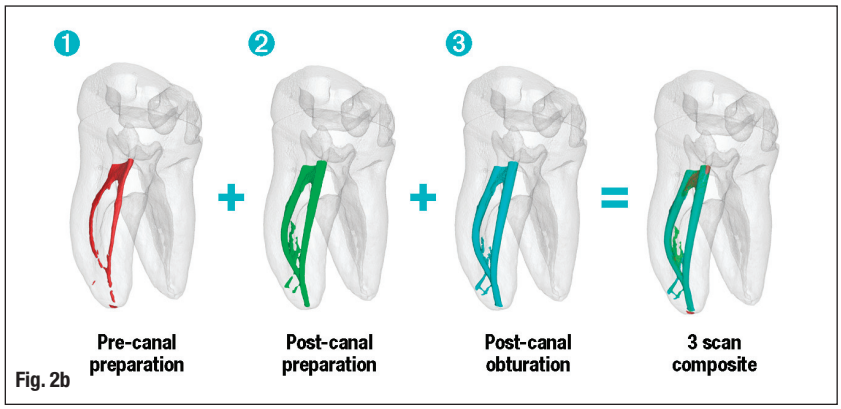

Fig. 2b

Fig. 2a_This image shows the excellent adaption of the bioceramic sealer (and gutta-percha) to the true shape of the prepared canal.

Fig. 2b_A composite image demonstrating the true excellence of the technique.

resistance was recorded for both the negative control and Group I (bioceramic sealer /Activ GP cone) with no statistical difference between them. The lowest reported value was in Group IV, which employed ActiV GP sealer in combination with regular gutta-percha cones.

The conclusion of this study was that employing a bioceramic sealer (such as BC Sealer) is very promising in terms of strengthening the residual root and increasing the in vitro fracture resistance of endodontically treated teeth. This is a very significant finding, especially regarding the long-term retention of an endodontically treated tooth.

In this particular study, the bioceramic sealer performed best when combined with ActiV GP cones. In fact, bonding will occur between the bioceramic sealer and the ceramic particles in the ActiV GP cones as well as to the bioceramic particles present in the new bioceramic coated cones (BC cones). The technique of achieving a true bond between the root canal wall and the master cone (as a result of creating endodontic synchronicity and advanced material science) is known as synchronized hydraulic condensation.

_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.[6]

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.

Think about what we have just accomplished. We are now doing root canals in a manner that truly is easier, faster and better. As further evidence of this technique, we asked Dr. Adam Lloyd, the chairman of the Department of Endodontics at the University of Tennessee, to share the results of a study recently conducted at the University of Tennessee.[7]

_Materials and methods

Sixteen recently extracted human molars were mounted on individual stubs and underwent an initial high spatial resolution CT scan prior to any treatment. Following biomechanical crown-down canal preparation to an apical matrix of 35/0.04 and ultrasonic irrigation with 6 percent sodium hypochlorite, each sample was scanned a second time. Obturation was completed using a single matched gutta-percha cone and EndoSequence BC sealer. The coronal 4 mm of the gutta-percha was thermo-softened and compacted vertically. Subsequent to canal obturation, a third scan was made.

Scanning of the specimens was performed (Actis 150/130, Varian Medical Systems, Palo Alto, Calif.) with a 180-degree rotation around the vertical axis and a single rotation step of 0.9 degree with a cross-sectional pixel size of approximately 24 µm. All three backscatter pro-

Figs. 3a–5c_Cases treated with bioceramics. (Clinical X-rays/Provided by Allen Ali Nasseh, DDS, MMSc)

jections were aligned post-processing with sub-voxel accuracy at 92 percent CI in VG Studio Max 2.1 (Volume Graphics GmbH, Heidelberg, Germany) and manipulated to create regions of interest for each of the scans.

_Results

Analysis of volume occupied by sealer in relation to total original canal volumes was found to be extremely high with a mean of 97 percent ± 2.8, much higher than reported previously using studies on canal surface area occupancy of material, with 75 percent of samples occupied at the ≥ 95 percent level (Figs. 2a, 2b).

While the properties associated with bioceramics make them very attractive to dentistry, in general, what would be their specific advantage if used as an endodontic sealer? From our perspective as endodontists, some of the advantages are: enhanced biocompatibility; possible increased strength of the root following obturation; high pH (12.8) during the setting process, which is strongly anti-bacterial; sealing ability related to its hydophilicity; and ease of use.[8] Furthermore, the bioceramic sealer does not shrink upon setting (it actually expands 0.002 percent) and once it is fully set, the material will not resorb.

The cases pictured in Figures 3a through 5c demonstrate the excellence of this technique.

_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.[8] 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