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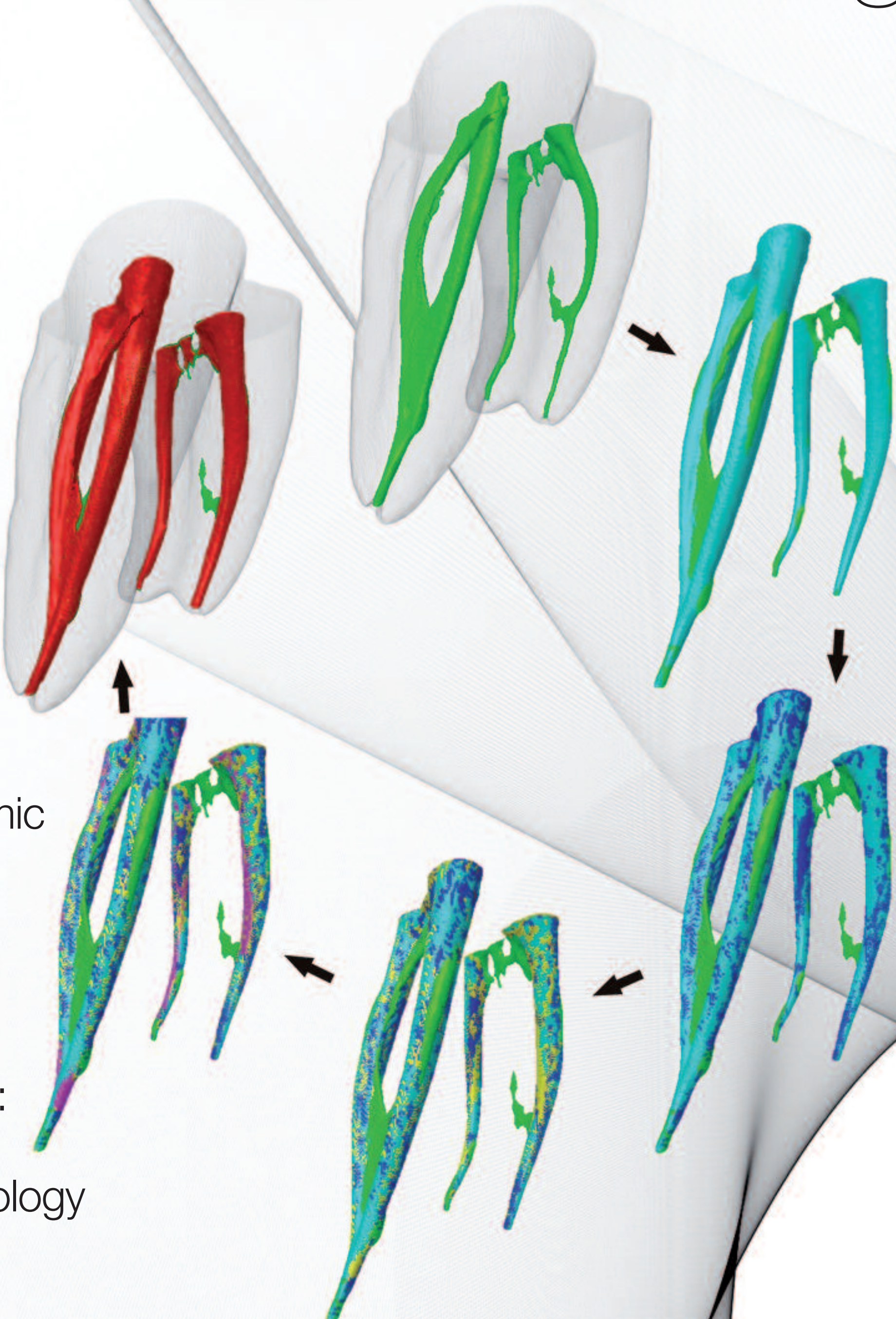

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oemus

Dear Reader,

Prof. Marco Versiani, DDS, MS, PhD

_On 5 March, the Root Canal Anatomy Project (http://rootcanalanatomy.blogspot.com) will have been online for two years. This project was conceived in the Laboratory of Endodontics of the University of São Paulo, Brazil. During this time, the blog has registered over 210,000 visitors from 161 countries and the videos have been watched more than 50,000 times. Considering that root-canal anatomy is a specific subject in dentistry, we believe that our aim is being achieved.

The original goal of this project was the development and availability of non-commercial educational resources in the endodontic field for educators, scholars, students, clinicians and the general public. The main purpose is to demonstrate the complexity of the root-canal system in different groups of teeth and the limitations of some procedures related to endodontic therapy. In a world where 3-D entertainment rules, it is unthinkable that dentists, dental students and patients are still being educated using only 2-D models such as radiographs and photographs. The project emphasises the importance of animated images of the internal anatomy of the teeth in the educational process.

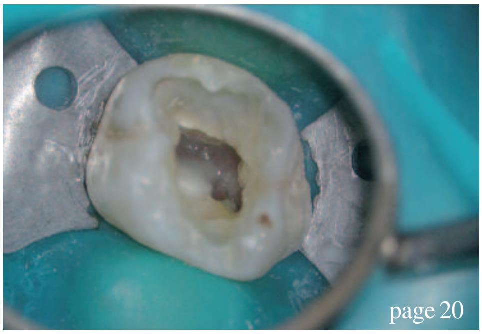
People have asked me why the content of this project has not yet been commercialised. Basically, there are two reasons for this. The first one is that the technology and training of our staff were only possible because of a government sponsorship. So the government believed in our project and public money was granted in order to develop our idea. It is thus only fair to make the project content available in the form of free educational material.

The second reason has been guided by the following: dividing to multiply. Since the blog first went online, the number of people who appreciate and respect our work has increased exponentially. I have been invited to travel worldwide to talk about this project and had the unique opportunity to experience other cultures and met amazing people I would otherwise not have met. Our images have been used on invitation cards, personal web pages, educational flyers, and even on some covers of roots. Amazing! It has been a wonderful experience to be a giver and a receiver at the same time. This is the most beautiful of paradoxes. It is in the very act of giving of ourselves to others that we truly receive all for which we could ever possibly wish.

While this editorial is not full of references to the newest innovations in endodontics or the answers to your deep clinical questions, I am sure that you will be able to find such information in the pages of this marvellous magazine. My purpose here is another one. Considering that this is the first issue of roots in 2013, I would like to wish you a year full of new friendships, happiness, peace, and unforgettable moments with your family. I hope that you will keep providing the best of your skills in order to fulfil your patients' needs and use our gift to provide pain release to make this world a better place. Keep giving! Giving is an act of gratitude. Plant the seeds of generosity through your acts of giving, and you will grow the fruits of abundance for yourself and those around you. Thank you for supporting us throughout these years.

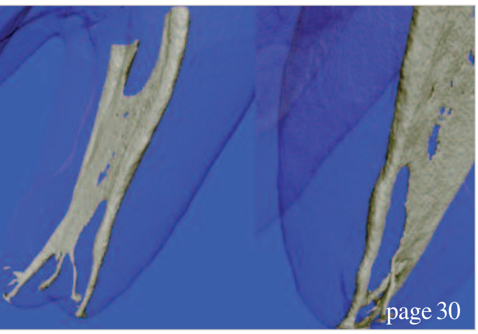
My best wishes,

Prof. Marco Versiani, DDS, MS, PhD
Major Dental Officer (Brazilian Military Police)
Specialist in endodontics, didactics and bioethics



Cover image courtesy of Prof. Marco Versiani

3-D micro-CT models of a mandibular molar showing the changes of the original root-canal anatomy (green) after preparation with a multiple-file rotary system. Each colour represents preparation by one of five instruments. The last image in the sequence represents the root canal after shaping (red) superimposed on the original canal (green), demonstrating that most of the surface area was prepared using the multiple-file system.



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A review of bioceramic technology in endodontics

Authors_ Drs Ken Koch, Dennis Brave & Allen Ali Nasseh, USA

_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 is, "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.

Although employed in both medical and dental applications, it is important to understand the specific advantages of bioceramics in dentistry and why they have become so popular. 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. 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.

Fig. 1

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 Ken Koch, DMD)*

_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 as following:

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

$$2[3CaO \cdot SiO_2] + 6H_2O \rightarrow 3CaO \cdot 2SiO_2 \cdot 3H_2O + 3Ca(OH)_2 \quad (A)$$
$$2[2CaO \cdot SiO_2] + 4H_2O \rightarrow 3CaO \cdot 2SiO_2 \cdot 3H_2O + Ca(OH)_2 \quad (B)$$

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

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

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 anti-bacterial); 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) 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 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 per cent (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 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.

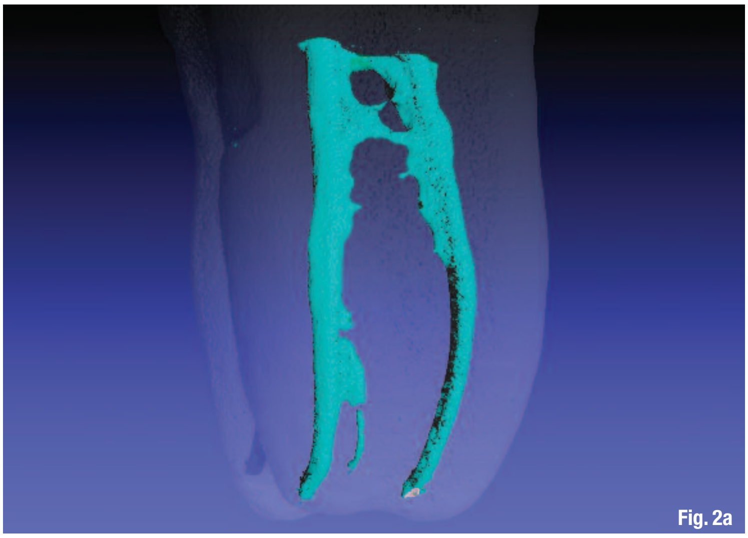

Fig. 2a_This image shows the excellent adaption of the bioceramic sealer (and gutta-percha) to the true shape of the prepared canal.

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) 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.

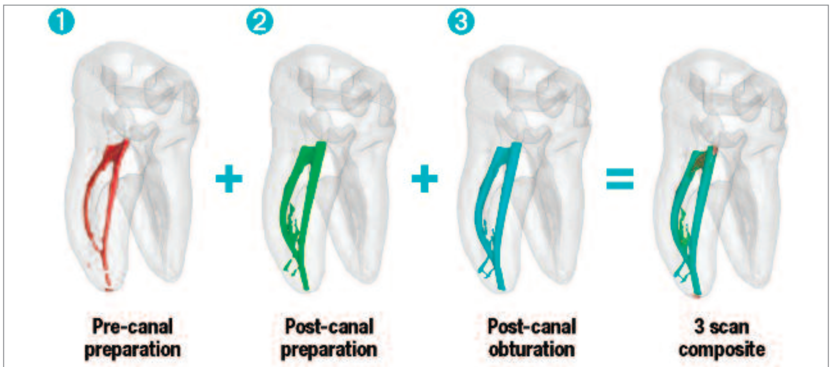

Fig. 2b

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

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.

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