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Bonded Restorative Endodontics for the Conservative Dentist

With the advent of a new class of materials known as “premixed bioceramics”, minimally invasive techniques are entering the root canal system — challenging prevailing paradigms and maximizing the long-term prognosis of the endodontically treated tooth.

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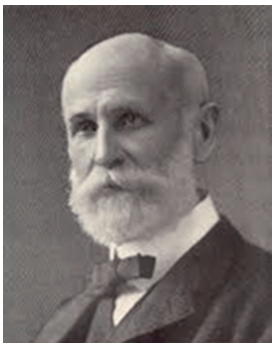
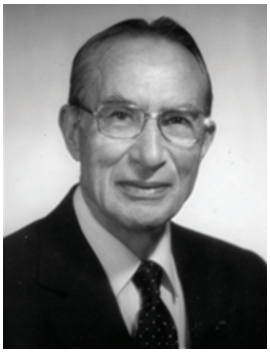


Dr. G.V. Black
(1836 - 1915)



Dr. Louis I. Grossman
(1902 - 1988)

Photo used with permission from the AAE.

Scan this QR code for a video tutorial on "Restorative Endodontics".

It is unlikely that the Father of Restorative Dentistry (G. V. Black 1836-1915) could have imagined the direct bonding of modern day composite materials to coronal dentin, or that the Father of Endodontics (Louis I. Grossman 1902-1988) could have imagined bioceramic sealers that could bond to radicular dentin. But both of these dentistry giants advocated the latest theory, techniques and technology of their day and certainly would have been quick to embrace the advent of bioceramics that we are seeing today.

Restorative Endodontics™

Historical standard of care versus the emerging modern standard of care

The reason for restoring a cavity and/or performing a root canal are both the same — to restore a tooth to its natural function and to preserve the tooth in that state for as long as possible.

Historically, dentists recognized the need for retentive preparations for the successful placement of an amalgam restoration when there was no other option. This served patients well and was the standard of care at the time. These techniques were advanced based on the physical and chemical properties (and limitations) of the materials available at the time (Fig. 1).

Today we have newer and better materials that do not require outdated methods.

You were probably taught that gutta percha needs to be heated and condensed to achieve 3D obturation, that your endodontic sealers are the weak link in your root canal procedure and that it didn't matter how you got to the apex, only that you got there. Yet present day material science has shown these concepts to be antiquated.

If we agree that the fundamentals of root canal therapy are cleaning, shaping and obturation, then it would make sense to look carefully at how each part of the procedure interfaces and supports the other. In addition, it is also important to consider how each part of the procedure supports the objective of maximizing the long-term retention of the endodontically treated tooth.

Some 50 years ago, Dr. Louis Grossman acknowledged that the then-current-day sealers (zinc oxide and eugenol- and resin-based sealers) left much to be desired. They were and still are hydrophobic, dimmensionally unstable (shrink), are not very biocompatible, lack resistance to wash out and are generally irritating if extruded past the apex.

Because of these less-than-stellar characteristics, it became accepted theory and practice to try to reduce the sealer interface to the thinnest possible thickness in the root canal — it being well understood that the thicker the sealer interface, the greater the shrinkage, the more irritating, etc. Therefore, all of our obturation/condensation techniques (warm vertical, cold lateral, and heated-carrier based) were developed (and accepted) based on the recognition that the then-current sealers were, at best, poor and that the gutta percha should displace as much sealer as possible.

These techniques are antiquated given that we now have root canal sealers that exhibit zero shrinkage and hermetically seal the canal through chemical bonding. It should be acknowledged that while active condensation is no longer necessary we still deliver the sealer and provide a retreatment path with a bioceramic-coated gutta percha cone.

The historical standard of care utilized the best techniques available at that time to overcome the limitations of the materials at our disposal. Modern material science (bonding) now allows us to remove decay and debride canals in a more conservative manner (Fig. 2 & Fig. 4).

"Endodontics is a specialty that has had long-held beliefs regarding the compaction of gutta percha and some minimal amount of sealer. With the advent of a new class of materials known as bioceramics which bond to dentin, minimally invasive shaping techniques are now being embraced in Endodontics."

— Dr. Thomas Giacobbi

Restorative Endodontics™

Restorative

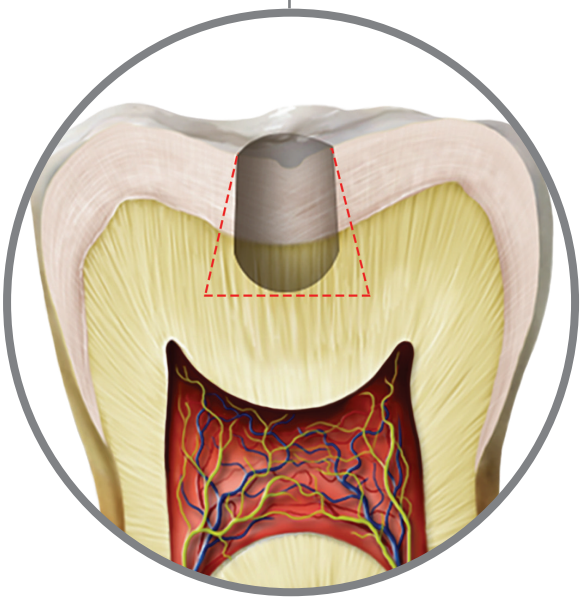


FIG 1 Historic - "Retention Form" for Non-Bonded Amalgam

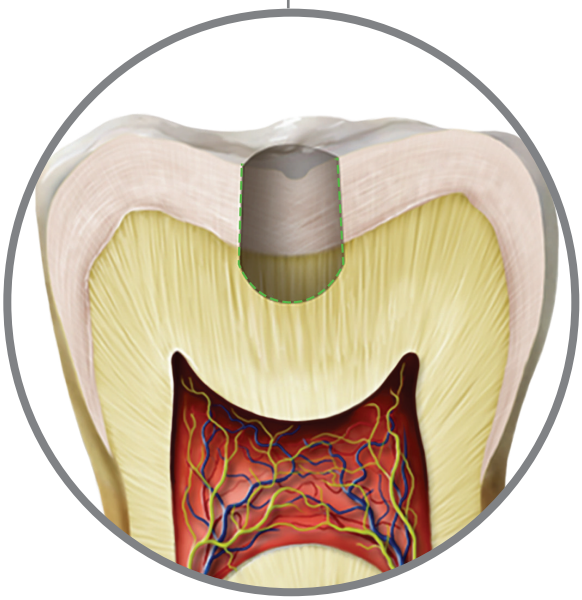


FIG 2 Modern - Minimally Invasive Cavity Preps with Bonded Restorations

Endodontics

FIG 3 Historic - Large Tapers for placement of Non-Bonded Melted Gutta Percha

FIG 4 Modern - Minimally Invasive Shaping with Bonded Obturation

Minimally invasive root canal shaping and bonded obturation made possible through:

BioCeramic NanoTechnology

What are bioceramics?

Bioceramics are inorganic, ceramic materials specifically designed for use in medicine and dentistry. They are non-toxic, non-corrosive, biocompatible, do not shrink, are chemically stable within the biological environment and are able to withstand interfacial interactions with surrounding organic tissue.

10 tips for using bioceramics in endodontics

1. Do not store in a refrigerator. Store at room temperature.
2. Do not use too much sealer.
3. New users do not have to place the syringe into the tooth.
4. Use bioceramic-coated cones.
5. Use the residual sealer material that remains in the tip.
6. Use bioceramics for pulp caps.
7. Do apexifications with bioceramics.
8. Use bioceramics as a retrofilling material.
9. Use bioceramics as a canal locator.
10. Use advanced obturation technique with bioceramics.

For a detailed version of these tips, read "Ten Tips for Using Bioceramics in Endodontics" (Dentaltown Magazine, December 2010) by Drs. Kenneth Koch and Dennis Brave.

The emergence of bioceramic nanotechnology

A new technology that paves the way for minimally invasive shaping.

The World Congress of Minimally Invasive Dentistry defines minimally invasive dentistry as: those techniques that respect the health, function, and aesthetics of all oral tissue by preventing disease from occurring or intercepting its progress with minimal tissue loss.

"Restorative Endodontics" is the concept of embracing modern material science for root canal therapy in the same way that it has been done in restorative dentistry. Just as bonded composite restorations have antiquated retention forms with amalgams, bioceramic nanotechnology has now antiquated excessive root canal shaping.

Present-day material science has allowed us to produce nanoparticle premixed bioceramic root canal sealers (BC Sealer, BUSA) (Fig 5.) that meet (or exceed) all of Dr. Grossman's requirements for an ideal endodontic sealer, such as:

- No shrinkage
- Biocompatible
- Osteogenic by nature
- Hydrophilic
- Anti-bacterial
- Produces hydroxyapatite upon setting
- Highly radiopaque, premixed and will produce a true chemical bond to the dentin and bioceramic-coated cone (BC Sealer™ and BC Points™, BUSA) (Figs. 6-7)

Because we are now able to chemically bond to the radicular dentin (right down to the apex), it is now possible to produce a true monoblock for the first time. This is why it can be said that the restoration of an endodontically treated tooth should begin at the apex. With bioceramic materials, this is now possible.

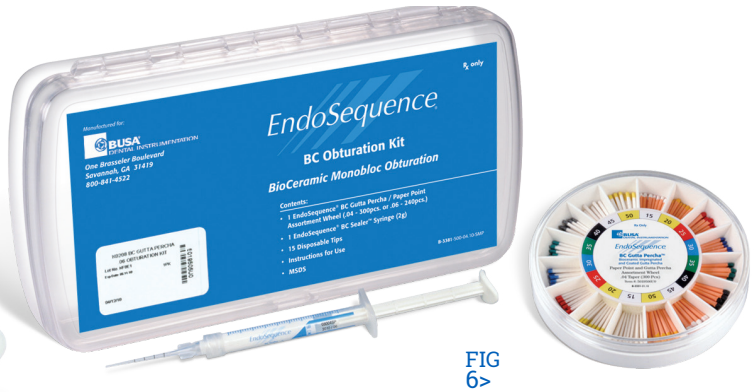


FIG 6>

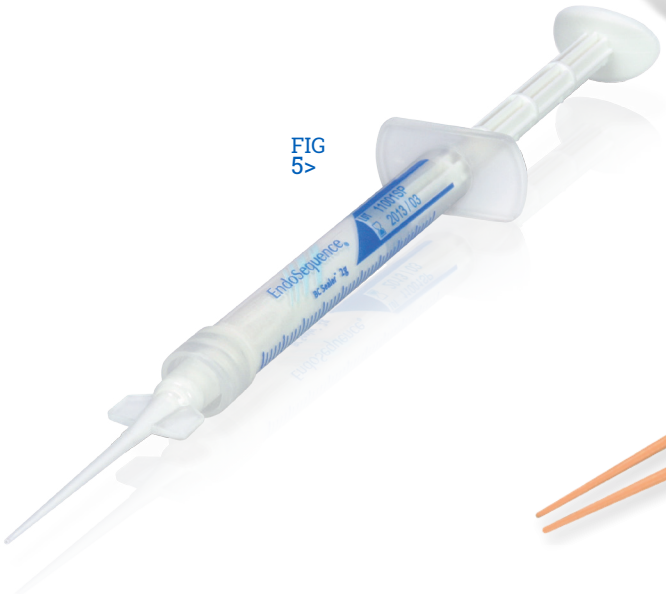


FIG 5>

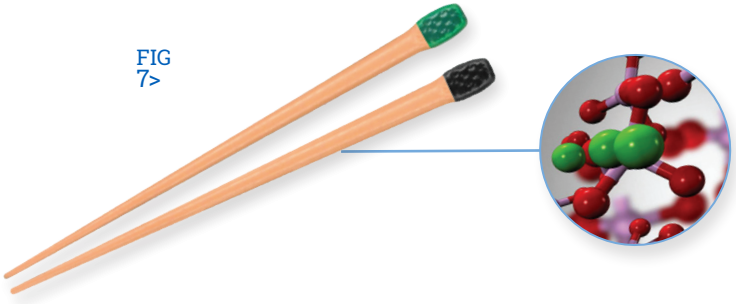


FIG 7>

Minimally invasive root canal shaping

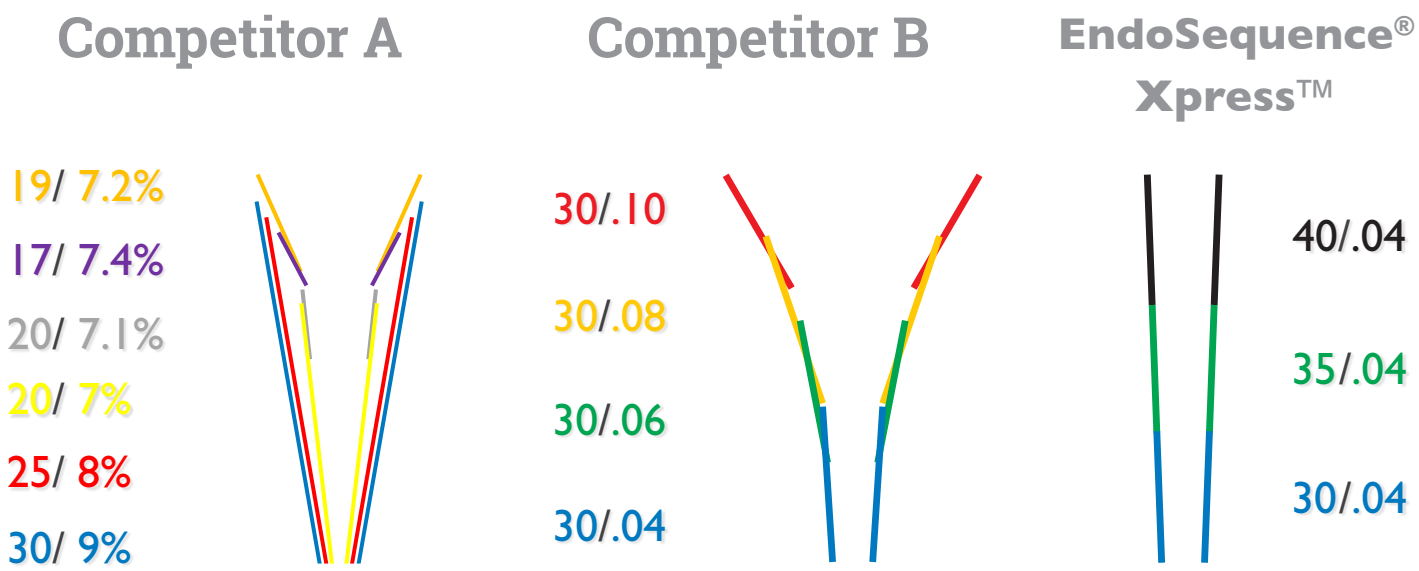
Maintaining the innate strength of the tooth through the use of conservative instrumentation and bonded obturation.

The advent of bioceramic materials is not the end of the story but the beginning. And the future of bioceramics promises to be even more exciting!

For years the techniques used to prepare and shape canals have focused on trying to not only clean the canal but also to produce a shape that will provide for the difficult task of condensing gutta percha — something we now understand is actually unnecessary (Fig. 8).

FIG 8>

Constant Taper = Constant Shapes = Conservative
Variable Taper = Variable Shapes = Non-Conservative



Cleaning, it turns out, can be accomplished with minimal coronal enlargement, particularly if facilitated with ultrasonics and modern irrigation techniques. All that is truly required is to produce a shape that allows the canal to be cleaned responsibly to the apex.

Teeth (canals) that are overly prepared and weakened to accommodate filling techniques, lead to unnecessary failures (fractures, strip perforations, etc.). Obturation should not dictate shaping! We now have bioceramic obturation techniques that do not require excessive canal enlargement.

As conservative-minded clincians, we should focus on maintaining the innate strength of the tooth through the use of responsible instrumentation and obturation techniques that do not require the excessive removal of dentin. Now that we have the ability to perform bonded obturation we can follow our instincts and preserve more tooth structure during root canal shaping.

We now recognize that all instrument systems are not the same and do not accomplish the same goals. Some years ago, it was recognized that constant tapered file systems (versus variable tapered) would consistently produce minimally invasive shapes in the root canal. Further, that the synchronization of all the parts of the procedure (i.e., the instruments, paper points and gutta percha) would lead to the preservation of more structually important dentin. Those who claim that root canals fracture and don't hold up for the long term do not recognize the importance of maintaining the inherent strength of a tooth throughout the root canal procedure by the use of minimally invasive techniques and technology. Root canals that are carried out with instrumentation systems designed to retain as much coronal radicular dentin as possible and are restored utilizing bonded obturation will stand the test of time. The restoration of an endontically treated tooth should begin at the apex. Through the use of minimally invasive techniques and advanced material science, this is now a reality.●

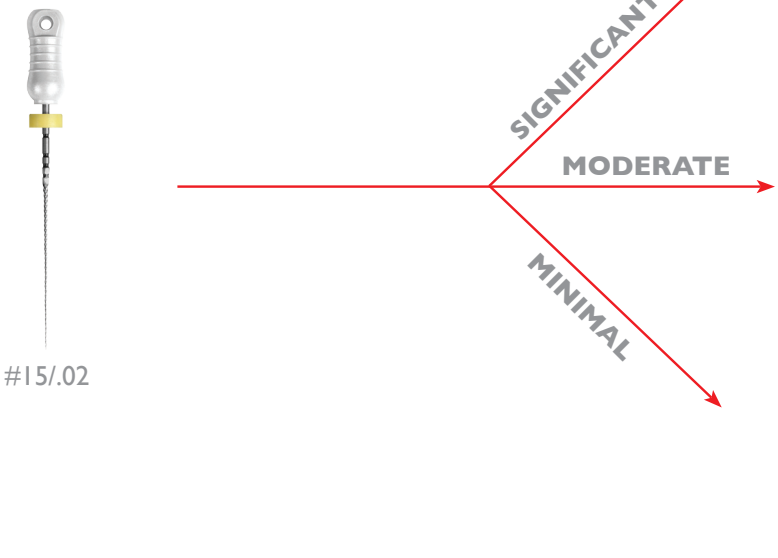
EndoSquence® Xpress™ Technique

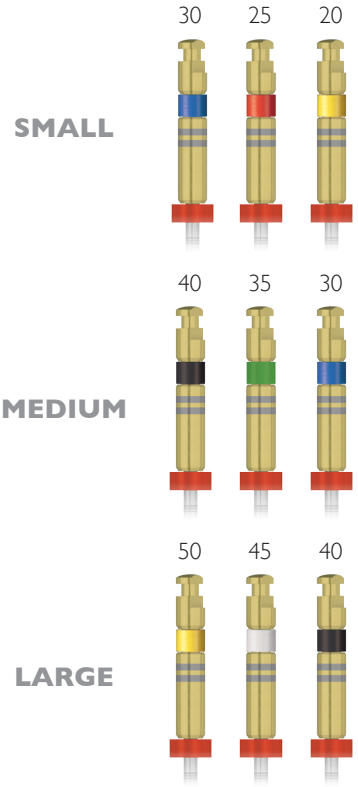
General Instructions and Tips

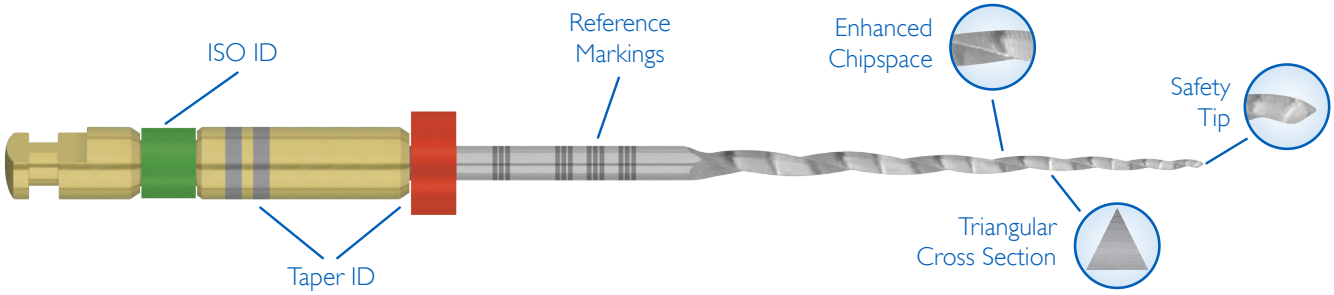
1. Run @ 500-600 RPM
2. Torque setting 1.8-2.3 Ncm
3. Use a very gentle touch. Never force a file.
4. Irrigation with ultrasonics is recommended.
5. Always clean the file after three (3) engagements.

Video Tutorial

Scan this QR code for a step-by-step tutorial for the EndoSequence® Xpress™ shaping and obturation technique.







EndoSequence® Xpress™ Product Offering

Assorted Procedure Packs

File/ Tip ID	Tip Size	.04 Taper	
		21 mm	25 mm
Small	30, 25, 20	5024727EU	
Medium	40, 35, 30	5024728EU	
Large	50, 45, 40	5024731EU	
Small	30, 25, 20		5024732EU
Medium	40, 35, 30		5024733EU
Large	50, 45, 40		5024734EU

Individual Packs

File/ Tip ID	Tip Size	.04 Taper			.02 Taper	
		21 mm	25 mm	31 mm	21 mm	25mm
△ White	15	5024696EU	5024707EU	5024716EU	5024726EU	5024730EU
△ Yellow	20	5024697EU	5024708EU	5024717EU		
△ Red	25	5024698EU	5024709EU	5024718EU		
△ Blue	30	5024700EU	5024710EU	5024719EU		
△ Green	35	5024701EU	5024711EU	5024720EU		
△ Black	40	5024702EU	5024712EU	5024721EU		
△ White	45	5024703EU	5024713EU	5024722EU		
△ Yellow	50	5024704EU	5024714EU	5024723EU		
△ Red	55	5024705EU	5024715EU	5024724EU		

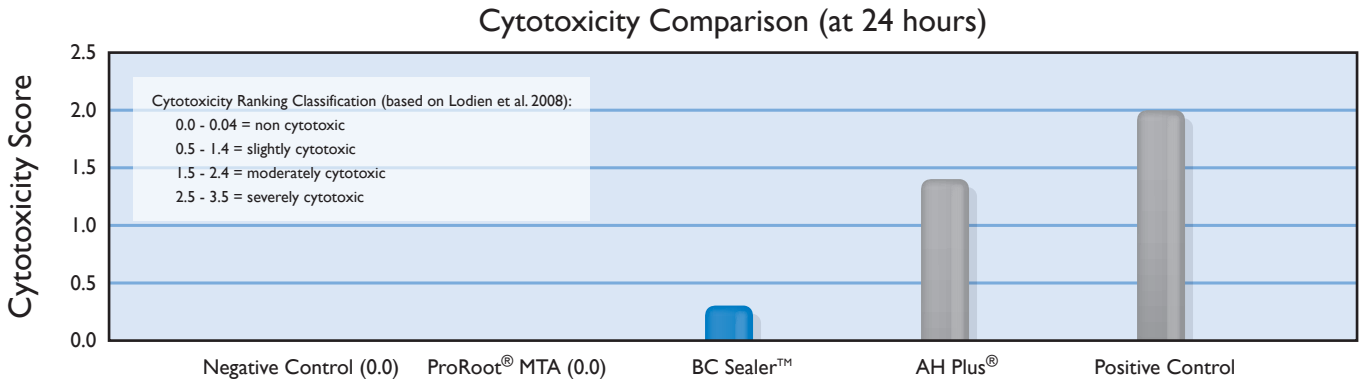
Endosquence® BC Sealer™ and Root Repair Material (RRM™) Research Bibliography

Biocompatibility / Cytotoxicity

Zhang W, Li Z, Peng. Ex vivo cytotoxicity of a new calcium silicate-based canal filling material. International Endodontic Journal. 2010; 43(9): 769. DOI:10.1111/j.1365-2591.2010.01733.

Subject: BC Sealer Cytotoxicity vs. AH Plus and MTA

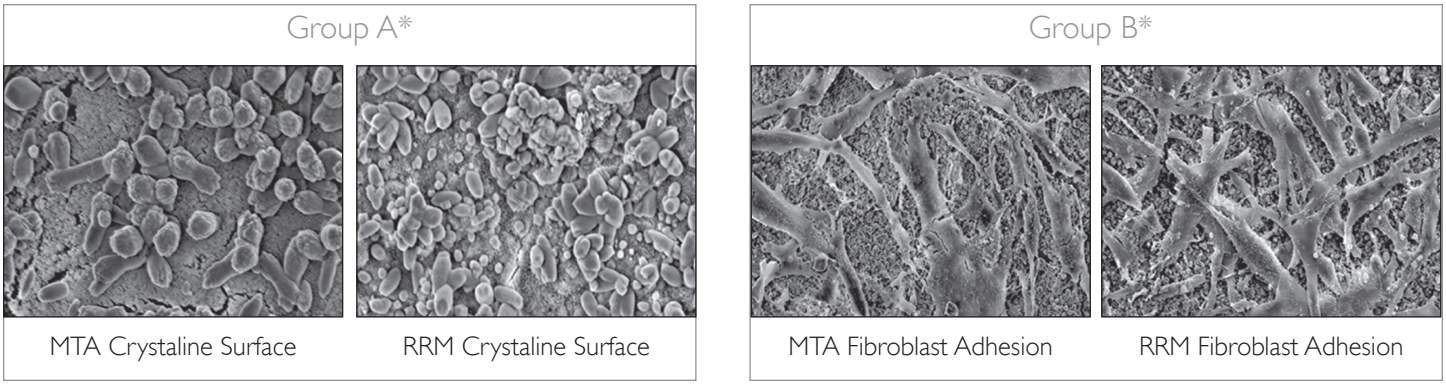
Significance/Conclusion: Concluded that BC Sealer™ is highly biocompatible and that it is significantly less cytotoxic than AH Plus.



Jingzhi M, Shen Y, Stojicic S, Haapasalo M. Biocompatibility of Two Novel Root Repair Materials. JOE. 2011; 37(6): 793-8

Subject: Biocompatibility of RRM (Syringable Paste and Putty)

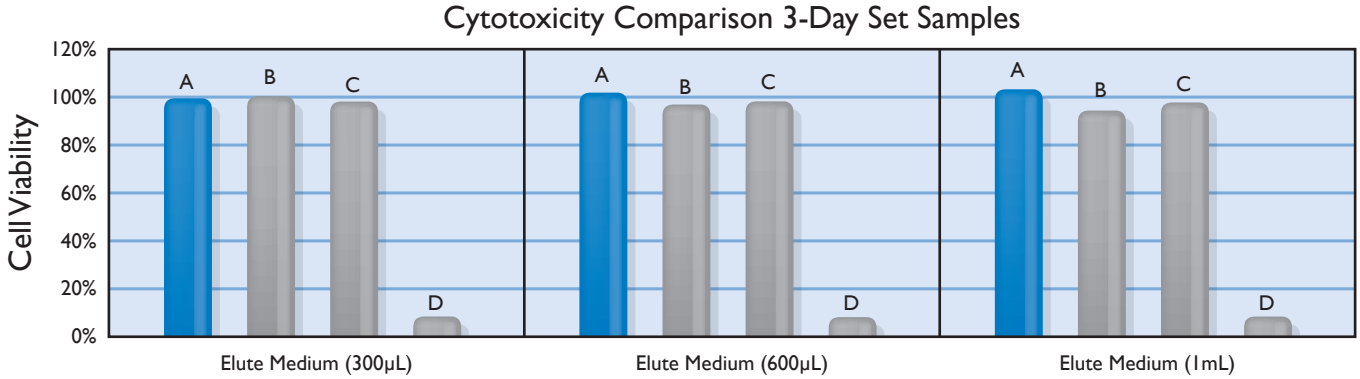
Significance/Conclusion: Concluded that both versions of RRM™ are highly biocompatible and comparable to MTA.



AlAnezi AZ, Jiang J, Safavi KE, Spangberg LSW, Zhu Q. Cytotoxicity evaluation of EndoSequence Root Repair Material. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology. 2010; 109(3): 122-5. DOI:10.1016/j.tripleo.2009.11.028

Subject: Cytotoxicity/Biocompatibility of RRM™ compared to MTA (gray and white).

Significance/Conclusion: Concluded that cell viability is similar to both gray and white MTA in fresh and set conditions.



Ruparel, Ruparel, Chen, Ishikawa, Diogenes. Direct Effect of Endodontic Sealers on Trigeminal Neuronal Activity Published Online: March 20, 2014 DOI: http://dx.doi.org/10.1016/j.joen.2014.01.030
Subject: Evaluation of the effect of sealers on peripheral nociceptors. A post-operative sensitivity study.
Significance/Conclusion: Concluded that ZOE and AH Plus in their fresh form evoked greater CGRP release than the control groups. Conversely, EndoSequence BC Sealer reduced basal GCRP release at all concentrations tested.

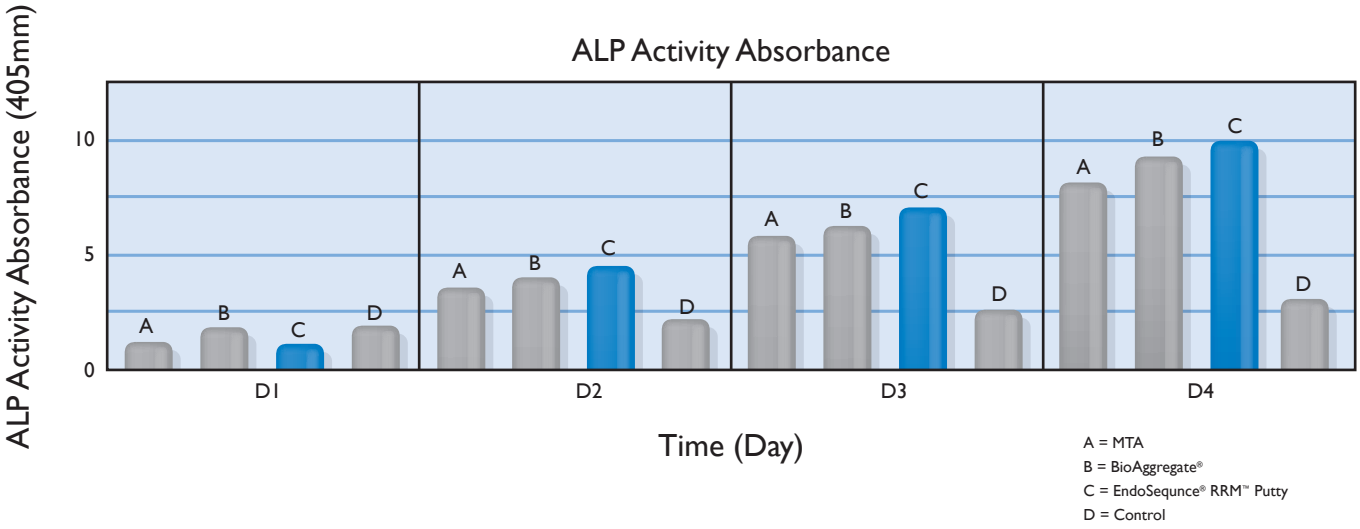
Chang, Lee, Kang, Kum, Kim. In Vitro Biocompatibility, Inflammatory Response, and Osteogenic Potential of 4 Root Canal Sealers: Sealapex, Sankin Apatite Root Sealer, MTA Fillapex, and iRoot SP Root Canal Sealer. 2014 (online June 7th 2014); DOI: http://dx.doi.org/10.1016/j.joen.2014.04.006
Subject: Comparison of the cytotoxicity, inflammatory response, osteogenic effect and the signaling mechanisms of the sealers tested.
Significance/Conclusion: iRoot SP (aka BC Sealer) showed lower expression of inflammatory mediators and enhanced osteoblastic differentiation of PDLCs.

Ciasca M, Aminoshariae A, Jin G, Montagnese T, Mickel A. A Comparison of the Cytotoxicity and Proinflammatory Cytokine Production of EndoSequence Root Repair Material and ProRoot MTA in Human Oseoblast Cell Culture Using Reverse- Transcriptase Polymerase Chain Reaction. JOE. 2012; 38(6); 486-9
Subject: Cytotoxicity and Proinflammatory Cytokine Production of RRM™ compared to MTA.
Significance/Conclusion: Concluded that RRM™ and MTA showed similar Cytotoxicity and Cytokine Production.

Hirschman W, Wheater M, Bringas J, Hoen M. Cytotoxicity Comparison of Three Current Direct Pulp-capping Agents with a New Bioceramic Root Repair Putty. JOE 2012; 38(3);385-8.
Subject: Cytotoxicity comparison of RRM™ vs. popular pulp capping agents (White MTA, Dycal and UltraBlend Plus).
Significance/Conclusion: Concluded that RRM™ was the most biocompatibile of the group ("after exposure to the 8-day elutes, the respective percentage of cell survivability was 91% (BUSA), 88% (MTA-Angelus), 76% (UltrablendPlus), and 37% (Dycal)").

Mineralization / Osteogenic / Pulp Cells

Zhang S., Yang X., Fan M. Bioagreggate and iRoot BP Plus (RRM™ Putty) optimizes the proliferation and mineralization ability of human dental pulp cells. International Endodontic Journal. 2013; DOI:10.1111/iej.12082
Subject: cytotoxicity comparison of BC RRM vs MTA to pupal cells
Significance/Conclusion: ES BC RRM was found more biocompatible and less cytotoxic to pulpal cells than MTA.

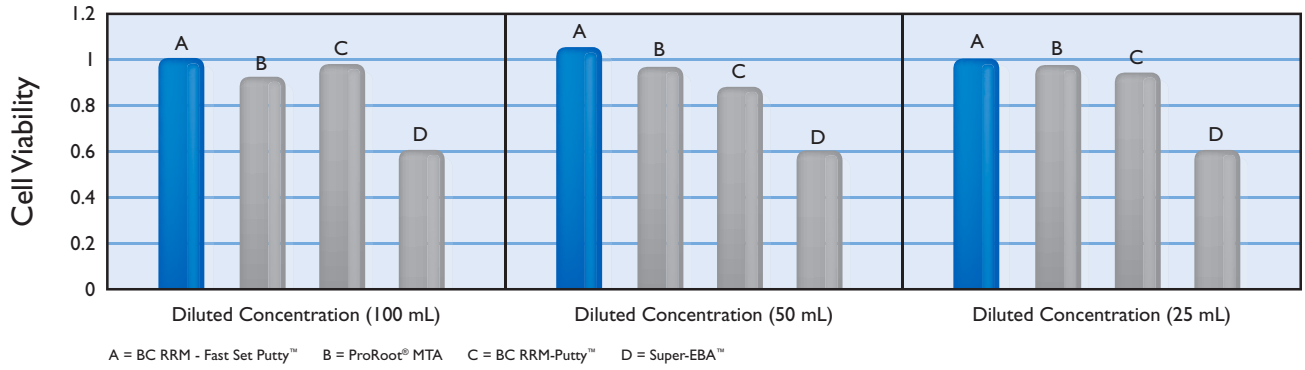


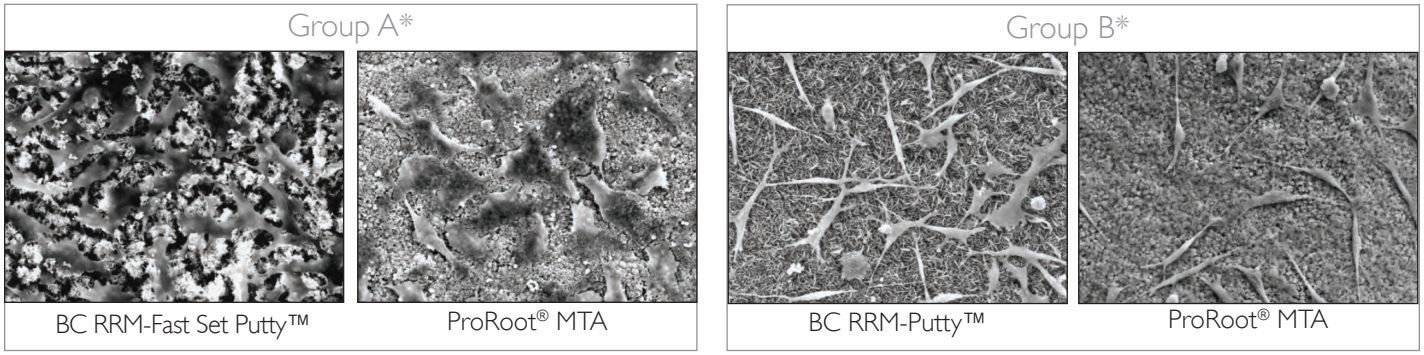
Zhang W, Li Zhi, Peng, B. Effects of iRootSP (aka BC Sealer™) on Mineralization-related Genes Expression in MG63 Cells. JOE. 2010; 36(12); 1978-1982
Subject: Cytotoxicity and Osteoconductivity of BC Sealer vs. AH Plus
Significance/Conclusion: Concluded that BC Sealer was nontoxic and able to induce mineralization and odontoblastic cell differentiation in hDPCs (human dental pulp cells) at a higher level than mineral trioxide aggregate (MTA).

Yuqing Jiang et al. A Comparative Study on Root Canal Repair Materials: A Cytocompatibility Assessment in L929 and MG63 Cells. The Scientific World Journal Volume 2014, Article ID 463826

Subject: The aim of this study was to conduct a comparative assessment on the surface morphology and the cell adhesion capacity of iRoot BP Plus (aka BC RRM Putty), iRoot FS (aka BC RRM Fast Set Putty), ProRoot MTA, and Super-EBA on both fibroblast and osteoblast-like cellsmodels. Furthermore, the time-course in vitro cytotoxicity of these materials was accessed.

Significance/Conclusion: Concluded that BC RRM-Fast Set Putty™ is extremely biocompatible and non-cytotoxic. Furthermore, BC RRM exhibited the fastest set time and the best cell adhesion capacity of all the materials tested including ProRoot®.





Retreatability

H. Ersev, B. Yilmaz, M.E. Dincol & R. Daglaroglu. The efficacy of ProTaper Universal rotary retreatment instrumentation to remove single gutta-percha cones cmented with several endodontic sealers. International Endodontic Journal. 2012; DOI:10.1111/j.1365-2591.2012.02032.x

Subject: Evaluation of the retreatability of BC Sealer vs. AH Plus and other sealers.

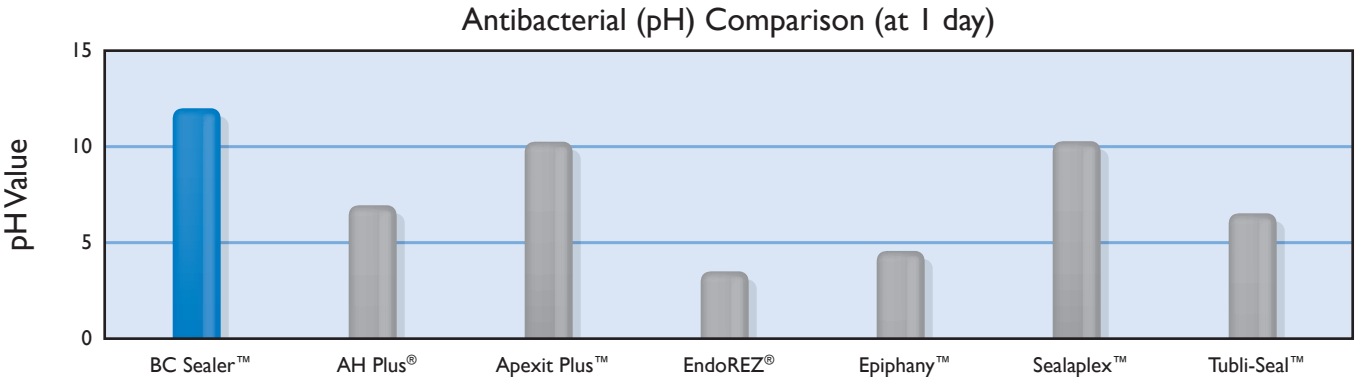
Significance/Conclusion: Both BC Sealer and AH Plus were readily retreated using conventional retreatment methods with the ProTaper retreatment instruments.

Antibacterial Properties

Zhang H, Shen Y, Ruse ND, Haapasalo M. Antibacterial activity of endodontic sealers by modified direct contact test against enterooccus faecalis. JOE. 2009; 35(7): 1051-5

Subject: Evaluation of the antibacterial properties of BC Sealer vs. AH Plus, Apexit Plus, TubliSeal, Sealapex, Epiphany SE and Endo Rez.

Significance/Conclusion: BC Sealer killed all bacterial within 2 min of contact (fastest), had the strongest antibacterial activity and continued to be effective at killing bacteria for 7 days after mixing/setting. The high pH of BC Sealer makes it extremely effective at killing bacteria.



Lovato, K, Sedgley, M. Antibactieral Activity of EndoSequence Root Repair Material and ProRoot MTA against Clinical Isolates of Enterococcus faecalis JOE. 2011; 37(11); 1542-6.

Subject: Evaluation of the antibacterial properties RRM™ (Syringable and Putty) vs. MTA.

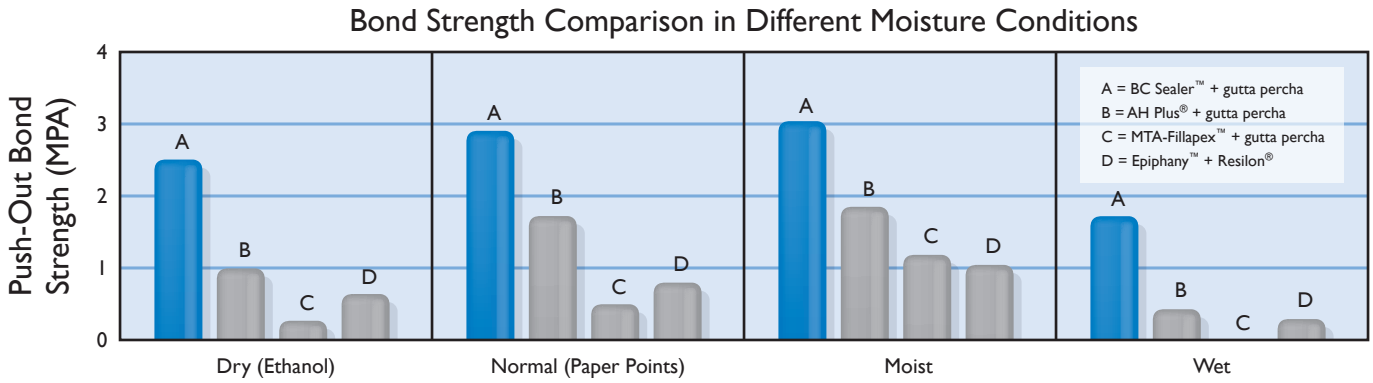
Significance/Conclusion: RRM and MTA both effectively killed E. faecalis. There was no statistical difference between their effectiveness.

Leakage/ Bond Strength/ Sealing Ability / Fracture Resistance

Nagas E, Uyanik MO, Eymirli A, Cehreli ZC, Vallittu PK, Lassila LVJ, Durmaz V. Dentin moisture conditions affect the adhesion of root canal sealers. JOE. 2011; 38 (2): 240-4

Subject: Comparison of the push out bond strength (and the assumed sealability) of BC Sealer™ + Gutta Percha vs. AH Plus + Gutta, MTA Fillapex + Gutta and Epiphany + Resilon in a full range of moisture conditions (artificially dry, normal, moist and wet).

Significance/Conclusion: BC Sealer exhibited, by far, the highest bond strength in all moisture conditions. Many sealers are negatively affected if water or bleach remains in the canal when the sealer is applied. BC Sealer is hydrophilic and achieves its set by utilizing the moisture naturally present in the dentinal tubules. This study proves that regardless of moisture level in the canal, BC Sealer will achieve its set and it exhibits excellent bonding to the canal walls.



Zhang W, Zhi L, Peng B. Assessment of a new root canal sealer's apical sealing ability. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology 2009; 107;e79-e82.

Subject: Comparison of sealability of BC Sealer with a single cone technique vs AH Plus with a warm vertical technique (continuous wave)

Significance/Conclusion: The study concluded that there was no statistical difference in the sealing ability of each material with the associated technique used.

Note: Warm vertical is considered by many to be the standard of care because it minimizes the sealer layer and fills the majority of the canal three dimensionally with a relatively stable filling material (gutta percha does shrink upon cooling). The warm techniques were developed to overcome the limitations of the sealers at our disposal (prior to BC Sealer, sealers have been known to shrink significantly). This study showed that BC Sealer used with a single cone technique, can provided the same sealability as the more time consuming and technique sensitive continuous wave technique with AH Plus.

Fernanda Leal, Gustavo De-Deus, Claudia Brandao, Aderval Luna, Erick Souza, Sandra Fidel. Similar Sealability Between Bioceramic Putty Ready-To-Use Repair Cement and White MTA. Brazilian Dental Journal (2013) 24(4): 362-366 ISSN 0103-6440 http://dx.doi.org/10.1590/0103-6440201302051

Subject: BC RRM Putty Salability vs. White MTA.

Significance/Conclusion: Concluded that BC RRM Putty (aka. iRootBP Plus) has a similar ability to that of white MTA in preventing glucose leakage as a root end filling material.

Ersahan S, Aydin C. Dislocation Resistance of iRootSP (aka BC Sealer), a Calcium Silicate- based Sealer, from Radicular Dentine. JOE. 2010; 36(12); 2001-2

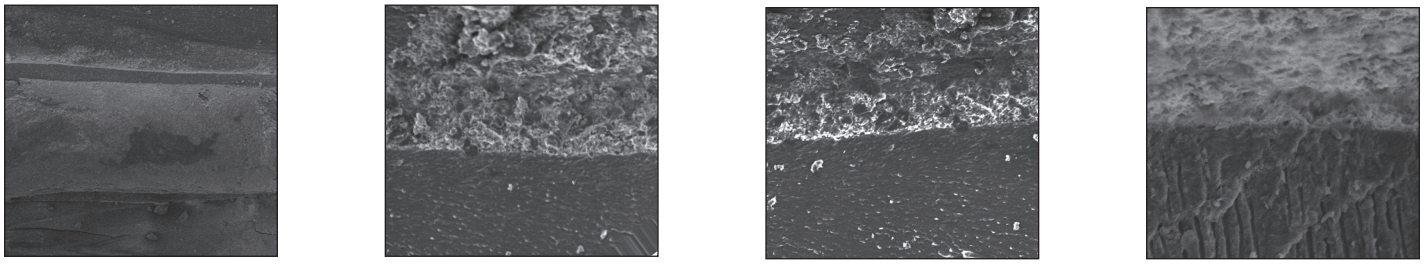
Subject: Comparison of the push out bond strength (and the assumed sealability) of BC Sealer™ vs. AH Plus and Sealapex and EndoRez.

Significance/Conclusion: BC Sealer and AH Plus both exhibited high bond strengths which were significantly higher than Sealapex and EndoRez.

Yuqing Jiang et al. A Comparative Study on Root Canal Repair Materials: A Cytocompatibility Assessment in L929 and MG63 Cells. The Scientific World Journal Volume 2014, Article ID 463826

Subject: The aim of this study was to conduct a comparative assessment on the surface morphology and the cell adhesion capacity of iRoot BP Plus (aka BC RRM Putty), iRoot FS (aka BC RRM Fast Set Putty), ProRoot MTA, and Super-EBA on both fibroblast and osteoblast-like cellsmodels. Furthermore, the time-course in vitro cytotoxicity of these materials was accessed.

Significance/Conclusion: Concluded that BC RRM-Fast Set Putty™ is extremely biocompatible and non-cytotoxic. Furthermore, BC RRM exhibited the fastest set time and the best cell adhesion capacity of all the materials tested including ProRoot®.



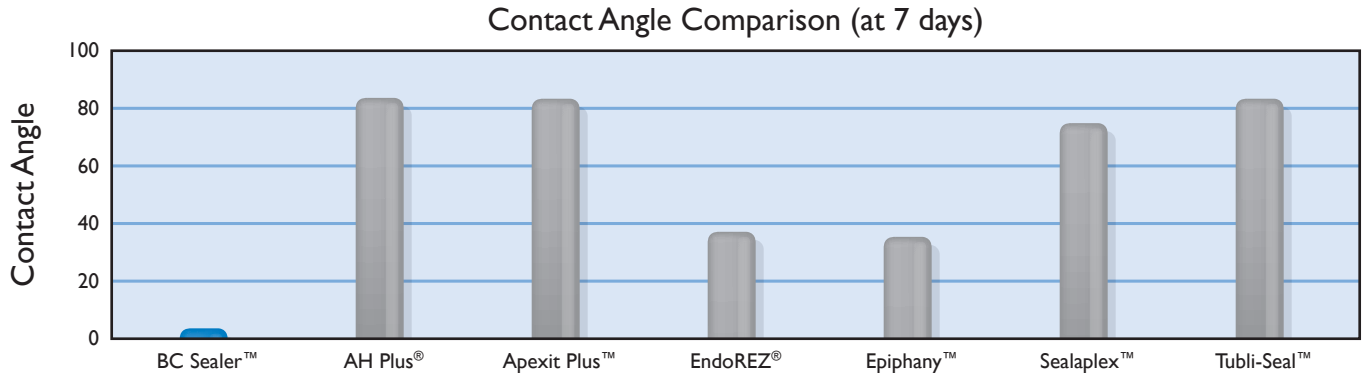
x35 Magnification | x200 Magnification | x350 Magnification | x1000 Magnification

Hydrophilicity, Low Contact Angle, Calcium Hydroxide diffusion & Release of Calcium Ions

Zhang H, Shen Y, Ruse ND, Haapasalo M. Antibacterial activity of endodontic sealers by modified direct contact test against enterooccus faecalis. JOE. 2009; 35(7): 1051-5

Subject: Evaluation of the antibacterial properties of BC Sealer vs. AH Plus, Apexit Plus, TubliSeal, Sealapex, Epiphany SE and Endo Rez.

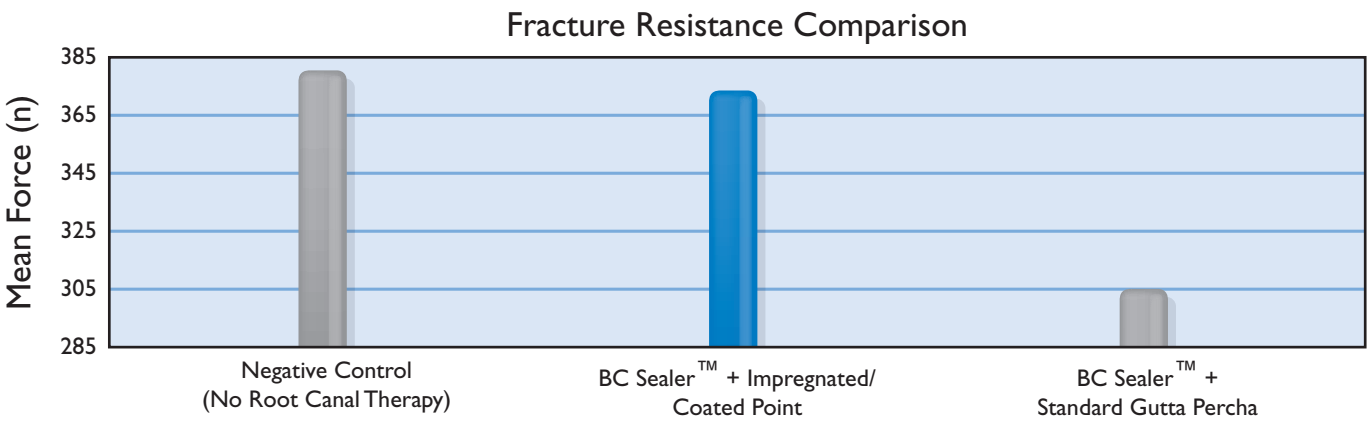
Significance/Conclusion: "BC Sealer, by far had the lowest contact angle / wetting ability". The authors attribute the favorable sealing properties of BC Sealer to its "combination of high pH, hydrophilicity, and active calcium hydroxide diffusion".



Ghoneim AG, Lutfy RA, Sabet NE, Fayyad DM. Resistance to fracture of roots obturated with novel canal-filling systems. JOE. 2011; 37 (11): 1590-2

Subject: Evaluation of the fracture resistance of teeth obturated with BC Sealer™ + gutta percha and BC Sealer™ + Silicate Coated Points.

Significance/Conclusion: The negative control for this study was tooth that had not undergone root canal therapy. The study concluded that BC Sealer used in conjunction with BUSA's coated/impregnated cones (originally ActivGP Point™ but later updated to BC Points™) actually increased the fracture resistance of the root to a level comparable to the negative control. This type of restorative obturation could represent a significant advancement in root canal therapy.



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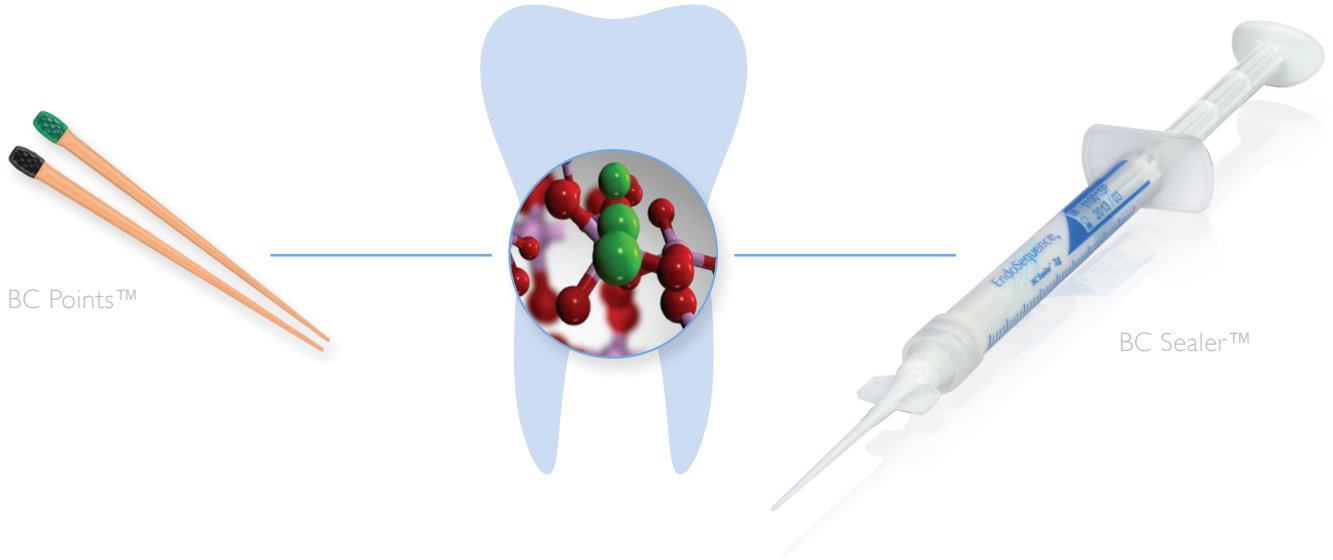

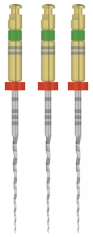

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