

# Retreatability of a Bioceramic Root Canal Sealing Material

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## Abstract

**Introduction:** The efficacy of retreatment techniques for BC Sealer (BCS) (Brasseler USA, Savannah, GA) removal has not yet been assessed. The purpose of this study was to evaluate the efficacy of solvent and rotary instrumentation in the removal of BCS when used in combination with gutta-percha (GP) as compared with AH Plus sealer (Dentsply, Tulsa, OK). **Methods:** The mesiobuccal canals of 40 mandibular molars were instrumented and obturated with either GP/AH Plus with warm vertical compaction or GP/BCS using a single cone. The groups were subdivided into samples with the master GP cone placed to the working length (WL) or intentionally 2 mm short of the WL. Canals were then retreated using heat, chloroform, rotary instruments, and hand files. The ability to regain the WL and patency were evaluated as well as the time required to remove obturation material. Representative samples were also analyzed via scanning electron microscopy. **Results:** The WL was not regained in 70% of samples with BCS/master cone short of the WL. Patency was not re-established in 20% of samples with BCS/master cone to the WL or in 70% of samples with BCS/master cone short of the WL. **Conclusions:** Conventional retreatment techniques are not able to fully remove BCS. (*J Endod* 2011; ■:1–3)

## Key Words

Bioceramics, obturation, retreatment, root canal sealer

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Brasseler USA (Savannah, GA) recently introduced a bioceramic sealer in an attempt to provide an obturation method that can be successfully and predictably performed by a majority of practitioners while taking advantage of its biocompatibility and physical properties (1). According to the manufacturer, BC Sealer (BCS) is a premixed, injectable, radiopaque, bioceramic material composed of zirconium oxide, calcium silicates, calcium phosphate monobasic, calcium hydroxide, and filler and thickening agents. BCS is hydrophilic and uses moisture in dentinal tubules to initiate and complete its setting reaction. The working time can be more than 4 hours at room temperature. The setting time is dependent on the presence of moisture in dentinal tubules and may range from 4 hours to more than 10 hours in very dry canals. The web site states the sealer has no shrinkage upon setting, resulting in a gap-free interface between gutta-percha (GP), sealer, and dentin. It also states the sealer is highly biocompatible and is antibacterial during the setting reaction because of its highly alkaline pH (2, 3).

The properties of an ideal obturation material or sealer were outlined by Grossman (4). Several of these properties have thus far been shown by bioceramic sealers in limited published research. The apical sealing ability of a bioceramic sealer (iRoot SP; VerioDent, Vancouver, BC, Canada) with GP in a single-cone technique was recently shown to be as effective as iRoot SP or AH Plus (Dentsply, Tulsa, OK) with GP in the continuous wave condensation technique (5). Zhang et al (3) also showed the antimicrobial activity of iRoot SP for *Enterococcus faecalis*. An additional property of an ideal material as yet not addressed in studies of bioceramic sealers is the ability to be easily removed from canals if necessary. Because calcium silicate phosphate-based bioceramic materials are known to be hard upon setting, the ability to retreat canals obturated with BCS is a current concern for practitioners (6). The purpose of this study was to evaluate the efficacy of conventional solvent and rotary instrumentation in the retreatment of GP and BCS as compared with AH Plus.

## Materials and Methods

### Sample Preparation

Mesiobuccal roots of 40 extracted human mandibular first molars were sectioned from teeth using a diamond disk and stored in 0.5% NaOCl. Only canals of less than 20° curvature and mature apices were included. Patency was confirmed by extending a #10 Flexofile (Dentsply Maillefer, Tulsa, OK) 1 mm past the anatomical apex. The working length (WL) of each canal was established with a #10 Flexofile 1 mm short of where the file tip exits onto the root surface. The canal was instrumented using a crown-down technique with EndoSequence 0.04 tapered nickel-titanium rotary instruments (Brasseler) at 500 revolutions per minute (rpm) to master apical file size 35. Three milliliters of 5.25% NaOCl was used as the irrigant. The smear layer was removed by irrigating with 2 mL 17% EDTA followed by 2 mL 5.25% NaOCl and a final rinse of 2 mL of sterile saline. A 30-G Max-i-Probe irrigating needle (Dentsply) was used for all irrigation. The canals were dried with paper points. Patency was reconfirmed before obturation with a #10 Flexofile.

The teeth were randomly divided into two groups of 20 to be obturated with GP/AH Plus or GP/BCS. These groups were further subdivided into two groups of 10. In group 1, BCS was used, and a single GP master cone was placed to the full WL. In group 2, BCS was used with a single GP cone, but the master GP cone was trimmed to fit approximately 2 mm short of the WL. Group 3 was obturated using AH Plus sealer and the continuous wave compaction technique with a GP master cone and backfilled with GP using the Obtura II (Obtura Spartan, Fenton, MO). Group 4 was obturated with AH Plus sealer and CWC as in group 3, but the master cone was fitted short of the WL as in group 2. EndoSequence (Brasseler USA, Savannah, GA) 0.04 tapered GP points were used

## Basic Research—Technology

**TABLE 1.** The Ability to Regain the WL, Patency, and Time Required for Retreatment in Different Groups

	Group 1 (%)	Group 2 (%)	Group 3 (%)	Group 4 (%)
WL regained	100 <sup>a</sup>	30 <sup>b</sup>	100 <sup>a</sup>	100 <sup>a</sup>
Patency regained	80 <sup>a,c</sup>	30 <sup>b</sup>	100 <sup>c</sup>	100 <sup>c</sup>
Time required (min)	7.14 ± 2.27 <sup>a</sup>	5.48 ± 1.58 <sup>a,b</sup>	3.73 ± 1.09 <sup>b</sup>	5.28 ± 2.32 <sup>a,b</sup>

Different letters indicate statistically significant difference. For the WL regained, group 2 is significantly different from groups 1, 3, and 4 ( $P = .000$ ); for patency regained, a significant difference is found between groups 1 and 2 ( $P = .035$ ), 2 and 3 ( $P = .0015$ ), and 2 and 4 ( $P = .0015$ ); and for the time required, group 1 is significantly different from group 3 ( $P = .003$ ).

in all groups. For the AH Plus groups, the sealer was introduced into the canal via a paper point to length. Then, the master cone was coated with AH Plus sealer and placed to the appropriate length. For the BCS groups, the sealer and single-cone technique were used according to manufacturer recommendations. The intracanal tip was inserted into the coronal third of the canal. Two calibration markings of BCS were dispensed into the canal. A #15 Flexofile was then used to coat the canal walls with BCS to the WL. The master GP cone was then coated with BCS and slowly inserted into the canal to the appropriate length. Each canal orifice was sealed with Fuji IX GP glass ionomer restorative material (GC America Inc, Alsip, IL). All specimens were stored at 37°C in 100% humidity for 2 weeks.

### Retreatment

All groups were retreated with the same technique. An activated System B 0.06-tapered plugger (SybronEndo, Orange, CA) was introduced at 200°C to resistance and withdrawn to remove coronal obturation material. Three to four drops of chloroform were then introduced into the reservoir. EndoSequence 0.04 tapered NiTi rotary instruments were then introduced into the canal system at 600 rpm in a crown-down technique. Rotary instruments were advanced 2 to 3 mm into the canal system followed by flute clearing. This was repeated until the WL was reached or resistance was met. If the WL was reached, crown-down instrumentation was performed using EndoSequence 0.04 rotary instruments (to size 40) at 500 rpm to the WL to remove the remaining obturation material. If the WL was not reached, small hand files (C-Files, C+ Files, and Flexofiles sizes 6, 8, and 10, Dentsply) were used in an attempt to penetrate or bypass blockages. When WL was reached, the canal was instrumented to length with EndoSequence 0.04 rotary instruments as described above. If WL was not reached, the canal was instrumented with EndoSequence 0.04 rotary instruments to the maximum length reached.

Five ml of 5.25% NaOCl was used as the irrigant in each canal. The end-point of instrumentation during the retreatment phase was determined when a size 40 EndoSequence 0.04 rotary instrument reached

the WL or was otherwise found unable to advance further apically. The ability to reach the WL and regain patency was determined for each canal. The time required to retreat each canal was also recorded. All sample preparation, treatment, and evaluation were performed by a single operator.

### Scanning Electron Microscopy

The roots were scored longitudinally using a ½ round carbide bur and wedged apart. Representative specimens were fixed with 10% formalin solution for 24 hours and then dehydrated with ascending concentrations of ethanol (30%–100%) and air dried. Each specimen was sputter-coated with gold and examined with a scanning electron microscope at 15 kV. The apical area and foramen were examined at 50× magnification.

### Statistical Analysis

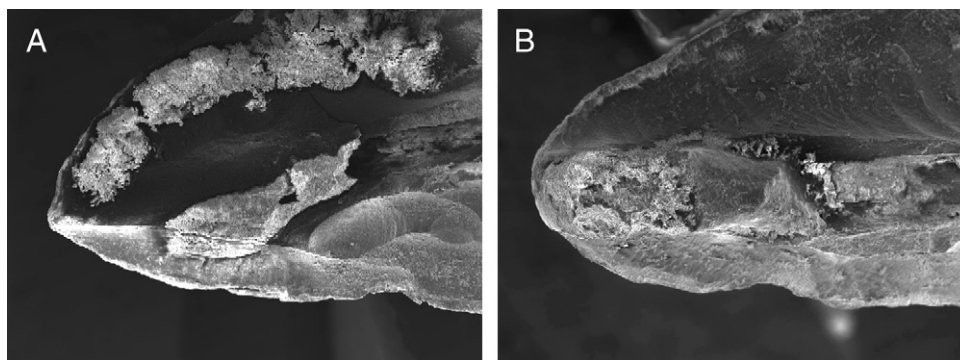
The time required for material removal per group was measured in minutes and expressed as mean ± standard deviation. Group comparisons were performed using one-way analysis of variance and a Student-Newman Keuls post hoc test. Pearson chi-square analyses and Fisher exact tests were performed using SPSS 16.0 (SPSS Inc, Chicago, IL) to analyze the ability to reach the WL and regain patency. A  $P$  value of  $\leq .05$  was used to determine significance.

## Results

### The Ability to Regain the WL and Patency

The WL was re-established in 100% of samples in groups 1, 3, and 4 and in 30% of group 2 (Table 1). Chi-square tests indicated this difference was significant (Pearson chi-square value = 18.781,  $P = .000$ ).

In groups 3 and 4, patency was re-established in 100% of samples. Patency was regained in 80% of group 1 and 30% of group 2 (Table 1). The Fisher exact test indicated significant differences between groups 1 and 2 ( $P = .035$ ), 2 and 3 ( $P = .0015$ ), and 2 and 4 ( $P = .0015$ ). No significant difference was noted between groups 1 and 3 or 4.



**Figure 1.** Residual BCS in the canal space (original magnification 50×). (A) A sample from group 1 showing BCS in the apical foramen. (B) A sample from group 2 showing BCS in the apical canal space.

### Time Required for Obturation Material Removal

The average times required for retreatment of each group are summarized in Table 1. Group 1 took the longest time to retreat followed by groups 2, 4, and 3. One-way analysis of variance indicated a significant difference between groups ( $F = 5.461, P = .003$ ). Post hoc tests noted a significant difference between groups 1 and 3. No significant difference was noted between groups 2 and 4.

### Electron Microscopy

Scanning electron microscopic micrographs of representative samples revealed debris and material remaining in all groups. In group 1, the apical foramen appeared filled with BCS (Fig. 1A). In the samples from group 2, residual BCS was noted in the apical canal space and foramina (Fig. 1B).

### Discussion

This study evaluated the retreatability of BCS. The results indicate obturation with BCS, and a single GP master cone may result in blockage of the apical foramen and a loss of patency in some cases. The WL was re-established in 100% of samples with the master cone seated to the WL regardless of the sealer or obturation technique. However, patency was only regained in 80% of BCS samples with the master cone to the WL. This may be explained by the results of scanning electron microscopic analysis, which showed what appeared to be BCS remaining in the apical foramen and preventing the re-establishment of patency in these samples.

With the master cone intentionally seated short of the WL, BCS proved to be impenetrable in 70% of samples for the WL and patency. It must be noted that this group represents improper usage of BCS but what may occasionally occur clinically. WL and patency were, however, re-established in 30% of this group. This may be explained by the ability of small hand files to navigate through voids within BCS or bypass the sealer in an irregularly shaped canal. Files are unlikely to penetrate BCS because of the hardness upon setting of bioceramics, but in some cases unset sealer may be penetrable. The inability to regain the WL and/or patency may compromise retreatment by preventing proper cleaning and shaping of the apical canal space, which may harbor bacteria.

The average time required for removing obturation material was also significantly longer in group 1 versus group 3. The average differed by 3.4 minutes and may be attributed to additional time and effort required to regain patency in several BCS samples. The lack of significant difference between groups 2 and 4 may be attributed to less time

devoted to group 2 when samples were early on confirmed to be apically nonnegotiable.

It was previously noted that “the key is using bioceramics as a sealer, not a filler” (1, 7). It was also suggested that retreatment be accomplished with ultrasonics in the coronal third to half, followed by chloroform, rotary instruments, and hand files for the remainder of canal space (1, 7). This technique proved ineffective in some samples in the present study and indicates the need for a new technique or solvent to be developed. Similarly, a previous study showed both nickel-titanium rotary instrumentation and ultrasonics were ineffective in completely removing MTA obturations (8). However, ultrasonic instrumentation was previously shown to be effective in hard paste removal and may be suggested in some cases of BCS retreatment (9, 10). In conclusion, the results of this *in vitro* study suggest that conventional retreatment techniques are not always able to fully remove BC Sealer.

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