Clinical Outcome of Non-Surgical Root Canal Treatment Using a Single-cone Technique with Endosequence Bioceramic Sealer: A Retrospective Analysis

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Abstract

Introduction: One of the important steps in root canal treatment is to create a well-sealed root canal system. EndoSequence BC Sealer (BC; Brasseler USA, Savannah, GA) has several beneficial properties and thus has been incorporated into the practitioner's armamentarium. No studies to date have evaluated the clinical success of using BC. The purpose of this study was to evaluate the outcome of nonsurgical root canal treatment using a single-cone and BC technique and to identify factors associated with success or failure. **Methods:** This retrospective cohort study included patients treated in a private practice environment between 2009 and 2015. All cases, including initial and retreatment, were obturated with BC using a single-cone technique with a minimum of a 1-year recall. Patient and treatment factors were analyzed to determine their significance as prognostic factors. Outcome was evaluated based on clinical and radiographic findings at recall. Teeth were classified as healed, healing (success), or not healed (failure). Statistical analysis of potential prognostic factors was performed using the chi-square test (α = 0.05). **Results:** Three hundred seven teeth were included in the analysis, and the average follow-up time was 30.1 months. The overall success rate was 90.9%. Lesions <5 mm in diameter had a significantly higher success rate than lesions >5 mm in diameter. Sealer extrusion was observed in 47.4% of the cases. The presence of sealer extrusion did not have any significant effect on the treatment outcome. **Conclusions:** BC used with a single-cone technique is a viable option for obturation. *(J Endod 2018;44:941–945)*

Key Words

Bioceramic sealer, outcome, root canal obturation, single cone

Significance

This first clinical study on the outcome of nonsurgical root canal treatment using BC sealer showed a 90.9% overall success rate. Although sealer extrusion was observed in about half of the cases, it did not significantly affect the treatment outcome.

An important goal of root canal treatment is to properly seal the canal system after cleaning and shaping. However, irregularities such as fins, isthmuses, and lateral canals are often present and can pose challenges to clinicians during obturation (1–4). The inability to effectively fill and seal these anatomic spaces can have a detrimental effect on the success of endodontic treatment (5). Historically, the failure of root canal treatment has been associated with poor root canal obturation (6, 7). These findings suggest the importance of obturation techniques and materials.

Recently, bioceramics have gained popularity in the modern practice of endodontics because of their physicochemical and biological properties (8). EndoSequence Bioceramic Sealer (BC; Brasseler USA, Savannah, GA) is a calcium silicate–based sealer and is composed of zirconium oxide, calcium silicates, calcium phosphate monobasic, calcium hydroxide, filler, and thickening agents (9, 10). BC demonstrates many desirable properties such as biocompatibility, chemical stability, hydrophilicity, flowability, radiopacity, and slight expansive tendencies (9, 11–13). Bioceramic materials have also been shown to produce hydroxyapatite, which provides for a direct bond between dentin and the material (14). This sealer exhibits an antimicrobial effect on bacteria that are known to be resistant to disinfection procedures such as *Enterococcus faecalis* (15). In addition, BC sealer is conveniently delivered in a premixed form, making its usage consistent and efficient in a clinical setting. The superior flowability and the ability to slightly expand upon setting allow this sealer to be used in a single-cone obturation technique (16). The sealer sets upon contact with moisture, mostly originating from the dentinal tubules (10, 17, 18). Thus, these qualities of BC have improved the efficiency of root canal obturation and may allow for an enhanced seal within otherwise inaccessible canal anatomies.

Although the material is frequently used, few studies to date have evaluated its clinical success. Therefore, the purpose of this study was to evaluate the success rate of nonsurgical root canal therapy using BC and a single-cone technique within a private practice setting.

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Materials and Methods

Case Selection and Treatment Procedure

A search of patients treated in an endodontic private practice setting from 2009 through 2015 was conducted. Patients received a postcard as a reminder to return for a 6-month or 12-month recall appointment. This task was performed using TDO (San Diego, CA) software by searching radiographs labeled "recall." The recall records dated in 2015 and earlier were chronologically evaluated for inclusion. Patients were selected based on the following criteria:

1. A mature tooth that had nonsurgical root canal treatment or nonsurgical retreatment in which obturation was performed using a single-cone technique with BC and gutta-percha
2. American Society of Anesthesiologists classification I or II
3. Radiographs and records documenting preoperative, postoperative, and follow-up of acceptable quality
4. Acceptable obturation quality: all canals filled, no voids measuring larger than 1 mm in diameter radiographically, and filled within 2 mm of the radiographic apex
5. A recall of 1 year or longer
6. Adequate coronal restoration at the recall

Patients were excluded from the study if the overall prognosis of the tooth was poor such as clinical and radiographic signs and symptoms; documented evidence of perforation, cracks extending into canal orifices, or severe periodontal bone loss; or evidence of vertical root fracture (a narrow deep probing defect and/or a J-shaped lesion with a previously treated tooth).

Teeth were treated by 4 endodontists from the same private practice in a single visit. A generalized overview of root canal treatment at the practice involved local anesthesia and dental dam isolation. After access, the canals were prepared using the operator's preferred rotary instrumentation technique using a crown-down approach. The working length was determined using an electronic apex locator (Root ZX II; J Morita, Irvine, CA). In cases in which a reliable electronic apex locator reading could not be achieved, a radiograph was taken to confirm the working length. The master apical file size was case specific and determined based on the initial canal size. In retreatment cases, previous obturation materials and canal obstructions were removed using a combination of ultrasonics, chloroform, Hedstrom files, and rotary instruments. The canals were irrigated throughout instrumentation with 12 mL 5.25% sodium hypochlorite followed by a final rinse with 3 mL 17% EDTA (Vista Dental Products, Racine, WI) using a27-G side-venting needle (Unipack, Sante Fe Springs, CA). Passive ultrasonic irrigation was used to aid irrigation in necrotic and retreatment cases. After the preparation was complete, the canals were dried using paper points. Gutta-percha cones that were 1 size smaller than the master apical file were used. BC was dispensed to fill the coronal half of the canal using a Visco-tip (Vista Dental Products), and a single gutta-percha cone (Brasseler USA) was slowly placed to the working length. Excess gutta-percha was removed using EndoPro 270 (Brasseler USA), and the remaining gutta-percha was vertically packed with a plugger. In the case of oval- or ribbon-shaped canals, additional cones were passively placed adjacent to the master cone. Excess sealer was removed from the chamber before placing the permanent or temporary restoration. In cases in which a permanent restoration was placed, the access cavity was filled with composite (EndoSequence Core Build-Up Material, Brasseler USA); otherwise, a cotton pellet and IRM (Dentsply, York, PA) were used to temporize the tooth, and the patient was advised to return to the referring dentist for permanent restoration as soon as possible. All procedures were performed under surgical microscopes.

Clinical and Radiographic Evaluation

Recall appointments included a radiographic and clinical examination of the treated tooth. The examination was documented and included any signs or symptoms, the presence of a sinus tract, sensitivity to percussion and palpation, swelling, periodontal pockets, or a history of pain. Radiographs were evaluated by 2 calibrated examiners.

The teeth were divided into outcome categories based on the following classification:

1. Healed: Functional, asymptomatic teeth with no or minimal radiographic periradicular (apical) pathosis (radiolucency)
2. Nonhealed: Nonfunctional, symptomatic teeth with or without radiographic periradicular (apical) pathosis (radiolucency) or asymptomatic teeth with unchanged, new, or enlarged radiographic periradicular (apical) pathosis (radiolucency)
3. Healing: Teeth that are asymptomatic and functional with a decreased size of radiographic periradicular (apical) pathosis (radiolucency)

Examples of each outcome category are shown in Figure 1.

Outcome Assessment

The outcome assessment was dichotomized. Both healed and healing cases were considered success, and nonhealed cases were considered failure. Several patient-, tooth-, and treatment-related variables were evaluated to identify possible prognostic factors. Patient factors examined included sex and age of the patient. Tooth-related factors included tooth type, pulpal and periapical diagnosis, pocket depths, sinus tract, presence/absence of periapical lesion, lesion size, and preoperative percussion and palpation sensitivity. Treatment factors evaluated included treatment type (initial treatment or retreatment), sealer extrusion, follow-up time, and type of restoration at recall (access restoration, crown, or bridge).

Analysis of Data

For statistical analysis, the Pearson chi-square test was used to analyze the effect of each prognostic factor after the data were grouped. A P value $<.05$ was considered significant, and all tests were 2-sided. Statistical tests were performed with SPSS v23.0 software (IBM Corp, Armonk, NY).

Results

Three hundred seven patients were included for analysis with a mean follow-up time of 30.1 months ($\pm$18.7 months) and an average age of 48.0 years ($\pm$13.5 years). The sample was composed of 58.6% (180/307) female patients and 23.5% nonsurgical retreatment cases (72/307). The majority of the cases were posterior teeth (92.2%). The demographic characteristics of the patient pool are summarized in Table 1.

The overall success rate was 90.9%, with 83.1% healed, 7.8% healing, and 9.1% not healed. The success rate was 90.6% for initial treatment and 91.7% for retreatment. No significant difference was found between the 2 treatment types. Table 2 shows the outcomes according to tooth factors and treatment factors. A statistically significant difference was found between the groups with lesions <5 mm and >5 mm in diameter (P = .044). Patients younger than 50 years tended to have a higher rate of success than older patients (94.0% vs 87.1%); the difference was approaching statistical significance (P = .054). None of the remaining factors showed a significant influence on the outcome of treatment.

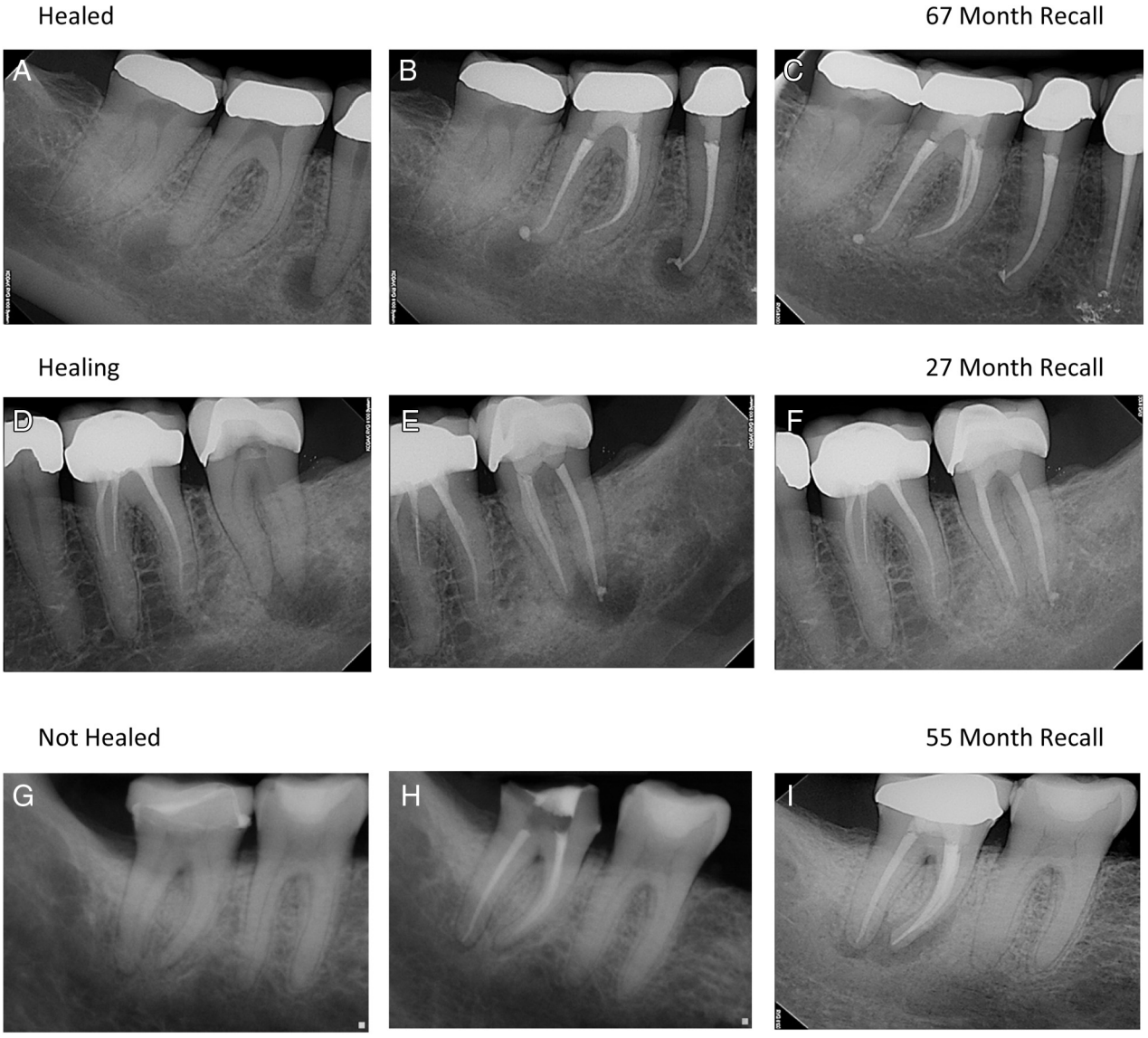

Figure 1. (*A, D,* and *G*) Preoperative, (*B*, *E*, and *H*) postoperative, and (*C*, *F*, and *I*) recall radiographs exemplary of outcomes. (*A–C*) Healed, (*D–F*) healing, and (*G–I*) not healed.

Forty-seven percent of treated teeth exhibited postoperative sealer extrusion on 1 or more root(s). There was no significant difference in success between the presence or absence of postoperative sealer extrusion. Extruded sealer was completely absorbed radiographically 15.8% of the time and partially resorbed 36.3% of the time. Sealer extrusion was more likely to occur when a preoperative lesion was present (66%) compared with when no lesion was present (30.7%), ($P < .001$). No statistical difference was noted when evaluating whether the presence of a lesion affected the absorption of sealer ($P = .165$).

Discussion

The favorable properties of BC such as hydrophilicity, slight setting expansion, and biocompatibility allow it to be used in a single-cone technique and could potentially create an enhanced seal of the root canal system. This technique improves the clinical efficiency of root canal obturation and may subsequently translate to an improved success rate of endodontic therapy. Within the limitations of this study, the overall success rate of nonsurgical endodontic treatment in a private practice setting using BC and a single-cone obturation technique was 90.9%.

The success rate reported in this study is comparable with previous studies that evaluated the prognosis of nonsurgical endodontic treatment. The Toronto studies found a cumulative success rate of 86% in initial treatment after 4 to 6 years postoperatively (19). In a more recent study with a large sample size, the reported success rate was 89.1% for the initial root canal treatment and 85.6% for retreatment using loose criteria and root as a unit of measure (20). This study also reported no significant difference between the initial treatment and retreatment, which is consistent with our findings (20). A considerable difference between previous studies and this study is that the treatment setting is not an educational institution but instead a private practice. The private practice patient pool typically represents a higher degree of difficulty and complexity. On the other hand, the specialists are more efficient and have more practice experience compared with students. These factors may have contributed to the differences in the success rate. In addition, the differences in patient selection criteria,

TABLE 1. Population Demographics

Demographic	*n* (%)
Sex	
Male	127 (41.4)
Female	180 (58.6)
Treatment type	
Initial RCT	235 (76.5)
ReTx	72 (23.5)
PARL presence	
Present	145 (47.2)
Absent	162 (52.8)
Tooth type	
Maxillary anterior	13
Maxillary posterior	113
Mandibular anterior	11
Mandibular posterior	170
Average age	48.0 years
Average time to recall	30.1 months

PARL, periapical radiolucency; RCT, root canal treatment; ReTx, retreatment.

treatment protocol, follow-up time, and outcome assessment make it difficult to compare interstudy results.

In contrast to the majority of previous studies, the presence of preoperative radiolucency was not found to be a significant predictor for success (19, 21–24). However, when the size of the lesion was considered, larger lesions (>5 mm) had a significantly lower rate of success than smaller lesions. This difference could be contributed to the lower availability of osteoblast progenitors present in larger lesions and the higher likelihood of such lesions being a cyst (25, 26).

In this study, 9.1% of cases were deemed failures. Important causes of failure that were observed were cracks and vertical root fractures. Forty-four percent (13/28) of failed cases showed clinical, radiographic, and surgical evidence of either a crack (4 cases) or a vertical root facture (9 cases). Vertical root factures and cracked teeth remain to be a significant source of failure in the private practice setting despite the use of modern techniques in endodontic treatment and coronal restoration placement. A potential benefit of BC and single-cone obturation is the ability to maintain a more conservative preparation design during instrumentation without any aggressive taper. Traditional warm vertical and lateral compaction techniques may demand a larger preparation size and taper to afford for spreader, plugger, and backfill instrument handling within the canal space. Conservation of dentin is important in protecting against initiation and propagation of vertical root fractures (27–29). The remaining 15 failed cases had either persistent pain or persistent, enlarged, or newly developed periapical lesions. The possible reasons for these failures include incomplete cleaning and shaping, coronal leakage, and nonodontogenic neuralgia.

Sealer extrusion and its impact on treatment outcome are topics of interest concerning BC. Because of its excellent flowability, sealer extrusion is frequently observed in cases obturated using BC, especially when there is periapical radiolucency. Postoperative sealer extrusion occurred in 47.4% of treated teeth included in the study; extrusion occurred 66.2% of the time when a lesion was present but only 30.9% of the time when a lesion was not present preoperatively. There is a debate regarding the fate of extruded bioceramic sealer. On one hand, it is suggested that the extruded sealer may remain in the periapical tissue because of the low solubility of calcium silicates. One the other hand, BC is believed to interact with tissue fluids and form hydroxyapatite, which is bioactive and may be replaced by host bone. In this study, approximately half of the extruded sealer cases showed a partial or complete absorption of sealer. Sealer absorption may be related to the periapical status of the tooth such as the presence of inflammatory exudates or cysts. Similar to previous studies of other sealer types, BC extrusion had no significant influence on the nonsurgical treatment outcome (30–32).

This was the first study to report on the clinical success of root canal treatment using BC and a single-cone technique. It included a relatively large patient pool in a private practice setting. The results may be more representative of the clinical success of root canal treatment in the "real world." However, this study was limited by the retrospective nature of the recalls. The inherent selection bias of retrospective studies has the potential to alter outcome measures (33, 34). All patients treated in this practice were mailed a postcard to make a 6- or 12-month recall appointment. However, patients in pain could be more likely to attend the recall appointment. This higher attendance of symptomatic cases could skew the outcome measures toward a higher failure rate than the actual failure rate. In contrast, patients who remain asymptomatic will not attend the recall, making asymptomatic failures less likely to be counted in the study's outcome measurements. It is likely that selection bias played a role in the lack of statistical significance when evaluating certain prognostic factors such as lesion presence and type of treatment. Another source of potential bias is the interpretation of radiographic findings. Although efforts were made to ensure objective evaluation by following the set criteria, bias may still exist in the determination of outcome, especially when 1 of the examiners was involved in the treatment of some of the cases.

TABLE 2. Treatment Outcome by Factors and Demographics

Factor/Demographic	Healed, *n* (%)	Healing, *n* (%)	Not healed, *n* (%)	Success, *n* (%)	*P* value
Sex					.441
Male (127)	105 (82.7)	9 (7.1)	13 (10.2)	114 (89.8)	
Female (180)	150 (83.3)	15 (8.4)	15 (8.3)	165 (91.7)	
Age (y)					.054
≤50 (168)	143 (85.1)	15 (8.9)	10 (6.0)	158 (94)	
>50 (139)	112 (80.6)	9 (6.5)	18 (12.9)	121 (87.1)	
Treatment type					.719
Initial (235)	204 (86.8)	9 (3.8)	22 (9.4)	213 (90.6)	
Retreatment (72)	51 (70.9)	15 (20.8)	6 (8.3)	66 (91.7)	
Lesion					.300
Present (145)	110 (75.9)	24 (16.5)	11 (7.6)	134 (92.4)	
Absent (162)	145 (89.5)	0 (0)	17 (10.5)	145 (89.5)	
Lesion size					.0457
<5 mm	77 (82.8)	12 (12.9)	4 (4.3)	89 (95.7)	
>5 mm	33 (63.4)	12 (23.1)	7 (13.5)	45 (86.5)	
Sealer extrusion					.537
Present (146)	116 (79.4)	16 (11.0)	14 (9.6)	132 (90.4)	
Absent (161)	139 (86.3)	8 (5.0)	14 (8.7)	147 (91.3)	

This study is also limited by having no control group for comparison. The private practice participated in the study has been using BC exclusively since 2008. The success rate found in this study cannot reliably be compared with other obturation techniques and other outcome study results. The success rate of this study does fall within the range found in previous outcome studies, suggesting that BC and a single-cone technique is a viable treatment option (35).

In conclusion, within the limitations of this study, it was found that BC sealer using a single-cone technique can achieve a success rate of 90.9%. Lesion size was determined to be a prognostic factor, with lesions <5 mm in diameter having a higher success rate ($P = .044$). Although sealer extrusion was found in almost half of the cases, it did not appear to affect the outcome of treatment. In the future, prospective case-controlled studies would provide a higher level of evidence in the evaluation of BC and a single-cone technique in comparison with other currently used obturation techniques such as warm vertical compaction.

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The authors deny any conflicts of interest related to this study.

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