

## Original Research

### Evaluation of two bioceramic sealers in Filling Artificial Internal Resorption Cavities using single cone technique: An in vitro CBCT Study

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#### ABSTRACT:

**Introduction:** Obturation of root canal with internal resorption represents a major challenge in Endodontics. In spite of that, usual obturation techniques are often employed without considering the best technique to solve this problem. The goal of this study was to investigate the ability of EndoSequence BC Sealer HiFlow (Brasseler USA), and conventional EndoSequence BC Sealer (Brasseler USA), in filling artificial internal resorption cavities using single cone technique. **Materials and methods:** The study sample included 24 human mandibular premolars that were prepared using Protaper system (F3). Internal resorption cavities were prepared by cutting each tooth at 7 mm from the apex and preparing hemispherical cavities on both the sides and then re-attaching them. The samples were randomly separated into two groups (n = 12 in each group). In the first group, single cone obturation with EndoSequence BC Sealer was done and in group II single cone obturation with EndoSequence BC Sealer HiFlow was done. **Results:** Both the sealers showed best results for filling of artificial internal resorption defects. EndoSequence BC Sealer HiFlow was insignificantly superior to the EndoSequence BC Sealer (p>0.05). **Conclusion:** The EndoSequence BC Sealer HiFlow and conventional EndoSequence BC Sealers with single cone technique seemed to be a promising filling materials for filling artificial internal resorption defects. **Clinical significance:** Internal resorption defects can be successfully filled with both EndoSequence BC Sealer HiFlow and conventional EndoSequence BC Sealer materials when supplemented with a master cone, and the results for both the Sealers are comparable to each other.

Keywords: EndoSequence BC Sealer HiFlow, Internal resorption, CBCT, Single cone Obturation technique.

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#### INTRODUCTION

Root resorption (RR) is the progressive loss of dentin and cementum by the action of odontoclasts.<sup>1</sup> Root resorption might occur as a physiologic or pathologic phenomenon, and is classified into external or internal resorption based on the location of the defect in relevance to the root surface.<sup>2-3</sup> Internal root resorption is the progressive destruction of intraradicular dentin and dentinal tubules along the canal walls as a result of clastic

activities.<sup>4</sup> Various etiological factors have been proposed for internal resorption including the loss of periodontium, trauma, caries and periodontal infections, excessive heat generated during restorative procedures on vital teeth, intra canal calcium hydroxide medicament, anachoresis, orthodontic treatment, cracked teeth or simply idiopathic dystrophic changes with normal pulps.<sup>4</sup>

Internal root resorption (IRR) presents as an irregular resorptive defects in the root canal, making these areas inaccessible with normal methods of cleaning and shaping as well as obturation.<sup>5</sup>The prolonged presence of debris and bacteria in these areas may interfere with the long-term success of the endodontic treatment.<sup>6</sup>Therefore, the importance of achieving total cleaning and filling of the root canal system has been emphasized in case of IRR. Thus, the filling materials should be flowable enough to obturate the resorption defect adequately.<sup>7</sup>

Earlier Mineral trioxide aggregate after its introduction in 1993 was a widely used repair material in endodontic treatments because of its useful properties like good sealing capability, excellent biocompatibility and acceptable antibacterial activity. Now with the advent of new Calcium silicate-based bioceramic sealers such as EndoSequence BC Sealer (Brasseler USA, Savannah) and EndoSequence BC Sealer HiFlow (Brasseler USA, Savannah) from the last decade have received considerable attention because of their favourable physico-biological properties.<sup>8</sup>

EndoSequence BC sealer (Brasseler, Savannah, USA) has been recently introduced (2012) to improve the seal of root canal filling. EndoSequence BC Sealer is a premixed and hydrophilic calcium silicate-based sealer. BC Sealer forms hydroxyapatite upon setting and chemically bonds to dentine. Calcium silicate-based materials are recommended due to their higher bond strength, which is attributed to their small particle size and excellent level of viscosity. Less than 2  $\mu\text{m}$  of particle size enhances its flow into dentinal tubules, lateral canals/spaces, and leading to improved adaptation and gap-free seal.<sup>9</sup> BC sealer expands on setting forming a 'self seal', this expansion can reach upto 0.2% on completion of setting reaction. This expansion, chemical and micromechanical bonding all in total increase the bonding of the sealer to root canal walls. Adding to this, high pH (12.8) during the initial 24 hours of the setting process makes this sealer strongly antibacterial.<sup>9</sup>

Also the manufacturer has recently come with new improved flowable bioceramic sealer the EndoSequence BC Sealer HiFlow (Brasseler, Savannah, USA), introduced in 2018 as a premixed and pre-loaded calcium-silicate-based sealer in a syringe. BC HiFlow Sealer (Brasseler USA) has shown to be biocompatible and bioactive material, incites odontoblastic proliferation, mineralization, and osteogenesis, and at the same time, this bioceramic material has significant anti-bacterial properties.<sup>10-11</sup> As per the manufacturer it has less viscosity and more radiopacity than the conventional EndoSequence BC Sealer.

These calcium silicate-based sealers (EndoSequence BC Sealer and Bio Root RCS) are recommended to use them with the Single Cone (SC) technique.<sup>12</sup> In addition, the SC method is easier to implement;

consequently, it is less sensitive to variations in technique or operator ability.

To the best of our knowledge and after literature review there are no studies on the evaluation of EndoSequence BC Sealer HiFlow and EndoSequence BC Sealer regarding their ability to fill internal resorptive defects especially using Cone Beam Computed Tomography (CBCT). Therefore, the purpose of this study was to evaluate and compare the obturation quality of two contemporary bioceramic root canal sealer (EndoSequence BC Sealer and EndoSequence BC Sealer HiFlow) with single cone technique in internal resorptive defects using Cone Beam Computed Tomography (CBCT).

## MATERIALS AND METHODS

24 mandibular premolars were selected for the study. These teeth were adjusted to a length of 20 mm through the coronal portion reduction using a diamond fissure bur. A conventional endodontic access cavity was prepared in each tooth. Then, a size 10 K-file was inserted into the canal until only the tip was visible at the apical foramen. The length of the file was measured, and 1mm was subtracted from it to determine the working length. After that, ProTaper Universal files (#S1- F3, Dentsply Maillefer, OK, USA) were used. The manufacturer instructions were followed in cleaning and shaping of the root canal system up to F3 file combined with 1 ml of 2.5% sodium hypochlorite (Pyrex Polykem, India) irrigation with 30 gauge side-vented needle (NeoEndo) between each step. Subsequently, all teeth canals were rinsed to remove any remaining smear layer using 1 ml 17% EDTA (Prevest Dentpro, India) for 1 min, followed by 5 ml 2.5% sodium hypochlorite irrigation.

To create Artificial Internal Resorption Cavity, the roots were horizontally sectioned 7 mm from the root apex by a fine diamond disc. Hemisphere cavities were created using a low speed no. 6 round carbide bur around the periphery of the opening of the root canal of each section. The sections were joined together by cyanoacrylate glue (FewiQuic) on the dentine surface around the cavities. The teeth were radiographed in buccolingual and mesiodistal views to visualize the AIRC. The prepared teeth were randomly divided into two groups, each with 12 samples.

Group I: Single-cone technique with EndoSequence BC sealer (ES) Following the manufacturer instructions, the tip of the syringe was inserted into the coronal third of root canal. A small amount of EndoSequence BC sealer was gently dispensed into the root canal by compressing the plunger of the syringe. Then, the master gutta-percha cone (F3 ProTaper gutta-percha) was coated with a thin layer of sealer, and inserted very slowly into the canal. Eventually, the master point was cut off at the orifice, and a hand plugger was used to compact the filling vertically.

Group II: Single-cone technique with EndoSequence BC sealer HiFlow(ESHF) Following the manufacturer instructions,same as that of group I.

To check the filling, filled roots were radiographed in buccolingual and mesiodistal views. Then, they were stored in humid environment at the room temperature for 7 days to ensure that the materials had been set.

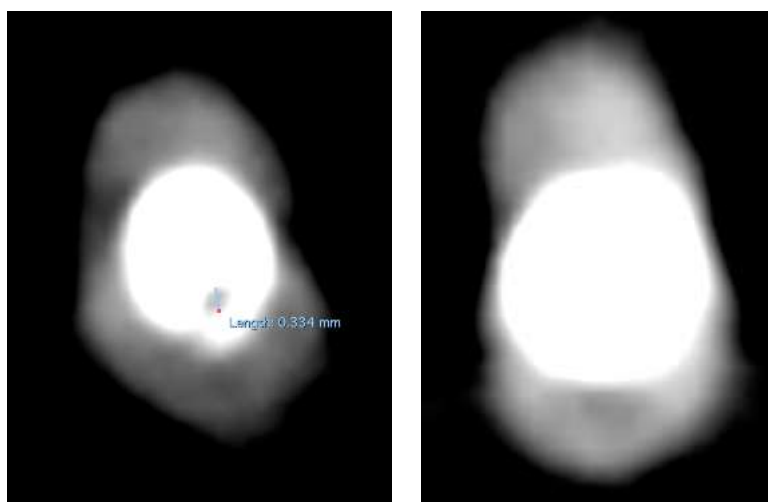
**CBCT EXAMINATION**

Following the obturation and sealing of the coronal access the teeth were embedded in wax on a customized acrylic jig for the precise positioning on the CBCT machine. Then CBCT scans of samples

were taken with FOV size of 8 × 5cm; minimum slice thickness of 100 micron having x-ray source of 0.5 mm focal spot, 60-90 kV voltage and 1-10 mA current. The analysis for the presence of voids in the simulated root resorption defect area was done using HOROS Software. The voids greater or equal to the size of 0.1 mm were detected.

The presence of the voids was categorised according to the following criteria:

- No voids- if the area is devoid of any void (< 0.1mm diameter),
- Presence of small voids (<0.5 mm diameter),
- Presence of voids (>0.5 mm - <1 mm diameter).



(1)

(2)

CBCT images showing (1) obturation with EndoSequence BC sealer HiFlow(ESHF),and (2) showing obturation with EndoSequence BC sealer .

**Statistical Methods:** The recorded data was compiled and entered in a spreadsheet (Microsoft Excel) and then exported to data editor of SPSS Version 20.0 (SPSS Inc., Chicago, Illinois, USA). Statistical software SPSS (version 20.0) and Microsoft Excel were used to carry out the statistical analysis of data. Continuous variables were expressed as Mean±SD and categorical variables were summarized as frequency and percentages. Analysis of variance (ANOVA) was employed for inter group analysis of data and for multiple comparisons, least significant difference (LSD) test was applied. Chi-square test or Fisher’s exact test, whichever appropriate, was used for comparison of categorical variables. A P-value of less than 0.05 was considered statistically significant.

**RESULTS**

The results obtained from CBCT analysis have been summarized in Tables 1 and 2.

Table 1:Comparison based on presence of voids in two groups.

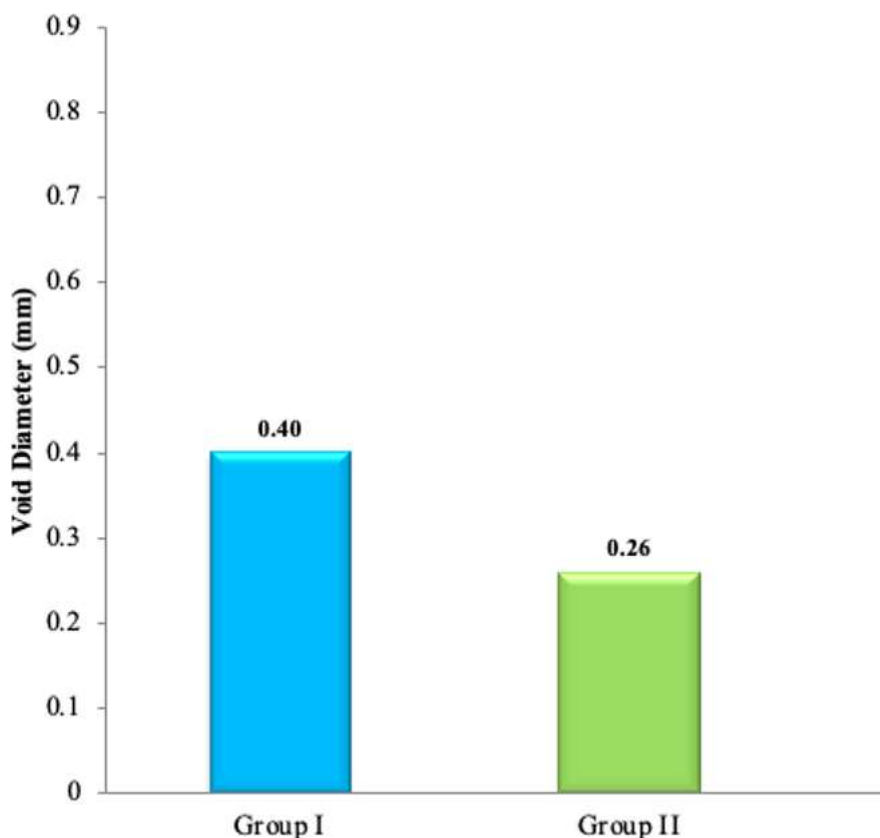
Presence of voids	Group I		Group II	
	No.	%age	No.	%age
No void	12	70.6	14	82.4
Small void (< 0.5 mm)	4	23.5	3	17.6
Void (0.5-1.0 mm)	1	5.9	0	0.0
Total	17	100	17	100

- Statistically no significant difference is present when Group I was compared with Group II(p=0.523).

Table 2: Comparison on the basis of void diameter in two groups.

Group	Mean	SD	Range
Group I	0.40	0.148	0-2-0.6
Group II	0.26	0.058	0.2-0.3

- Statistically no significant difference is present when Group I was compared with Group II on the basis of void diameter ( $p=0.287$ ).



Graph : Bar diagram Showing comparison based on void diameter(mm) in three groups.

## DISCUSSION

The anatomy of root canal system has diversity and some pathologic processes, such as IRR, makes it more complicated. Filling of IRR is a complex procedure that needs high degree of precision. The search for a permanent filling material and a filling system to thoroughly obturate the affected areas by resorption is critically demanded. Many researchers have investigated different techniques and materials to introduce the best technique with excellent resorption defects filling capability. Keles et al proposed vertical compaction technique as an optimum method

for the internal resorption defect filling that was significantly superior to lateral compaction and core carrier techniques such as Thermafil.<sup>13</sup> Basavana et al found that the thermoplasticized gutta-percha injection techniques by using Obtura II provided the best result for filling of simulated internal resorption lesions compared to system B, Thermafil, and lateral compaction techniques.<sup>14</sup> Agarwal et al reported that Thermafil and lateral compaction fillings were inferior compared to thermoplasticized gutta-percha injection fillings using Obtura II and ultrasonic compaction for filling of internal resorption cavities.<sup>5</sup>

MTA is a suitable repair material in endodontic treatments because of its useful properties like good sealing capability, excellent biocompatibility and acceptable antibacterial activity. However, it cannot be recommended as a routine sealer or root canal filling material because of its disadvantages such as difficulty in filling of complicated root canal system, long setting time, unknown solvent for set MTA inadequate water to powder ratio and insufficient compaction which prevent adaptation of MTA to the root canal walls. To overcome potential shortcomings of MTA as a root canal filling material, calcium-silicate-based sealer is used during the root canal filling procedures. Therefore the calcium silicate based bioceramic sealer materials with faster setting time, homogeneous mass during placement, with good bioactivity and better handling characteristics are better alternatives to MTA.

EndoSequence BC sealer (Brasseler, Savannah, USA) has been recently developed in 2012, to improve the seal of root canal filling. According to the manufacturer, it is a premixed ready-to-use injectable bioceramic cement paste that requires the presence of moisture in the dentinal tubules to set.<sup>15</sup> Its major inorganic components include tricalcium silicate, dicalcium silicate, calcium phosphates, colloidal silica, and calcium hydroxide. It uses zirconium oxide as the radiopacifier and contains water-free thickening vehicles to enable the sealer to be delivered in the form of a premixed paste.<sup>16</sup>

Endosequence BC Sealer HiFlow (Brasseler, Savannah, USA) most recently introduced (2018) as a premixed and pre-loaded calcium-silicate-based sealer in a syringe, with better flowable properties. Some desirable mechanical and biological characteristics of calcium-silicate-based sealers include initial fast setting time, higher washout resistance, biocompatibility and bioactivity. As per the the manufacturer it has less viscosity and more radioopacity than the conventional Endosequence BC Sealer.<sup>10-12</sup>

Avoiding voids in the sealer is of importance for root canal treatment, especially when the shrinkage or degradation of sealers and the core materials would happen or in the cases where obturation relies more on sealers than the core materials, i.e. single cone technique. It makes sense that excellent radiopaque, well consistent, limited shrinkage and degradation, at least within the due bounds, are a prerequisite for these newly developed sealers to secure their clinical performance.

After the review of literature, less data was available regarding these new sealers and the voids they leave in obturating the internal resorption defects. With these facts in mind the present study was undertaken to compare the filling ability of; Endosequence BC Sealer and Endosequence BC Sealer HiFlow in obturation of internal resorption defects.

Several techniques, such as radiography, transverse root cutting and dye injection associated with diaphanization, have been described in the literature for evaluating the quality of the root canal system filling; however, these techniques have limitations. The cross-cut technique may lead to the loss of material during its execution. The insertion of dyes into the root canal system is negatively affected by the air present in the gaps at the dentin-filling material interface, resulting in failure to reveal the total volume of the bubble. These techniques also require the destruction of the specimen analysed.<sup>17</sup>

CBCT has the advantages of providing accurate three-dimensional data and preserving the specimens. Hence in present study high resolution non-destructive 3D imaging modality was to quantitatively assess voids in simulated internal root resorption defects obturated by three different sealers and to explore the feasibility of using CBCT for quantitative analysis of filling quality of root canal sealers. This study using high-resolution imaging allowed further exploration of voids 3 dimensionally in a non-destructive way.

The results of the present study revealed that EndoSequence BC Sealer HiFlow and the conventional EndoSequence BC Sealer exhibited the less percentage of voids in filling of the simulated root resorption defect present at the middle third of the tooth. This can be attributed to the filling technique, because the manufacturer of EndoSequence BC Sealer recommend that it is injected in the middle part of the root canal, and then a master gutta-percha cone is placed which ensures the least amount of voids there. The observed nonsignificant superiority of the EndoSequence BC Sealer HiFlow over the conventional EndoSequence BC Sealer may be due to the increased flowability, and the lower viscosity of the former one, as per Binwen Chen et al.<sup>18</sup> This comparable filling ability of EndoSequence BC Sealer and EndoSequence BC Sealer HiFlow is in accordance with a previous study done by John Z. Reynolds et al (2020).<sup>19</sup> This study compared the depth and percentage of dentinal tubule penetration of two different bioceramic sealers (BC Sealer [BCS], BC Sealer HiFlow [BCSHF]) with single-cone (SC) obturation technique, and found that there was no significant difference in dentinal tubule penetration on comparing BC Sealer and BC Sealer HiFlow.

So as per the results of the present study, none of the sealers showed void free obturation of internal root resorption defects. However, a lower void percentage both at dentine/ sealer interface and inside the material of both the sealers, may favour their application in internal root resorption cases.

## CONCLUSION

Within the limitations of the present study it can be concluded that ,EndoSequence BC Sealer and EndoSequence BC Sealer HiFlow with single cone

technique are the promising filling materials to fill internal root resorption cavities. Among the two sealers EndoSequence BC Sealer HiFlow showed the least percentage of voids.

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