ISSN Print: 2394-7489
ISSN Online: 2394-7497
IJADS 2021; 7(4): 597-600

www.oraljournal.com
Received: 27-02-2021
Accepted: 30-03-2021

Dr. Tahseena Ashraf
Post Graduate Student, Department of Conservative and Endodontics, Govt. Dental College and Hospital, Srinagar, Jammu and Kashmir, India

Dr. Riyaz Farooq
Professor (HOD), Department of Conservative Dentistry and Endodontics, Srinagar, Jammu and Kashmir, India

Dr. Amir Rashid Purra
Associate Professor, Dept. of Conservative Dentistry and Endodontics, Srinagar, Jammu and Kashmir, India

Dr. Fayaz Ahmed
Assistant Professor Conservative Dentistry and Endodontics, Srinagar, Jammu and Kashmir, India

Corresponding Author:
Dr. Tahseena Ashraf
Post Graduate Student, Department of Conservative and Endodontics, Govt. Dental College and Hospital, Srinagar, Jammu and Kashmir, India

3D CBCT evaluation of root filling quality of two sealers in oval-shaped canals

Dr. Tahseena Ashraf, Dr. Riyaz Farooq, Dr. Amir Rashid Purra and Dr. Fayaz Ahmed

DOI: https://doi.org/10.22271/oral.2021.v7.i2i.1369

Abstract
Aim: The oval canals may be associated with inadequate debridement, which can affect the quality of the root canal filling, thus the treatment outcome. The aim of the present work was to compare the quality of oval canals fillings using EndoSequence BC sealer and Bio Root RCS with the single-cone technique.
Materials and Methods: In total, 20 freshly extracted human single-rooted maxillary premolars were used. Specimens instrumented with the Protaper gold rotary instruments were assigned randomly into two groups. In each group, root canals were filled with single-cone gutta-percha and one of the tested sealers. Each specimen was then scanned using. CBCT at a voxel resolution of 100 mm.
Proportions of sections with voids in cross-sectional images and void volumes for each sealer were calculated in the apical, middle, and coronal thirds. Differences according to root canal sealers were evaluated statistically using the Kruskal–Wallis test and the Mann– Whitney U-test at a significance level of 5%.
Results: The analysis showed a decrease in void formation in the apical third, with a significant difference between the apical and coronal thirds among bioceramic sealers The bioceramic sealers (EndoSequence BC Sealer, Bio Root RCS) produced similar voids which had the fewest in the apical third of root canals among the sealers tested which can be related due to root canal
anatomy variations

Keywords: Bioceramic sealers, EndoSequence BC sealer, root canal filling, single-cone technique

Introduction
Root canal obturation aims to provide a complete filling of the canal creating a fluid-tight seal, which can prevent residual bacteria and their toxins from affecting the periapical tissues. Many obturation materials and techniques have been introduced over the years, each attempting to provide a better seal of the root canal. In vitro studies have demonstrated that most of the root canal filling techniques did not fill the entire root canal system [1]. The irregularities on dentin walls and the complex geometry of the root canal system, especially in oval and ribbon-shaped root canals, may be the main explanations for these results. These anatomical features of the root canal system may impede adequate cleaning of the narrow fissured areas increasing the risk of creating voids. It is assumed that unfilled areas may harbor unaffected residual bacterial biofilms and serve as a potential cause of persistent infection and poor treatment outcome [2].
Earlier Single cone technique was not considered satisfactory for oval canals, as the larger amount of sealer required to fill oval canals resulted in a large area of shrinkage, with subsequent formation of voids between the filling material and the root canal wall [3]. Consequently, fluid leakage and sealer degradation were frequent [4]. Now with the advent of bioceramic sealers with low contraction rates [5, 6] and the introduction of single-file systems combined with matching gutta-percha points, the former practice of obturating canals with a single cone has resumed. With these new sealers, the role of the gutta-percha point is solely to act as a vehicle rather the filling material. Simplicity of use, speed of treatment, and lighter pressure on the root canal walls are the main advantages of this technique.
EndoSequence BC sealer (Brasseler USA; Savannah, GA; also marketed as Total Fill BC Sealer in other countries) has stood out among these new sealers. A recent study evaluated the

clinical outcomes of non-surgical root canal treatment with EndoSequence BC sealer, reporting a success rate of 90.9%.8 The favorable properties of this material include antibacterial action,[7] biocompatibility [8], adequate seal [9], and adhesion to dentin [10]. An earlier study revealed that EndoSequence BC sealer undergoes slight expansion, whereas traditional sealer such as AH Plus undergo shrinkage. As a calcium phosphate silicate-based sealer, EndoSequence BC sealer forms hydroxyapatite in the presence of water, which leads to a direct bond between sealer and dentin [11]. The manufacturer of EndoSequence BC sealer recommend the use of sealer with single-cone technique. According to the manufacturer, this technique results in a root canal filling free of gaps, and that facilitates retreatment, when necessary.

Recently in 2015 a new tricalcium silicate-based sealer was introduced, BioRoot RCS (Septodont, Saint-Maur-des-Foss_es, France) which is a water-based sealer composed of tricalcium silicate and zirconium oxide [12, 13]. BioRoot RCS releases calcium hydroxide after setting. BioRoot RCS leaches high levels of calcium exhibiting double the calcium ion leaching compared with EndoSequence BC Sealer [12]. It also forms a calcium phosphate phase when in contact with physiologic solution. BioRoot RCS has less toxic effects on periodontal ligament cells and induced secretion of angiogenic and oestrogenic growth factors indicating a higher bioactivity [14].

Obturation of oval root canals has always been challenging in comparison with root canals with a circular cross-section. The irregular shape of oval canals is associated with inadequate debridement, which can negatively affect the quality of the root canal filling.[15]For this reason, concerns regarding the obturation of oval root canals with the single-cone technique are still valid, even when using bioceramic sealers. Thus, the aim of this study was to compare the quality of obturations of oval root canals using EndoSequence BC sealer and BioRoot RCS with the single-cone technique. CBCT images were used to evaluate the volume of voids in the obturations.

Materials and methods

In our study, 20 extracted human single-root maxillary premolars without caries, root resorption, or fractures were used. Root surfaces were scaled with a curette to remove soft tissue, calculus, and bone. Each tooth was placed in 5.25% sodium hypochlorite (NaOCl) for 2 h for surface disinfection, and then stored in distilled water until testing was performed.

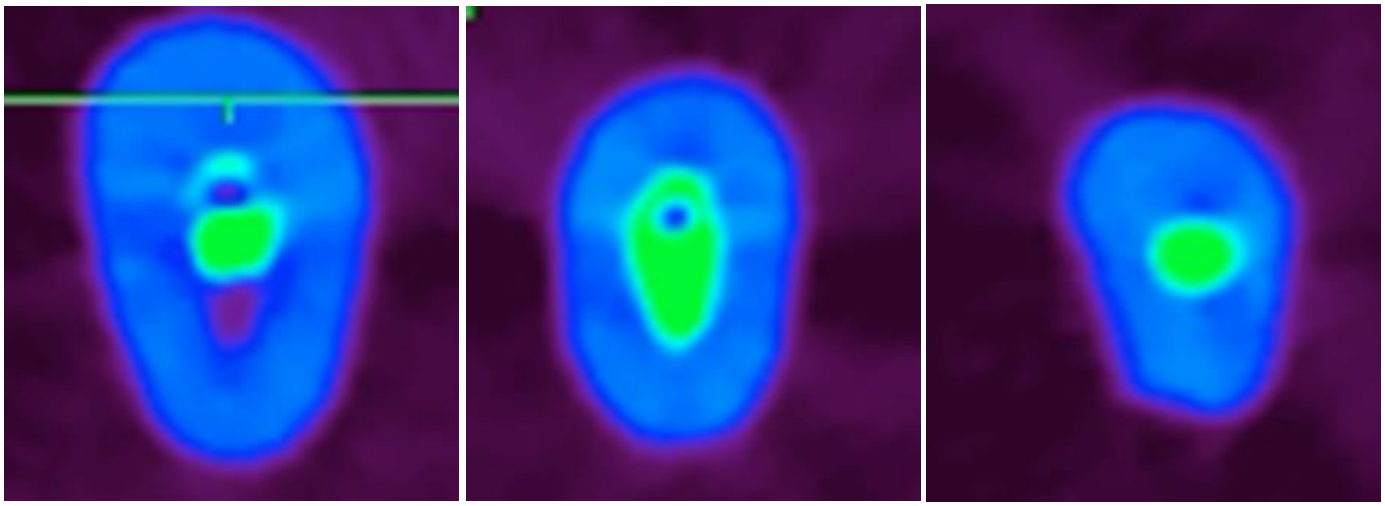
Before starting the experiment, a pre-operative radiograph was taken to evaluate the anatomy of the extracted teeth before their selection. After inspection only specimens with oval canals were selected, to standardize the root canal 3D configuration. All teeth were decoronated at the cemento–enamel junction and adjusted so that each root was approximately 12 mm in length. Subsequently, a size #10 K-File (Maillefer, Ballaiges, Switzerland) was inserted into the root canal until the tip was just visible beyond the apex. Working length was determined by subtracting 1 mm from this length. All samples treated and measured had the same taper. Accordingly 20 experimental teeth were instrumented to F2 Protaper gold NiTi rotary instruments. Irrigation was performed with 2 mL 2.5% NaOCl between each instrument. A final rinse with 2 mL 2.5% NaOCl, 2 mL 17% EDTA for 1 min, and 10 mL distilled water was performed. Then, the canals were dried with paper points.

Root Canal Filling: Teeth were assigned randomly into two experimental groups (10 roots each). Root canal sealers were prepared in accordance with the manufacturers' recommendations and then the experimental groups of teeth were filled with a single-cone technique. Group 1 was filled with EndoSequence BC Sealer (Brasseler, USA) and Group 2 was filled with Bio Root RCS (Septodont, France). After the filling process, roots were stored at 37℃ at 100% humidity for 5 days to ensure the sealer was set.

CBCT Evaluation

The samples were embedded in wax on a customized acrylic jig for precise positioning on CBCT machine. 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. Images data was transferred to the computer hard drive and was analysed using NNT software and Horos software. Horos software was used for the 3-dimensional volumetric visualization and analysis.

Each tooth was divided into three regions for the evaluation of voids, from the apical end of the root at a level of 0–4 (apical), 4–8 (middle), and 8 12 mm (coronal). The volume of internal voids distributed inside the root canal root canal filling material, the external voids along the canal walls, and the combined voids in materials communicating with the canal walls, were calculated with the CBCT analysis.



(1) (2) (3)

CBCT Images: (1) Coronal section, (2) Middle section, (3) Apical section

Statistical Analysis

Kruskal Wallis test was performed first, and then, in cases where statistically significant p-values were found, Mann–Whitney's U post-hoc tests carried out for pairwise comparisons. These analyses were performed with the SPSS software (version 20.0) at significance level of (p>0.05).

Results

Voids were found with both the root canal sealers. Overall the filling quality of both sealers did not differ significantly. The volume of voids in detail, in the apical, middle, and coronal thirds is given in the table below (Table 1). The analysis showed considerable reduction of voids in terms of combined voids in the apical third, with significant differences between apical and coronal third of the teeth (p <0.05). However no significant difference was found between the apical and middle or middle and coronal thirds (p >0.05) for both the tested sealers in the study.

Table 1: Show the table of analysis of considerable reduction

Regions	Root canal filling materials	Mean	SD	*p*-value
Apical third	EndoSequence BC sealer	0.226	0.196	p <0.05
	BioRoot RCS	0.229	0.197	
Middle third	EndoSequence BC sealer	0.380	0.37	p >0.05
	BioRoot RCS	0.487	0.321	
Coronal third	EndoSequence BC sealer	0.710	0.804	p <0.05
	BioRoot RCS	0.975	0.831	

Discussion

In the past, the adequacy of root canal filling procedure was primarily based on its vertical appearance on the dental radiograph and whether the material had reached the radiographic apex or not. But now what is required is a deeper appreciation of the importance of filling canals laterally as well as vertically [16]. Herbert Schilder describes the final objective of endodontic procedure as being the "total obturation of root canal space" or filling the radicular space three dimensionally. Rich Mounce in 2004 defined three-dimensional (3D) obturation as placing a homogeneous and dense filling material, from the canal orifice to the minor constriction of the apical foramina, as well as into all anatomical ramifications.

Vannier, *et al.* demonstrated the feasibility of CBCT for quantitative study of oral hard tissues in the presence of metal restorations. Blake Nielson R, *et al.* evaluated the value of micro computed tomography in morphological relationships in endodontic research and concluded that CBCT is an important diagnostic tool used for various dental hard and soft tissues. Kleoniki Ly Roundi, *et al.* studied the application of both digital 3D image processing and virtual reality techniques in endodontics, and he concluded that the CBCT is an important tool for depicting the 3D volume of the obturated canals.

Thus, the volume-rendering technique used with the help of CBCT is the most accurate mode of depiction of 3D volume of the obturated canals. It allows the clinician to visualize the filling from all angles unlike radiographs, which give 2d reproductions. The voids at various axial levels can be calculated [17].

Several studies have been reported using micro-CT data for the evaluation of voids and the filling quality of sealers (Metzger *et al.*, 2010 [18]; Flores *et al.* [19], 2011; Somma *et al.* [20]). Naseri *et al.* (2013) studied voids with different filling techniques with micro-CT using AH-26 and determined that all samples had some voids with all the different filling techniques. Somma *et al.* (2011) used three different filling techniques with AH Plus and indicated no significant difference in detecting voids. The mean values of root filling for the methods were between 98.167% and 99.023%, while the internal voids were between 0.059% and 0.322%. Similarly the external voids were between 0.485% and 0.94%, and the combined voids were 0.273–0.828%. In on our results, similar gaps and voids were found for all the root canal sealers tested. In our opinion, these voids are closely related to the root canal anatomy rather than the root canal filling material or technique. Generally, the morphology of the root canal varies greatly in shape and transversal cross sections in different groups of teeth.

In the present study, the volume of voids was greater in the coronal portion of the canal, which is probably due to the tendency to the canals toward a rounder shape closer to the apex, and to the fit of the cone in this portion.[21]Still, none of the sealers with single cone obturation technique was capable of filling the root canal space completely in all specimens, which corroborates previous studies involving micro-CT analyses in oval root canals [9, 22].

Based on our results, both sealers resulted in some voids in all three thirds of the teeth. However, significant differences were found in terms of combined voids in the apical third versus the coronal third of the teeth. In both groups, the less voids were observed in the apical third of the root canals it may be explained because root canals tend toward a rounder cross section at this level (Wu *et al.* 2002), favouring well adaptation of the master cone. Actually, considering the results from previous 3D studies on root filling (Hammad *et al.* 2009, Mirfendereski *et al.* 2009, Metzger *et al.* 2010, Somma *et al.* 2011, Angerame *et al.* 2012), it seems that the distribution of sealer and voids within the root canal space after is unpredictable, irrespective of the filling method.

Oval canals are regarded as the best model to evaluate the filling ability of different obturation techniques [23] Voids are more common in this type of canal than in circular canals, not only due to the limitations of the obturation techniques but also due to the presence of unprepared areas, especially in buccal and lingual recesses [24-26]. The risk of treatment failure may be higher when the filling material is unable to trap the bacteria left in these areas [27, 28]. Hence, the development of new materials and techniques to fill oval canal recesses should be encouraged.

A limitation of this study is that it was based on the single-cone technique; the bioceramic root canal sealers used in this study should also be tested with other filling techniques. Thus, further studies should be conducted for full comparisons using both different filling techniques and root canal sealers in combination.

Conclusions

All root canal sealers tested resulted in voids. The bioceramic sealers (Endo-Sequence BC Sealer, BioRoot RCS) produced similar voids which had the fewest in the apical third of root canals among the sealers tested which can be related due to root canal anatomy variations.

References

1. Metzger Z, Zary R, Cohen R, Teperovich E, Paqué F. "The quality of root canal preparation and root canal obturation in canals treated with rotary versus self-

adjusting files: a three-dimensional micro-computed tomographic study", J Endod. 2010;36:1569-73,
1. Fornari VJ, Silva-Sousa YTC, Vanni JR, Pécora JD, Versiani MA, Sousa-Neto MD. "Histological evaluation of the effectiveness of increased apica enlargement for cleaning the apical third of curved canals", Int Endod J. 2011;43:988-94.
2. Wu MK, Ozok AR, Wesselink PR. Sealer distribution in root canals obturated by three techniques. Int Endod J. 2000;33(4):340–34.
3. Yücel AC, Ciftçi A. Effects of different root canal obturation techniques on bacterial penetration. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2006;102(4):e88–e92.
4. Trope M, Bunes A, Debelian G. Root filling materials and techniques: bioceramics a new hope? Endod Topics. 2015;32:86–96.
5. Zhou HM, Shen Y, Zheng W, Li L, Zheng YF, Haapasalo M. Physical properties of 5 root canal sealers. J Endod. 2013;39(10):1281–1286.
6. Wang Z, Shen Y, Haapasalo M. Dentin extends the antibacterial effect of endodontic sealers against Enterococcus faecalis biofilms J Endod. 2014;40(4):505–508.
7. Rodríguez-Lozano FJ, García-Bernal D, Oñate-Sánchez RE, Ortolani-Seltenerich PS, Forner L, Moraleda JM. Evaluation of cyto-compatibility of calcium silicate-based endodontic sealers and their effects on the biological responses of mesenchymal dental stem cells. Int Endod J. 2017;50(1):67–76
8. Celikten B, Uzuntas CF, Orhan AI, *et al*. Evaluation of root canal sealer filling quality using a single-cone technique in oval shaped canals: An in vitro Micro-CT study. Scanning 2016;38(2):133–140.
9. Pawar AM, Pawar S, Kfir A, Pawar M, Kokate S. Push-out bond strength of root fillings made with C-Point and BC sealer versus gutta-percha and AH Plus after the instrumentation of oval canals with the Self-Adjusting File versus WaveOne. Int Endod J. 2016;49(4):374–381.
10. Loushine BA, Bryan TE, Looney SW, *et al.* Setting properties and cytotoxicity evaluation of a premixed bioceramic root canal sealer J Endod 2011;37(5):673–67.
11. Xuereb M, Vella P, Damidot D, Sammut CV, Camilleri J. In situ assessment of the setting of tricalcium silicate–based sealers using a dentin pressure model. Journal of endodontics. 2015;41(1):111-24.
12. Camilleri J. Sealers and warm gutta-percha obturation techniques. Journal of endodontics. 2015;41(1):72-8.
13. Camps J, Jeanneau C, El Ayachi I, Laurent P, About I. Bioactivity of a calcium silicate–based endodontic cement (BioRoot RCS): Interactions with human periodontal ligament cells in vitro. Journal of endodontics. 2015;41(9):1469-73.
14. De-Deus G, Reis C, Beznos D. de Abranches AM, Coutinho-Filho T, Paciornik S. Limited ability of three commonly used thermo plasticized gutta-percha techniques in filling oval-shaped canals. J Endod. 2008;34(11):1401–1405.
15. Stephen C, Burns R. Pathways of pulp. 6th ed. USA: Mosby Publications, 2000, 225.
16. Chokkalingam M, Ramaprabha, Kandaswamy D. Three dimensional helical computed tomographic evaluation of three obturation techniques: in vitro study. J Conserv Dent. 2011;14(3):273-276.
17. Metzger Z, Zary R, Cohen R, Teperovich E, Paque F. The quality of root canal preparation and root canal obturation incanals treated with rotary versus self-adjusting files: a three- dimensional micro-computed tomographic study. J Endod. 2010;36:1569–1573.
18. Flores DS, Rached FJ, Jr, Versiani MA, *et al.* Evaluation of physicochemical properties of four root canal sealers. Int Endod J. 2011;44:126–135.
19. Somma F, Cretella G, Carotenuto M, *et al.* Quality of thermoplasticized and single point root fillings assessed by micro-computed tomography. Int Endod J. 2011;44:362–369.
20. Wu MK, R'oris A, Barkis D, Wesselink PR. Prevalence and extent of long oval canals in the apical third. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2000;89(6):739–743.
21. Keleş A, Alcin H, Kamalak A, Versiani MA. Micro-CT evaluation of root filling quality in oval-shaped canals. Int Endod J. 2014;47(12):1177–1184.
22. Jarrett IS, Marx D, Covey D, Karmazin M, Lavin M, Gound T. Percentage of canals filled in apical cross sections – An in vitro study of seven obturation techniques. Int Endod J. 2004;37(6):392–398.
23. Versiani MA, Pécora JD, de Sousa-Neto MD. Flat-oval root canal preparation with self-adjusting file instrument: a micro-computed tomography study. J Endod. 2011;37(7):1002–1007
24. Wu MK, Wesselink PR. A primary observation on the preparation and obturation of oval canals. Int Endod J. 2001;34(2): 137–141
25. Siqueira JF Jr, Pérez AR, Marceliano-Alves MF, et al. What happens to unprepared root canal walls: A correlative analysis using micro-computed tomography and histology/scanning electron microscopy. Int Endod J. 2018;51(5):501–508
26. Ricucci D, Siqueira JF Jr, Bate AL, Pitt Ford TR. Histologic investigation of root canal treated teeth with apical periodontitis: a retrospective study from twenty-four patients. J Endod. 2009;35(4):493–502.
27. Torabinejad M, Ung B, Kettering JD. In vitro bacterial penetration of coronally unsealed endodontically treated teeth. J Endod. 1990;16(12):566–569.