




EVALUATION OF RETRIEVABILITY OF A NOVEL BIO-CERAMIC MATERIAL USING TWO DIFFERENT OBTURATION TECHNIQUES. (IN VITRO STUDY)

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ABSTRACT

Aim: This study aimed to evaluate the retrievability of new bio-ceramic material using either single cone technique or cold lateral compaction technique.

Methodology: Thirty recently extracted human permanent mandibular premolars were collected. Samples were randomly distributed among three groups (n=10) based on the obturation technique followed using different sealers; Single Cone Technique/Well-Root ST sealer (SCT/Well-Root ST), Cold Lateral Compaction/Well-Root ST sealer (CLC/Well-Root ST), and Cold Lateral Compaction/AH Plus Sealer (CLC/AH Plus). Following root canal instrumentation and obturation of samples, filling material was retrieved. Retrievability was evaluated in terms of percentage of remaining obturation material, and the mean time required for the retrieval. Samples were longitudinally sectioned into mesial and distal halves. The half containing the greater percentage of remaining obturation material was selected, imaged using dental operating microscope (DOM) at 16x. Photomicrographs of each third of the canal were captured using digital video camera mounted on the DOM. The percentage of remaining obturation material was evaluated using ImageJ software.

Results: The highest percentage of remaining obturation material and the mean time required was found in SCT/Well-Root ST group, and the lowest percentage was found in the CLC/AH Plus group.

Conclusion: Retrievability of canals obturated using SCT/Well-Root was difficult.

KEYWORDS: Retrievability, Single cone technique, Bio-ceramics, Well-Root ST, AH Plus.

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INTRODUCTION

Non-Surgical root canal retreatment allow for the destruction of the microorganisms causing persistent infection in case of failure of previously root canal treated teeth with maximum preservation of the remaining tooth structure and surrounding periodontium. Therefore, it is the first line of treatment when conventional root canal treatment fails^(1,2). Canal morphology may act against optimum and complete retrieval of obturation material during retreatment, especially in oval and irregularly shaped canals⁽³⁾, which consequently would worsen the prognosis of the outcome.

Nowadays, there's a great need for simple and efficient obturation method, which will increase optimum management and outcomes in negligible stress for patients and clinicians. With the extensive use of rotary NiTi instruments and matched taper gutta percha cones, the single cone obturation technique has become common and popular.

The perfect sealer and filling material have yet to be found. **Ingle et al.** reported that incomplete filling of the root canal space is linked to 58% of failures of root canal treatment⁽⁴⁾.

Therefore, evaluation of retrievability of bio-ceramic sealers using single cone obturation technique was thought to be of value.

Aim of the study

This study aimed to evaluate retrievability of new bio-ceramic material using either single cone technique or cold lateral compaction technique.

MATERIALS AND METHODS

Sample Selection and Preparation

Thirty recently extracted human permanent mandibular premolar teeth were selected to be free of root defect or fractures, having mature apices, with patent, single, straight root canals, with no evidence of resorption or calcification. Teeth were examined using Prima DNT Dental Operating

Microscope (Labomed, California, USA) at 10x magnification, then pre-operative radiographs were taken to confirm the previously mentioned inclusion criteria for both the mesio-distal and the buccolingual aspects. Decoronation was done for all samples using a diamond wheel stone mounted to a high-speed handpiece with copious amount of water coolant, and the length was standardized at 15 mm.

Sample Classification

Random distribution was done for all samples into three main groups according to obturation technique; Group 1: Bio GP Points (Bio-ceramic impregnated gutta percha – Sure Dent Corporation, Gyeonggi-do, South Korea)/ Well-Root ST (Bio-ceramic sealer - Vericom, Gangwon-Do, Korea) with single cone technique (SCT). (n=10), Group 2: Regular gutta percha points (MetaBiomed, Chungcheongbuk-do, South Korea) / Well-Root ST with cold lateral compaction technique (CLC) (n=10), and Group 3: Regular gutta percha points / AH Plus sealer (Dentsply, DeTrey, Konstanz, Germany) with cold lateral compaction technique (CLC) (n=10).

Root Canal Instrumentation

Patency of root canals was confirmed by utilizing a small K file #10 (MANI, Tochigi, Japan). Tooth length (TL) was determined using Prima DNT Dental Operating Microscope by introducing a K-file #15 till it became visible through the apical foramen. Working length (WL) determination was done by subtracting 1 mm from the measured TL. Root canals were prepared by the crown down technique using X7 EdgeFile rotary file system (EdgeEndo, New Mexico, USA) till size 40/0.06. The rotary files were operated using small pecking motion. Endomotor settings were adjusted according to the manufacturers instructions at speed setting 350 rpm and torque setting 3 N.cm. Apical stop was checked using manual K-File size 40 K file. Irrigation of root canals was done using 5.25% sodium hypochlorite irrigation (NaOCl) using 27-gauge sterile plastic

syringes, placed inside the canals passively 2mm away from the working length. Dryness protocol was done according to the obturation technique followed in the study groups.

Sample Obturation

For group 1, The canals were dried using one paper point of the same size of the master apical file. Optimum dryness of the canals was confirmed when 3- 4 mm from the tip of the used paper point was wet. Master gutta percha cone 40/0.06 was selected and checked to confirm that tug back was present and that it reached the full working length. A rubber stopper was inserted into the tip of the syringe of the bio-ceramic sealer and adjusted to be 3-mm short of the working length of the canal. Thereafter the sealer was injected into the canal, then the adjusted matching master cone was placed.

For group 2, the dryness protocol was done as followed in group 1. CLC technique was done as usual using hand spreader and auxiliary gutta percha cones.

For Group 3, dryness of the root canals was done using paper points of the same size of the master apical file. Optimum dryness of the canals was confirmed when the last used paper point came out dry and CLC technique was done as usual. Removal of excess gutta percha was done using heated instrument at the level of the canal orifice.

The obturation quality of samples in all groups was radiographically checked and any obturation with discernable voids or with missed canals were excluded and replaced with a new sample prepared in the same way. All treatment procedures were carried out by the same operator. Complete setting of the sealer was allowed by preservation of samples at 37°C and 100% relative humidity for 7 days⁽⁵⁾.

Sample Evaluation

Obturation material was removed using Rogin Dental NiTi Retreatment System (Rogin Dental, Shenzhen, China). D1 file (25/0.09 – 16mm) was

employed to remove the obturation material from the coronal 2/3 of the canal. Regaining patency was attempted using manual K-File #10-15. After regaining patency, WL was measured to avoid over-instrumentation. Complete removal of the remaining obturation material was done using D2 (25/0.08 – 18mm) and D3 (20/0.07 – 22mm) rotary files, till no obturation material was evident on the last used file.

Irrigation of the root canals was done using 5.25% NaOCl. Finally, remnants of NaOCl and debris were removed by rinsing with 10 mL of sterile saline. The irrigating solutions were introduced through 27-gauge sterile plastic syringes.

Each sample was then grooved with a diamond disc buccolingually until the shadow of the canal appeared through a thin layer of dentin, then longitudinally sectioned using chisel into mesial and distal halves⁽⁶⁾. The half of the roots having the greatest area of remaining obturation material were selected and canal cleanliness was assessed using Prima DNT Dental Operating Microscope at 16x magnification. Photomicrograph of each third of the canal (coronal, middle, and apical) was captured using digital video-camera (Sony, Tokyo, Japan) mounted on the microscope. Computer system was used for analysis of images. Retrievability was evaluated in terms of percentage of remaining obturation material, and the mean time required for removal of obturation material. ImageJ software (NIH, New York, USA) was used to calculate the percentage of remaining obturation material in sections. For evaluation of the mean time required for the retrieval process (6), three types of time records (in minutes) were measured; T1= the cumulative required time for regaining patency and reaching the WL starting from the first instrument used, T2= the required time for complete removal of the obturation material from the first instrument used after regaining patency until no obturation material was evident on the last used file, and T3= The cumulative time of

the retrieval process (T1+T2). The time taken for the handling of instruments, changing of files, irrigation, etc., was excluded in all measured records. Tabulation of the collected data was done using Microsoft Excel for subsequent statistical analysis.

Statistical Analysis

Numerical data were presented as mean and standard deviation (SD) values. They were explored for normality by checking the data distribution and using Shapiro-Wilk test. Data showed parametric distribution and were analyzed using one-way ANOVA followed by Tukey's post hoc test for independent samples. The significance level was set at $p \leq 0.05$. Statistical analysis was performed with Minitab statistical analysis software (Minitab Ltd., Brandon Court, United Kingdom) version 10 for Windows.

RESULTS

The percentage of remaining obturation material:

(As shown in table 1)

In the coronal level, the highest percentage was found in SCT/Well-Root ST group ($27.67 \pm 11.52\%$),

and the lowest percentage was found in CLC/AH Plus group ($10.32 \pm 3.42\%$). No statistically significant difference was found between CLC/Well-Root ST group and SCT/Well-Root ST group while there was a statistically significant difference between CLC/AH Plus group and the other two groups. In the middle level, the highest percentage was found in SCT/Well-Root ST group ($26.31 \pm 7.59\%$), and the lowest percentage was found in CLC/AH Plus group ($8.449 \pm 2.78\%$). A statistically significant difference was found between the three groups. In the apical level, the highest percentage was found in SCT/Well-Root ST group ($33.40 \pm 10.52\%$), and the lowest percentage was found in CLC/AH Plus group ($10.367 \pm 2.051\%$). A statistically significant difference was found between the three groups.

The mean time required for removal of obturation material

(As shown in table 2)

The highest value was found in SCT/Well-Root ST group (5.29 ± 0.43 minutes) and the lowest value was found in CLC/AH Plus group (2.67 ± 0.39 minutes). A statistically significant difference was found between the three groups.

TABLE (1) Mean \pm standard deviation (SD) of percentage of remaining obturation material (%) for different obturation techniques.

| | Coronal | Middle | Apical |
|------------------|----------------------|----------------------|----------------------|
| SCT/Well-Root ST | 27.67 ± 11.52^a | 26.31 ± 7.59^a | 33.40 ± 10.52^a |
| CLC/Well-Root ST | 18.095 ± 3.087^a | 14.439 ± 2.503^b | 19.43 ± 3.9^b |
| CLC/AH Plus | 10.32 ± 3.42^b | 8.449 ± 2.78^c | 10.367 ± 2.051^c |
| P-value | <0.05 | <0.05 | <0.05 |

TABLE (2) Mean \pm standard deviation (SD) of the mean time required (in minutes) for retreatment.

| | SCT/Well-Root ST | CLC/Well-Root ST | CLC/AH Plus |
|---------|-------------------|-------------------|-------------------|
| Time | 5.29 ± 0.43^a | 4.14 ± 0.62^b | 2.67 ± 0.39^c |
| P-value | <0.05 | | |

DISCUSSION

Clinical success rate of endodontic treatment ranges between 50% and 90%^(7,8). The preferred treatment of failing endodontic cases is nonsurgical retreatment. **Grossman**⁽⁹⁾ in 1988 enlisted the ideal characteristics that should be present in the materials used for root canal obturation. One of these characteristics is that the material should be easily retrievable if necessary.

Nowadays, bio-ceramic materials have acquired recognition in the modern practice of endodontics due to their physicochemical and biological properties⁽¹⁰⁾. Yet, their ability to be retrieved is of concern among researchers. The studies conducted in the literature evaluating their retrievability showed contradictory results.

Till now, AH plus sealer is one of the mostly used epoxy resin-based sealers. Consequently, it is regarded as a gold standard in opposition to which different sealers are most usually compared⁽¹¹⁾. Owing to its good flowability, proper film thickness, and viscosity, it is usually recruited as the control in studies on the properties of new sealers⁽¹²⁾. Therefore, it was also chosen as a control in this study.

Though decoronation of samples may not fully reproduce the clinical conditions, it ensures sample standardization by discarding some variables, such as dental crown anatomy and the root canal access, allowing for more reliable comparison, and proper assessment of the proposed objectives⁽¹³⁾.

CLC was used because it is regarded as the gold standard. It is the most used and studied technique. Newer obturation techniques are often compared to it⁽¹⁴⁾.

The preservation period of samples after obturation was chosen prior to sectioning based on long setting time of BCS in dry condition⁽⁵⁾.

Photomicrographic analysis using ImageJ software is a subjective method to an extent, yet it was

reported that it was efficient in assessment of the percentage of remaining obturation material and minimized subjectivity in the scoring method based on a scale⁽¹⁵⁾.

Regarding the percentage of remaining obturation material, the results showed a statistically significant difference between the three groups, with the highest percentage found in SCT/BCS group and the lowest percentage found in CLC/AH Plus group. It should be noted that previous literature concerned with the retrievability of bio-ceramic sealer was mostly in comparison to AH Plus Sealer. The results reported in literature regarding the retrievability of bio-ceramics sealer and AH plus sealer are contradictory in nature.

The results in this study came in line with those obtained by **Hess et. al.**⁽¹⁶⁾, **Oltra et. al.**⁽¹⁷⁾, **Prasad et. al.**⁽¹⁸⁾.

On the contrary, retrievability of bio-ceramic sealer was reported to be easier by **Alsubait et. al.**⁽¹⁹⁾, **Crozeta et. al.**⁽²⁰⁾. Also, three articles found no difference in the retrievability of AH plus and bio-ceramic sealer^(19,21,22).

Several variables may be the cause of the discrepancy in previously published studies regarding the percentage of remaining obturation material after retreatment. It should be taken into consideration that no system was able to completely remove the material. Example of these variables is the difference in obturation techniques⁽²³⁾, allowing for more percentage of gutta percha and less percentage of bio-ceramic sealer which facilitates retreatment. Unlike that in SCT, in which percentage of bio-ceramic sealer is higher, and its effect on retreatment procedure is more pronounced through its bio-mineralization capacity and the subsequent formation of strong chemical bonding with root dentin⁽²⁴⁾. Other factors include difference in used retreatment rotary system regarding size and taper⁽²¹⁾, usage of solvents^(17,25), or usage of auxiliary methods to assist rotary files in the retreatment procedure⁽²⁰⁾.

The results of the present study showed significant difference between the three study groups regarding the mean time required for retreatment procedure, with the highest value found in SCT/Well-Root ST group. The results came in line with those obtained by **Romeiro et. al.**⁽²¹⁾, and **Alsubait et. al.**⁽¹⁹⁾. On the other hand, no significant difference was found in the time required for retreatment between bio-ceramic sealer and AH Plus sealer as reported by **Athkuri et. al.**⁽²³⁾. This may be explained by the procedural difference, in which different obturation techniques were used which allowed more percentage of gutta percha in relation to the percentage of the sealer, allowing faster retrieval process.

CONCLUSION

Within the limitations of the present study, it can be concluded that, retrievability of filling material from teeth obturated with single cone obturation technique using bio-ceramic sealer is difficult and may require auxiliary methods to aid the retrieval process

REFERENCES

- Nair P. On the causes of persistent apical periodontitis: A review. *Int Endod J.* 2006 May;39:249–81.
- Siqueira J, Rôças I. Clinical Implications and Microbiology of Bacterial Persistence after Treatment Procedures. *J Endod.* 2008 Dec 1;34:1291–1301.e3.
- Volponi A, Pelegrine R, Kato A, Stringheta C, Lopes R, Silva A, et al. Micro-computed Tomographic Assessment of Supplementary Cleaning Techniques for Removing Bioceramic Sealer and Gutta-percha in Oval Canals. *J Endod.* 2020 Sep;46.
- Ingle J. Ingle JI, Bakland LK, Banmgatner JC. *Ingl Endod* 6th ed London BC Dec or Inc Hamilt. 2008;1020.
- Loushine B, Bryan T, Looney S, Gillen B, Loushine R, Weller R, et al. Setting Properties and Cytotoxicity Evaluation of a Premixed Bioceramic Root Canal Sealer. *J Endod.* 2011 May;37:673–7.
- Colaco A, Pai V. Comparative Evaluation of the Efficiency of Manual and Rotary Gutta-percha Removal Techniques. *J Endod.* 2015 Sep 13;41.
- Pirani C, Pelliccioni GA, Marchionni S, Montebugnoli L, Piana G, Prati C. Effectiveness of Three Different Retreat-ment Techniques in Canals Filled With Compacted Gut-ta-Percha or Thermafil: A Scanning Electron Microscope Study. *J Endod [Internet].* 2009;35(10):1433–40. Available from: <https://www.sciencedirect.com/science/article/pii/S0099239909005512>
- Gorni F, Gagliani M. The Outcome of Endodontic Retreat-ment: A 2-yr Follow-up. *J Endod.* 2004 Jan;30:1–4.
- Grossman, L. *Endodontic practice* 1988; ed 11, p242, Philadelphia L& F. No Title.
- Wang Z. Bioceramic materials in endodontics. *Endod Top.* 2015 May 1;32.
- Arul B, Varghese A, Mishra A, Elango S, Padmanaban S, Natanasabapathy V. Retrievability of bioceramic-based sealers in comparison with epoxy resin-based sealer assessed using microcomputed tomography: A systematic review of laboratory-based studies. *J Conserv Dent.* 2021 Sep 1;24:421.
- Zhou H-M, Shen Y, Zheng W, li li, Zheng Y, Haapasalo M. Physical Properties of 5 Root Canal Sealers. *J Endod.* 2013 Oct;39:1281–6.
- Yürüker S, Görduysus M, Küçükaya Eren S, Uzunoğlu-Özyürek E, Ilgın C, Gülen O, et al. Efficacy of Combined Use of Different Nickel-Titanium Files on Removing Root Canal Filling Materials. *J Endod.* 2016 Jan 6;42.
- Peng L, Ye L, Tan H, Zhou X. Outcome of Root Canal Obturation by Warm Gutta-Percha versus Cold Lateral Condensation: A Meta-analysis. *J Endod.* 2007 Mar 1;33:106–9.
- Saad Y, Alhadlaq S, Al-Katheeri N. Efficacy of Two Rotary NiTi Instruments in the Removal of Gutta-Percha During Root Canal Retreat-ment. *J Endod.* 2007 Jan;33:38–41.
- Hess D, Solomon E, Spears R, He J. Retreatability of a Bioceramic Root Canal Sealing Material. *J Endod.* 2011 Nov 1;37:1547–9.
- Oltra E, Cox T, Lacourse M, Johnson J, Paranjpe A. Retreatability of two endodontic sealers, EndoSequence BC Sealer and AH Plus: a micro-computed tomographic comparison. *Restor Dent Endod.* 2017 Feb;42:19.
- Prasad A, Nair R, Angelo J, Mathai V, Vineet R, Christopher S. A comparative evaluation of retrievability of Guttapercha, Resilon and CPoints for retreatment, using two different rotary retrieval systems-An ex vivo study. *Saudi Endod J.* 2018;8(2):87–92.

19. Alsubait S, Alhathloul N, Alqedairi A, Alfawaz H. A micro-computed tomographic evaluation of retreatability of BioRoot RCS in comparison with AH Plus. *Aust Endod J.* 2022 Jul 1.
20. Crozeta BM, Lopes FC, Menezes Silva R, Silva-Sousa YTC, Moretti LF, Sousa-Neto MD. Retreatability of BC Sealer and AH Plus root canal sealers using new supplementary instrumentation protocol during non-surgical endodontic retreatment. *Clin Oral Investig.* 2021;25(3):891–9.
21. Romeiro K, Almeida A, Cassimiro M, Gominho L, Dantas E, Chagas N, et al. Reciproc and Reciproc Blue in the removal of bioceramic and resin-based sealers in retreatment procedures. *Clin Oral Investig.* 2020 Jan;24:1–12.
22. Salim M, Ormiga F, Lopes R, Gusman H. Retreatment of mesial roots of mandibular molars filled with resin-based and bioceramic sealers. *Brazilian J Oral Sci.* 2021 Feb;20:e210432.
23. Athkuri S, Mandava J, Chalasani U, Ravi R, Munagapati V, Chennareddy A. Effect of different obturating techniques and sealers on the removal of filling materials during endodontic retreatment. *J Conserv Dent.* 2019 Nov 1;22:578.
24. Siboni F, Taddei P, Zamparini F, Prati C, Gandolfi M. Properties of BioRoot RCS, a tricalcium silicate endodontic sealer modified with povidone and polycarboxylate. *Int Endod J.* 2017 Sep 7;50.
25. Garrib M, Camilleri J. Retreatment efficacy of hydraulic calcium silicate sealers used in single cone obturation. *J Dent.* 2020 May 1;98:103370.