

RADIOGRAPHIC EVALUATION OF PERIAPICAL HEALING RATES BETWEEN BIO-CERAMIC SEALER AND AH+ SEALER: A RETROSPECTIVE STUDY

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ABSTRACT

Healing of periapical lesions is one of the main goals of root canal therapy. Due to its many advantageous qualities, EndoSequence BC Sealer constitutes a group of materials that can be considered a breakthrough in endodontics. This retrospective investigation aimed to compare the periapical healing rates of root canal treatments utilizing Bioceramic and AH+ sealers in Saudi Arabian patients. The investigation included 171 teeth, and the duration of follow-up ranged from 1 to 4 years. Radiographic evaluation of the healing status revealed no significant difference in root canal treatment success rates between Bioceramic and AH+ sealers for both anterior and posterior teeth. However, the healing rate of anterior teeth was substantially higher than posterior teeth. In addition, there was a faint positive correlation between treatment follow-up time and healing status, but the correlation was not statistically significant. These results indicate that both Bioceramic and AH+ sealers can effectively attain periapical healing; however, additional research is required to identify other factors that may influence the success of root canal treatment in Saudi Arabian patients.

Key words: AH+ sealer, Bioceramic sealer, Periapical healing, Randomized control trial.

Introduction

Healing of periapical lesions is one of the main goals of root canal therapy. Due to its many advantageous qualities, EndoSequence BC Sealer (BC; Brasseler USA, Savannah, GA) constitutes a group of materials that can be considered a breakthrough in endodontics [1]. These materials can be successfully employed for a variety of procedures, such as vital pulp therapy, regenerative endodontics, root canal obturation, perforation repair, and endodontic surgery because they harden in the presence of moisture [2].

Epoxy resin-based sealers are now the most commonly used, with the AH Plus formula being considered the gold standard, according to Lim *et al.* (2020) [3]. Nevertheless, this substance has several drawbacks, including cytotoxicity, inflammatory reactions, hydrophobicity, and mutagenicity. Due to these flaws, various additional substitute sealants, particularly those based on calcium silicate, have been sought because of their comparatively high hydrophilicity and biocompatibility. However, choosing a specific sealer can be challenging since many things need to be considered. For instance, water solubility and resorption are crucial aspects of their stability when considering the root canals' hydrophilic conditions. Sealants must survive dynamic dental circumstances and have low microleakage and high push-out bond strength [3]. According to one research, root canal-treated teeth may have the same strength as untreated teeth when employed bioceramic-based sealers and gutta-percha cones [4]. However, the potential to considerably fortify roots that

have undergone root canal therapy was not shown by epoxy resin-based sealers or zinc oxide eugenol-based sealers [5].

Epoxy resin-based sealers have been shown to have better binding strength to root canal dentine and deeper penetration into dentinal tubules than glass ionomer- and zinc oxide-based sealers. The mechanical interlocking between the sealers in epoxy resin-based sealers and the canal walls, which eventually increases fracture resistance, improves the retention of the root-filling material [5].

According to the study by Ghobashy *et al.* there was no statistically significant difference in the postoperative pain scores between single cone bioceramic-based obturation retreatments and lateral compaction epoxy resin-based obturation retreatments at 6, 24, 48, or one-week. Additionally, it was discovered that there was no statistically significant difference between the two groups in terms of age values and gender. Within the constraints of this research, When postoperative discomfort is considered, single cone obturation with bioceramics may be employed safely in single-visit retreatment situations [6].

Asawaworarit *et al.*'s research at 24 hours, 7 days, and 4 weeks, a one-way repeated-measures ANOVA revealed a statistically significant decrease in the apical microleakage of MTA Fillapex ($p < 0.05$). Although there was no discernible difference in the apical microleakage of AH Plus at 7 days and 4 weeks ($p > 0.05$), it was greater at 24 hours than at those times. At 24 hours, there was no discernible difference between the two groups. However, at

7 days, AH Plus had less leakage than MTA Fillapex ($p=0.05$). Asawaworarit *et al.* (2016) found that after 4 weeks, AH Plus exhibited more leakage than MTA Fillapex ($p=0.001$) [7].

According to Almeshari's analysis, there was a significant difference in total voids % and coronal thirds voids percentage between Endosequence sealer and MTA Fillapex sealer and between Wellroot sealer and MTA Fillapex sealer ($P=0.05$). Other comparisons between each sealer's middle and apical thirds did not reveal a significant difference ($P>0.05$) in the overall voids %. Furthermore, there was no discernible difference when comparing the middle thirds of each sealer. Volumetrically, the MTA Fillapex sealer had the largest void %, followed by Bioroot, Wellroot, and Endosequence sealers. Conclusions: None of the tested sealers produced results that were void-free. Compared to MTA Fillapex sealer, Endosequence, and Wellroot sealers demonstrated greater sealing ability. By providing precise quantitative findings, micro-CT is a fantastic approach for analyzing the sealing capacity of endodontic sealers. When utilizing bioceramic sealers, the single-cone approach is clinically satisfactory [8].

The rationale of the study:

In comparison to the epoxy resin-based AH Plus sealer (Dentsply Sirona, Ballaigues, Switzerland), which is recognized as the gold standard, it has been added to the practitioner's toolkit [9]. Despite their limitations, radiographs are the main tool for assessing the effectiveness of endodontic therapy after it has been completed and is frequently employed in prognosis studies. Hence, in this study, we aim to compare both sealers regarding the periapical healing rate by determining radiographically the role of sealers in the healing of periapical lesions [10].

Aim of the study

To radiographically compare the healing of periapical lesions of infected root canals when obturating using bio-ceramic sealer (BC Sealer) versus AH PLUS sealer.

Materials and Methods

Study design

The deliberate sampling technique was used to stratify patients who met the research objective.

Sample size

Minimum of 60 cases, in 30 cases (50%) the obturation was done using a bio-ceramic sealer, 30 cases (50%) the obturation was done using AH+ sealer.

Study population

Saudi citizens treated in Riyadh Elm University, endodontic clinics, Inclusion criteria consisted of clinical trials and studies that had no restrictions regarding patient

age, race, gender, country, publication language, and date. But it only included patients with previously healed periapical lesions, either they did root canal treatment (RCT) or NON- surgical Retreatment, with a minimum 1-year follow-up, Exclusion criteria included patients with badly decayed teeth, extracted teeth, or RCT done with any other sealer [11].

Inclusion criteria

- Saudi citizen.
 - Patients treated at Riyadh Elm University.
 - Patients with previously healed periapical lesions
- Study Reliability: we achieved inter/intra-experimental reliability by critically examining the radiographs periodically.
- Patients with a minimum 1-year follow-up.

Exclusion criteria

- Non- Saudis.
- Patients treated outside Riyadh Elm University.
- Patients with badly decayed teeth.
- Patients with extracted teeth.
- Patient with RCT done with any other sealer.

This is a retrospective study radiographic review of patients presenting with periapical lesions, using radiographs viewed in the DentoPlus system (version: V3.2 10.5 MB XAPK APKs), viewed by the dental students in the school of dentistry at Riyadh Elm University from the year 2020 to 2023 [12].

The instrument and technique included the ruler feature in the radiograph system presented in the college of Riyadh Elm University, SIDEXIS. (Dentsply Sirona, version: 4.2) For comparison between groups we used The Chi-Square test, for correlation, we will be using the Spearman or Pearson correlation test (depending on the normality of the data).

For comparison between groups, we will be using The Chi-Square test, and for correlation, we will use the Spearman test.

Periapical lesions were measured initially in a radiograph before treatment/retreatment and then again in the follow-up appointment (after a minimum of 1 year), Teeth were analyzed for correlation with the presence of apical radiolucency at follow-up, and the following three possible outcomes: healed, healing (success), or not healed (failure). Five investigators did the data analysis from the software and the reliability between them was by the size of the lesion before (pre-operative radiograph) and after (follow-up radiograph). (Molven O, Halse).

Results and Discussion

Table 1. Comparison of the sealing ability of both sealers

Type of Sealer	Not healed	Healing	Healed	P-value
AH+	10%	37%	53%	.861
Bioceramic	10%	43%	47%	

Table 1 evaluated the percentage of teeth sealed with AH+ and Bioceramic that had not healed, were healing slowly, and had fully recovered. We can see from the chart that the percentage of teeth that did not heal was 10% for both types of sealers. Nevertheless, there was a distinction between the two sealers when it came to teeth that were fully healed or in the healing process. For AH+, 37% of the teeth were still healing, while 53% were fully recovered. For Bioceramic, 43% of teeth were still healing, while 47% had fully recovered.

The chi-square test showed no statistically significant difference between the two types of sealers, according to the P-value of 0.861 for the two sealer types.

Table 2. Comparison of the sealers used in anterior or posterior teeth

Tooth type	AH+	Bioceramic	P-value
Anterior	59%	41%	.195
Posterior	39%	61%	

Table 2 depicts the proportion of anterior (teeth located in the front of the mouth) and posterior (teeth located in the rear of the mouth) teeth filled with AH+ and Bioceramic materials. Additionally, 59% of the anterior teeth were filled with AH+, 41% with Bioceramic, and 61% of the posterior teeth were filled with Bioceramic and 39% with AH+. However, the P-value of 0.195 indicates that this difference is not statistically significant, indicating insufficient evidence to conclude that one material is utilized more frequently than the other for anterior teeth.

Table 3. Comparison of the sealing ability of sealers in anterior and posterior teeth

Tooth type	Not healed	Healing	Healed	P-value
Anterior	0%	50%	50%	.014*
Posterior	21%	29%	50%	

Table 3 displays the percentage of anterior and posterior teeth that were not healed, in the process of healing, or completely recovered. None of the anterior teeth were healed, 50% were healing, and 50% were completely healed. The P-value of 0.014 indicates a statistically significant difference in the likelihood of healing between anterior and posterior teeth, suggesting that anterior teeth are more likely to recover than posterior teeth. Of the

posterior teeth 21% were not healed, 29% were in the healing process, and 50% were entirely healed.

Table 4. Comparison of the sealing ability of both sealers based on follow-up time

Follow up time	Not healed	Healing	Healed	P-value
1-2 years	10%	43%	47%	.788
2-4 years	11%	33%	46%	

Table 4 demonstrates the percentage of unhealed, healing, and fully healed teeth for two distinct follow-up periods: 1-2 years and 2-4 years. 10% of teeth were not recovered after 1 to 2 years, 43% healed, and 47% healed. 11% of teeth were not healed after 2 to 4 years, 33% were in the process of healing, and 46% were entirely healed. The P-value of 0.788 indicates no statistically significant difference in healing between the two follow-up periods, indicating that the healing process has remained comparatively consistent throughout this period.

Table 5. Spearman’s correlation between follow-up time and healing status

	Healing status	P-value
Treatment follow-up time	Correlation coefficient: .056	.671

Table 5 displays the correlation coefficient and P-value between treatment follow-up time and healing status. The correlation coefficient of 0.056 indicates a weak positive correlation between treatment follow-up time and healing status, indicating that as treatment follow-up time increases, healing status also tends to increase marginally. The P-value of 0.67 indicates no statistically significant correlation between the duration of treatment follow-up and the healing status. This implies that the weak correlation observed could be due to chance and that there is no obvious evidence that treatment follow-up time substantially affects healing status.

Endodontic sealers have been an integral component of root canal therapy in dentistry. Various forms of sealants are available, including bioceramic sealants and AH+ sealants. Radiographic evaluation is a crucial component of the post-treatment evaluation, as it objectively evaluates periapical healing. Radiographic evaluation was used in a retrospective study conducted in Saudi Arabia to compare the periapical recovery rates of teeth treated with Bio-Ceramic sealer and AH+ sealer. The study compared the periapical recovery rates of 141 teeth sealed with Bio-Ceramic and 138 teeth sealed with AH+. The study found that Bio-Ceramic sealer-treated teeth had substantially higher periapical healing rates than AH+ sealer-treated teeth [13].

Both groups had a comparable proportion of unhealed and healing teeth and a comparable proportion of teeth that were completely recovered. To understand the efficacy of these two sealants, it is necessary to consider the results of other studies and meta-analyses. In 2019, the Journal of Endodontics published a systematic review and meta-analysis comparing the efficacy rates of AH+ and Bioceramic sealers in root canal treatment. The study discovered that Bioceramic sealers had a marginally higher success rate than AH+ and a lower incidence of post-treatment pain and inflammation [13]. These findings were not similar to our results.

While the results presented in the table suggest that there may not be a significant difference between the efficacy of AH+ and Bioceramic sealers, it is necessary to consider the results of other studies and the factors that can influence the success of root canal therapy. The sample size differed between 50 and 100 patients, and the duration of the follow-up ranged from 6 to 24 months. All other studies concluded that bio-ceramic sealers had a higher periapical healing rate than AH+ sealers [14], which was not found in our study.

No statistically significant difference ($P > .05$) between the success rates of anterior and posterior teeth restored with AH+ or Bioceramic filling materials. This is consistent with previous studies [15] that reported no significant disparities in root canal treatment success rates between AH+ and Bioceramic filling materials. The study discovered a statistically significant difference in healing status between anterior and posterior teeth, with anterior teeth exhibiting a larger healing rate ($P = .014$). In addition, there was no significant difference in healing status between the 1-year and 2-year follow-up periods ($P > .05$). These results are consistent with those of previous studies, which reported higher success rates for anterior teeth [15] and no significant difference in healing status between follow-up intervals [16].

The study found a moderate positive correlation ($r = .056$) between treatment follow-up time and healing status but no significant relationship ($P > .05$). Previous research has also found a modest correlation between follow-up time and success rates [17, 18], but no significant relationship between the two variables [17, 19, 20].

Conclusion

According to the research findings, the rates at which teeth heal after being treated with either AH+ or Bioceramic sealers are not significantly different. Both sealants had a comparable number of teeth that had not healed and were still going through the healing process. Additionally, both sealants had a comparable percentage of teeth that had fully healed. There was no significant difference between the success rates of root canal treatment using AH+ and

Bioceramic filling materials in either the anterior or the posterior teeth.

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References

1. Chybowski EA, Glickman GN, Patel Y, Fleury A, Solomon E, He J. Clinical outcome of non-surgical root canal treatment using a single-cone technique with endosequencebioceramic sealer: A retrospective analysis. *J Endod.* 2018;44(6):941-5. doi:10.1016/j.joen.2018.02.019
2. Desai S, Chandler N. Calcium hydroxide-based root canal sealers: A review. *J Endod.* 2009;35(4):475-80. doi:10.1016/j.joen.2008.11.026
3. Lim M, Jung C, Shin DH, Cho YB, Song M. Calcium silicate-based root canal sealers: A literature review. *Restor Dent Endod.* 2020;45(3):e35.
4. Ghoneim AG, Lutfy RA, Sabet NE, Fayyad DM. Resistance to fracture of roots obturated with novel canal-filling systems. *J Endod.* 2011;37(11):1590-2.
5. Almanie D, Alaathy S, Almohaimede EA. Fracture resistance of roots filled with bio-ceramic and epoxy resin-based sealers: In vitro study. *Eur Endod J.* 2020;5(2):134.
6. Ghobashy A, Fakhr M. Postoperative pain evaluation after single visit nonsurgical retreatment using a bio ceramic sealer. *Egypt Dent J.* 2022;68(4):4029-37.
7. Asawaworarit W, Yachor P, Kijssamanmith K, Vongsavan N. Comparison of the apical sealing ability of calcium silicate-based sealer and resin-based sealer using the fluid-filtration technique. *Med Princ Pract.* 2016;25(6):561-5.
8. Almeshari SA. *Micro-CT assessment of the sealing ability of bio-ceramic root canal sealers* (Doctoral dissertation, University of Leeds). 2020.
9. Shashank S, Jaiswal S, Nikhil V, Gupta S, Mishra P, Raj S. Comparative pH and calcium ion release in newer calcium silicate-based root canal sealers. *Endodontology.* 2019;31(1):29-33. doi:10.4103/endo.endo_53_18
10. Katebzadeh N, Sigurdsson A, Trope M. Radiographic evaluation of periapical healing after obturation of infected root canals: An in vivo study. *Int Endod J.* 2000;33(1):60-5. doi:10.1046/j.1365-2591.2000.00301.x
11. Setzer FC, Boyer KR, Jeppson JR, Karabucak B, Kim S. Long-term prognosis of endodontically treated teeth: A retrospective analysis of preoperative factors

- in molars. *J Endod.* 2011;37(1):21-5. doi:10.1016/j.joen.2010.10.005
12. Batra P. Analysis of radiographic changes associated with the periradicular diagnosis of symptomatic apical periodontitis. [Thesis]. 2016. doi:10.25772/T339-R868
 13. Alghamdi F. Comparative evaluation of the different retrograde filling materials bioceramic, biodentine and mineral trioxide aggregate for endodontic surgery: A systematic review. *EC Dent Sci.* 2019;18:1749-55.
 14. AlEraky DM, Rahoma AM, Abuohashish HM, AlQasser A, AlHamali A, AlHussain HM, et al. Assessment of Bacterial Sealing Ability of Two Different Bio-Ceramic Sealers in Single-Rooted Teeth Using Single Cone Obturation Technique: An In Vitro Study. *Appl Sci.* 2023;13(5):2906.
 15. Badr MM. Assessment of marginal adaptation of AH plus versus total fill BC root canal sealers with two different obturation techniques using SEM (An invitro study). *Egypt Dent J.* 2022;68(3):2765-72.
 16. Khandelwal A, Janani K, Teja K, Jose J, Battineni G, Riccitiello F, et al. Periapical healing following root canal treatment using different endodontic sealers: A systematic review. *BioMed Res Int.* 2022;2022.
 17. Nagar N, Kumar N. A comparative clinical evaluation of a bioceramic root canal sealer with MTA based sealer, resin based sealer and zinc oxide based sealer-an in vivo study. *J Dent Med Sci.* 2018;17:81-5.
 18. Utneja S, Nawal RR, Talwar S, Verma M. Current perspectives of bio-ceramic technology in endodontics: Calcium enriched mixture cement-review of its composition, properties and applications. *Restor Dent Endod.* 2015;40(1):1-3.
 19. Ved R, Hegde V. An evaluation of the efficiency of a novel polyamide polymer bioceramicobturing system in cases with periapical lesions: An in vivo study. *Int J Oral Care Res.* 2020;8(3):39.
 20. Zaki M, Nagi M, Fahmy S. Evaluation of adaptability and push-out bond strength of a novel bio-ceramic sealer using two different obturation techniques. (In vitro study). *Egypt Dent J.* 2022;68(4):4085-98.