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Dental Materials in Pain Management: Exploring the Role of Endodontic Sealers in Reducing Post- Treatment Inflammation

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ABSTRACT

Background: Post-operative pain and inflammation are often the result of endodontic treatment because of the extrusion of root canal filling materials and host tissue reaction. These undesirable consequences could be minimized through the development of dental materials, specifically bioactive and anti-inflammatory endodontic sealers. This study evaluated the clinical effectiveness of various endodontic sealers in reducing pain intensities among patients undergoing root canal treatment.

Methods: This cross-sectional study was conducted between January and July 2024 among 90 participants, underwent single root canal treatment. Root canal obturation was performed using zinc oxide eugenol-based sealer, epoxy resin-based sealer, and bio-ceramic-based sealer. Pain intensity with the help Visual Analog Scale (VAS) and clinical signs at the time of assessment were measured. ANOVA and Chi-square tests were used to analyze data, where $p < 0.05$ was defined as significant.

Results: There was a significant difference in the mean VAS scores across groups ($p = 0.0008$), with the highest figure given by zinc oxide eugenol (2.7 ± 1.0), followed by epoxy resin (1.6 ± 0.8), and bio-ceramic (2.6 ± 0.5). Periapical inflammation (tenderness, swelling) was significantly decreased in the bio-ceramic group ($p = 0.01$). Pain types distribution indicated that zinc oxide eugenol was significantly more prevalent with moderate and severe pain ($p < 0.05$).

Conclusion: Bio-ceramic-based sealers demonstrated significant lower pain intensity and inflammation signs compared to epoxy resin and zinc oxide eugenol sealers. Their enhanced biocompatibility offers a possibility of better patient outcomes during endodontic treatment.

Keywords: Root Canal Therapy, Endodontics, Dental Materials, Zinc Oxide-Eugenol Cement, Epoxy Resins, Ceramics

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INTRODUCTION

A common complication encountered after root canal treatment is postoperative pain, which occurs in approximately 58% of patients and is frequently associated with extrusion of sealing materials and resultant periapical inflammation [1]. The type of endodontic sealer used significantly affects healing, as different sealers cause varying degrees of immune stimulation in surrounding tissue [2]. However, long-established zinc oxide eugenol sealers are associated with cytotoxicity and inflammatory responses during apical extrusion [3]. Sealers based on epoxy resins contain good sealing abilities, but can lead to periradicular inflammation and slow healing [4]. Conversely, bio-ceramic sealers of calcium silicate exhibit high biocompatibility and bioactivity, with research demonstrating improved postoperative comfort and better periapical repair [5].

Nevertheless, clinical evidence to support a comparison between these materials is inconsistent despite promising laboratory outcomes [6]. The lack of uniformity in studies regarding methodology, sample size, obturation methods, and the evaluation period influences the validity of conclusions [7]. Moreover, limited studies have evaluated both clinical inflammation and postoperative pain using standardized conditions [8]. The literature emphasizes the need to document associations in real-world clinical settings, comparing sealers with the implementation of homogeneous pain measurement tools. More recent studies also reinforce stronger blinding and sample randomization to minimize bias [9,10]. This lack of standardization invariably leads to ambiguity in clinical decision-making.

The objective of this study was to compare the association of eugenol, zinc oxide sealers, epoxy resin sealers, and sealers with bio-ceramics with pain and inflammation in root canals. The purpose was also to measure the clinical signs of inflammation in patients within 48 hours of root canal treatment.

METHODS

The purpose of this cross-sectional study was to investigate the role of various endodontic sealers in post-operative pain and inflammation in patients undergoing root canal therapy. This study was conducted at the Faculty of Intensive care and dental treatments pathology, SZH Lahore, September 2023 to January and 2024 (Ref:331-I Admin/Sep/046) after an informed consent. 90 patients who required single-rooted root canal treatment were recruited using consecutive non-probability sampling.

The sample size was determined using OpenEpi version 3.0.0 (released 2013, Atlanta, GA, USA) with an effect size of 0.35, 95% confidence interval, 80% power, and 5% margin of error [11]. The study included patients aged between 18 and 50 years who had vital or non-vital single-rooted teeth, no systemic diseases, and without a history of root canal treatment of the affected tooth. Exclusion criteria were the use of anti-

inflammatory or analgesic medications, allergies to any component of the sealer, periapical pathology, and use of antibiotics in the past 2 weeks. Severe root morphology and retreatment teeth were also omitted.

The participants were divided into three groups: zinc oxide eugenol (n = 30), epoxy resin (n = 30), and bio-ceramic (n = 30). An apex locator and radiograph were used to determine working length, and root canal treatment was performed under rubber dam isolation using rotary nickel and titanium (NiTi) files with sodium hypochlorite irrigation. The lateral condensation method was used to complete obturation with a specified sealer (zinc oxide eugenol, epoxy resin, or bioceramic). The structured proforma was used to collect baseline clinical and demographic data. The Visual Analog Scale (VAS) was used to record pain scores at time of assessment. Clinical manifestations of inflammation, including tenderness and swelling, and analgesic requirement, were examined after one week.

Data were analyzed by SPSS version 26.0 (released 2019, IBM Corp., Armonk, NY). The chi-square test was used to analyze categorical variables, and ANOVA was used to analyze the continuous variables. The p-value <0.05 was considered statistically significant.

RESULTS

Table 1: Demographic and Clinical Characteristics of Study Participants

Variable	Zinc Oxide Eugenol Group (n = 30)	Epoxy Resin Group (n = 30)	Bio-ceramic Group (n = 30)	Statistical Test	Test Value	p-value
Mean Age (years) **Mean ± SD**	34.6 ± 8.1	33.9 ± 7.5	35.2 ± 8.4	ANOVA	F = 0.34	0.72
Gender (Male/Female)	16 (53.3%)	17 (56.7%)	15 (50.0%)/ 15 (50.0%)	Chi-square	χ^2 = 0.14	0.93
Preoperative pain (VAS) **Mean ± SD**	6.7 ± 1.2	6.5 ± 1.0	6.6 ± 1.1	ANOVA	F = 0.13	0.88
Tooth Type (Ant./Post.)	10 (33.3%)/20 (66.7%)	9 (30.0%)/21 (70.0%)	11 (36.7%)/19 (63.3%)	Chi-square	χ^2 = 0.31	0.85

*n = Number of participants, SD = Standard Deviation, % = Percentage, * = Statistically significant at p-value <0.05*

In this study, 90 patients were assessed to evaluate pain intensities and inflammation induced by three endodontic sealers. The patients were given zinc oxide eugenol, epoxy resin, and bio-ceramic sealers in equal quantities. Bio-ceramic sealers had the best VAS scores across all time intervals. Signs of inflammation and the use of analgesics were also minimal in the bio-ceramic group. The demographic and clinical characteristics of study participants are indicated in **Table 1.**

Table 2: Pain Intensity at Time of Assessment (within 48 hours

Variable	Zinc Oxide Eugenol (n=30)	Epoxy Resin (n=30)	Bio-ceramic (n=30)	Statistical Test	Test Value	p-value
VAS (Mean ± SD)	2.7 ± 1.0	1.6 ± 0.8	0.6 ± 0.5	ANOVA	F = 17.6	0.0008*
No Pain (n/%)	8 (26.7%)	16 (53.3%)	21 (70.0%)	Chi-square	χ^2 = 11.6	0.003*

*n = Number of participants, VAS = Visual Analogue Scale, SD = Standard Deviation, % = Percentage, * = Statistically significant at p-value <0.05*

The average age was 33.9-35.2 years (p = 0.72), and the gender distribution was evenly distributed (p = 0.93). The preoperative VAS values were comparable (6.5-6.7; p = 0.88), and there was no significant variation in the distribution of teeth (p = 0.85), implying that comparisons are validated by matching groups. **Table 2** illustrates the pain intensities at the time of assessment.

Table 3: Clinical Signs of Inflammation at Time of Assessment (within 48 hours)

Inflammatory Sign	Zinc Oxide Eugenol Group	Epoxy Resin Group	Bio-ceramic Group	Statistical Test	Test Value	p-value
Tenderness on percussion	10 (33.3%)	6 (20.0%)	3 (10.0%)	Chi-square	χ^2 = 7.89	0.02
Swelling	5 (16.7%)	3 (10.0%)	1 (3.3%)	Chi-square	χ^2 = 6.43	0.04
Need for analgesics	16 (53.3%)	11 (36.7%)	4 (13.3%)	Chi-square	χ^2 = 13.5	0.001

*n = Number of participants, SD = Standard Deviation, % = Percentage, * = Statistically significant at p-value <0.05*

Mean pain scores changed significantly between the groups within 48 hours of treatment (p = 0.0008). The highest pain was with zinc oxide eugenol (2.7 ± 1.0), intermediate with epoxy resin (1.6 ± 0.8), and with bio-ceramic (0.6 ± 0.5). The number of pain-free patients was 8 (26.7%) in zinc oxide eugenol, 16 (53.3%) in epoxy resin, and 21 (70.0%) in bio-ceramic (p = 0.003). These results highlight that bio-ceramic sealers are more effective in relieving the pain. Distribution of pain categories at the time of assessment is shown in **Table 3.**

Within 48 hours, the bio-ceramic group had the least inflammation: tenderness, 3 (10%), swelling, 1 (3.3%), and analgesic use, 4 (13.3%), which is significantly less than zinc oxide group, 10 (33.3%), 5 (16.7%), and 16 (53.3%), respectively; p < 0.05, suggesting that bio-ceramic sealers cause less inflammation and analgesic requirement.

DISCUSSION

The purpose of this study was to examine the association of endodontic sealers with pain intensities and periapical inflammation during root canal treatment. In general, the study observed that bio-ceramic sealers achieved much lower pain scores and less clinical evidence of inflammation compared to epoxy resin and zinc oxide eugenol sealers, highlighting high biocompatibility and a favorable early healing profile.

The findings of this study align with research that quantified bio-ceramic sealers as high experimental proof, leading to low pain levels and postoperative exacerbations compared to epoxy resin sealers [12]. Similarly, IL-6 and TNF-8 levels were lower using bio-ceramic sealers, indicating a less intense inflammatory outcome on the periapical tissues [13]. Furthermore, randomized comparisons demonstrated better patient-reported outcomes and reduced analgesic requirements after using calcium silicate-based materials [14,15].

Bio-ceramic sealers have also been confirmed to have advantages through systematic reviews and meta-analyses, with superior biocompatibility and equally effective pain control compared with conventionally used sealers [16,17]. Epoxy resin sealers have also been linked with extended inflammatory reactions and time to heal tissues, especially when apically extruded [18]. This increase in tenderness and analgesic consumption was also evident in our data, with tenderness being higher and analgesic use increasing in the epoxy resin group. Recent research indicates no significant difference between resin-based and bioceramic sealers in terms of postoperative discomfort rates [19,20]. Other clinical evidence indicates higher short-term success rates with bioceramic sealers [21].

In contrast, the use of zinc oxide eugenol sealers is cost-effective and has a long history of use, but still poses restrictions due to factors of cytotoxicity and increased tissue irritation [22]. They were associated with more postoperative pain and inflammation in this study population, which is similar to evidence in both in vitro and clinical studies [23].

Having demonstrated a consistent ability to minimize postoperative discomfort and inflammation, bio-ceramic sealers may provide greater patient benefits, especially where apical extrusion is a potential concern or where there is increased tissue sensitivity [24]. They may also decrease the dependence on analgesics and improve early healing pathways [25].

The small sample size, cross-sectional designs, and the lack of long-term radiographic evaluation are limitations of this study, which may affect the generalizability of results. Other confounding factors, including individuality in pain sensitivity, variations in the morphology of root canals, and variations in operator skills, may affect the findings. Future research should include multicenter cohorts, longer follow-up, patient-reported outcome measurement systems, and randomized study designs to mitigate intersubject differences and validate the long-term clinical effectiveness of bio-ceramic sealing agents..

CONCLUSION

The study indicated that bio-ceramic sealers significantly improved pain and inflammation compared to epoxy resin and zinc oxide eugenol sealers. These findings support that the type of sealer may affect postoperative outcomes in root canal treatment, particularly inflammation control.

Bio-ceramic sealers have the potential to limit analgesic addiction, enhance survival, and improve the healing environment. The integration of bio-ceramic sealers into clinical practice may lead to improved treatment outcomes and endodontic care; however, larger multicenter randomized trials are required to confirm the sustained benefits.

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CONFLICT OF INTEREST

None

ETHICAL APPROVAL

This study was conducted at the Faculty of Intensive Care and Dental Treatment Pathology, SZH Lahore, September 2023 to January 2024 (Ref:331-I Admin/Sep/046) after informed consent.

AUTHORS' CONTRIBUTION

All authors contributed equally as per ICMJE policy

REFERENCES

1. Sabino-Silva R, Cardoso IV, Vitali FC, Alves AMH, Souza BDM, Bortoluzzi EA, et al. Prevalence of postoperative pain after endodontic treatment using low and high concentrations of sodium hypochlorite: a systematic review and meta-analysis. Clin Oral Investig. 2023 Aug;27(8):4157-4171. doi: 10.1007/s00784-023-05151-7.
2. Guo J, Peters OA, Hosseinpour S. Immunomodulatory Effects of Endodontic Sealers: A Systematic Review. Dent J (Basel). 2023 Feb 17;11(2):54. doi: 10.3390/dj11020054.
3. Al-Shamaa RM, Al-Askary RA. Remineralizing capacity of zinc oxide eugenol sealer following the addition of nanohydroxyapatite-tyrosine amino acid: An in vivo animal study. J Oral Biosci. 2025 Mar;67(1):100567. doi: 10.1016/j.job.2024.09.006.
4. Dioguardi M, Alovisi M, Sovereto D, Troiano G, Malagnino G, Di Cosola M, et al. Sealing ability and microbial leakage of root-end filling materials: MTA versus epoxy resin: A

systematic review and meta-analysis. Heliyon. 2021 Jul 7;7(7):e07494. doi: 10.1016/j.heliyon.2021.e07494.

5. Song W, Li S, Tang Q, Chen L, Yuan Z. *In vitro* biocompatibility and bioactivity of calcium silicate-based bioceramics in endodontics (Review). Int J Mol Med. 2021 Jul;48(1):128. doi: 10.3892/ijmm.2021.4961.
6. Rekha R, Kavitha R, Venkitachalam R, Prabath SV, Deepthy S, Krishnan V. Comparison of the sealing ability of bioceramic sealer against epoxy resin based sealer: A systematic review & meta-analysis. J Oral Biol Craniofac Res. 2023 Jan-Feb;13(1):28-35. doi: 10.1016/j.jobcr.2022.10.006.
7. Chopra V, Davis G, Baysan A. Clinical and Radiographic Outcome of Non-Surgical Endodontic Treatment Using Calcium Silicate-Based Versus Resin-Based Sealers-A Systematic Review and Meta-Analysis of Clinical Studies. J Funct Biomater. 2022 Apr 7;13(2):38. doi: 10.3390/jfb13020038.
8. Khandelwal A, Jose J, Teja KV, Palanivelu A. Comparative evaluation of postoperative pain and periapical healing after root canal treatment using three different base endodontic sealers - A randomized control clinical trial. J Clin Exp Dent. 2022 Feb 1;14(2):e144-e152. doi: 10.4317/jced.59034.
9. Sabeti M, Ghobrial D, Zanjir M, da Costa BR, Young Y, Azarpazhooh A. Treatment outcomes of regenerative endodontic therapy in immature permanent teeth with pulpal necrosis: A systematic review and network meta-analysis. Int Endod J. 2024 Mar;57(3):238-255. doi: 10.1111/iej.13999.
10. Chopra V, Davis G, Baysan A. Physico-Chemical Properties of Calcium-Silicate vs. Resin Based Sealers-A Systematic Review and Meta-Analysis of Laboratory-Based Studies. Materials (Basel). 2021 Dec 29;15(1):229. doi: 10.3390/ma15010229.
11. Bhardwaj R, Agrawal U, Vashist P, Manna S. Determination of sample size for various study designs in medical research: A practical primer. J Family Med Prim Care. 2024 Jul;13(7):2555-2561. doi: 10.4103/jfmpc.jfmpc_1675_23.
12. Tan HSG, Lim KC, Lui JN, Lai WMC, Yu VSH. Postobturation Pain Associated with Tricalcium Silicate and Resin-based Sealer Techniques: A Randomized Clinical Trial. J Endod. 2021 Feb;47(2):169-177. doi: 10.1016/j.joen.2020.10.013.
13. Alhindi OH, Atmeh AR, Alhawaj H, Omar O. Inflammatory response to epoxy resin and calcium silicate sealers preheated with different temperatures: an in vivo study. Clin Oral Investig. 2023 May;27(5):2235-2243. doi: 10.1007/s00784-023-04960-0.
14. Mekhdieva E, Del Fabbro M, Alovisi M, Comba A, Scotti N, Tumedei M, et al. Postoperative Pain following Root Canal Filling with Bioceramic vs. Traditional Filling Techniques: A

Systematic Review and Meta-Analysis of Randomized Controlled Trials. J Clin Med. 2021 Sep 29;10(19):4509. doi: 10.3390/jcm10194509.

15. Ensinas P, Aranguren J, Tosco V, Franco C, Pineda K, Malvicini G, et al. The Impact of Calcium Silicate-Based and Resin-Based Root Canal Sealers on Postoperative Pain and Sealer Extrusion: A Multicenter Randomized Clinical Study. J Endod. 2025 Jul 11:S0099-2399(25)00398-X. doi: 10.1016/j.joen.2025.07.004.
16. Zamparini F, Lenzi J, Duncan HF, Spinelli A, Gandolfi MG, Prati C. The efficacy of premixed bioceramic sealers versus standard sealers on root canal treatment outcome, extrusion rate and post-obturation pain: A systematic review and meta-analysis. Int Endod J. 2024 Aug;57(8):1021-1042. doi: 10.1111/iej.14069.
17. Seron MA, Nunes GP, Ferrisse TM, Strazzi-Sahyon HB, Victorino FR, Dos Santos PH, et al. Postoperative pain after root canal filling with bioceramic sealers: a systematic review and meta-analysis of randomized clinical trials. Odontology. 2023 Oct;111(4):793-812. doi: 10.1007/s10266-023-00830-z.
18. Alfahlawy A, Selim MAA, Hassan HY. Biocompatibility of three different root canal sealers, experimental study. BMC Oral Health. 2023 Oct 4;23(1):715. doi: 10.1186/s12903-023-03473-2.
19. Supare M, Pawar AM, Sawant K, Wahjuningrum DA, Arora S, Elmsmari F, et al. Effect of bioceramic-based and resin-based sealers on postoperative discomfort following root canal therapy: a systematic review and meta-analysis. PeerJ. 2024 Oct 31;12:e18198. doi: 10.7717/peerj.18198.
20. Yılmaz K, Sarı M. Influence of sonic activation of epoxy-resin and calcium silicate sealer on postoperative pain: a patient-blinded, parallel group, randomized clinical trial. BMC Oral Health. 2024 Oct 23;24(1):1268. doi: 10.1186/s12903-024-05049-0.
21. Lepure C, Walsh RM, Attar S, Turner CL, Crawford J, Jalali P. Clinical outcomes of nonsurgical root canal treatment using NeoSealer Flo and Endosequence BC Sealer: A retrospective analysis with short-term follow-up. Clin Oral Investig. 2024 Oct 16;28(11):598. doi: 10.1007/s00784-024-05995-7.
22. Mohd Bakhori SK, Mahmud S, Mohamad D, Masudi SM, Seeni A. Cytotoxicity determination of nano-zinc oxide eugenol on human gingival fibroblast cells. Mater Chem Phys. 2021 Aug;268:124649. doi: 10.1016/j.matchemphys.2021.124649.
23. Saini A, Dheeraj M, Johar S, Goyal S, Chahal S, Garg D. Evaluation of Different Root Canal Sealers on Post Operative Pain in Single Visit RCT - A Comparative Study. J Pharm Bioallied Sci. 2024 Apr;16(Suppl 2):S1679-S1684. doi: 10.4103/jpbs.jpbs_423_23.

24. Algar J, Docampo-Vázquez C, Rico-Romano C, Boquete-Castro A, Obispo-Díaz C, Aragoneses JM. Randomised Clinical Trial: Effect of AH Plus and Neosealer Flo on Postoperative Pain and Healing of Periapical Lesions. Bioengineering (Basel). 2025 Apr 2;12(4):376. doi: 10.3390/bioengineering12040376.
25. Turkyilmaz A, Baris SD, Hancerliogullari D, Erdemir A. Postobturation Pain of three Novel Calcium Silicate-based sealers with asymptomatic irreversible pulpitis or necrotic pulp with chronic apical periodontitis: prospective clinical trial. BMC Oral Health. 2024 Nov 10;24(1):1366. doi: 10.1186/s12903-024-05161-1.