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RESEARCH ARTICLE
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ANALYSIS OF POST-OPERATIVE PAIN IN ROOT CANAL THERAPY USING CALCIUM HYDROXIDE ($CA(OH)_2$)-BASED SEALER

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ABSTRACT

Background: Post-operative pain is a common concern in root canal therapy (RCT), affecting patient comfort and treatment outcomes. Calcium hydroxide ($Ca(OH)_2$)-based sealers are hypothesized to provide better pain relief and healing due to their anti-inflammatory and antimicrobial properties.

Objective: To evaluate the impact of $Ca(OH)_2$-based sealers on post-operative pain, analgesic consumption, and healing outcomes compared to non-$Ca(OH)_2$-based sealers in RCT.

Study Design & Setting: This experimental study was conducted at Sharif Medical & Dental College, Lahore over six months from Jan 2023 to June 2023.

Methodology: A total of 150 patients were randomly allocated into two groups: an experimental group using $Ca(OH)_2$-based sealers and a control group using non-$Ca(OH)_2$-based sealers. Standardized RCT procedures were performed, and post-operative pain was assessed using a visual analog scale (VAS) at 6, 24, 48, and 72 hours. Analgesic consumption and healing outcomes were also recorded. Statistical analysis was performed using SPSS version 25.0, with $p < 0.05$ considered significant.

Results: The experimental group demonstrated significantly lower pain scores at all-time points ($p < 0.001$). Analgesic consumption was reduced in the experimental group, with 24% requiring pain relief compared to 51% in the control group ($p < 0.001$). Complete healing was observed in 90.7% of the experimental group compared to 74.7% of the control group ($p = 0.01$).

Conclusion: $Ca(OH)_2$-based sealers significantly reduce post-operative pain, lower analgesic requirements, and enhance healing outcomes, making them an effective choice for improving RCT success.

Keywords: Analgesic consumption, Calcium hydroxide-based sealers, Healing outcomes, Post-operative pain, Root canal therapy

INTRODUCTION

Root canal therapy (RCT) is one of the most commonly performed procedures in endodontics, aimed at eradicating infection and preserving natural teeth. Despite its high success rate, post-operative pain remains a significant concern for patients and clinicians.[1] Pain following RCT is typically attributed to periapical inflammation, mechanical irritation during instrumentation, extrusion of debris, or chemical irritation caused by the sealing materials used during obturation. These factors underscore the importance of selecting a sealer with optimal properties to minimize post-operative discomfort while achieving effective sealing of the root canal system.[2,3]

Calcium hydroxide ($Ca(OH)_2$)-based sealers are widely recognized in endodontics for their favorable biological properties. The antimicrobial action of calcium hydroxide, attributed to its high pH and ability to release hydroxyl ions, makes it effective against various pathogenic microorganisms.[4] Additionally, $Ca(OH)_2$-based sealers promote periapical healing by stimulating mineralization and creating an environment conducive to tissue repair.[5,6] Post-operative pain after RCT is a multifactorial phenomenon influenced by procedural, patient-related, and material-specific factors. Procedural factors include the technique of canal instrumentation, apical extrusion of debris, and obturation methods, while patient-related factors such as pre-operative pain, systemic health, and individual pain thresholds also play a role. The type of sealer used can significantly affect post-operative outcomes due to variations in their chemical composition, biocompatibility, and interaction with periapical tissues.[6,7]

Several studies have explored the effect of different sealers on post-operative pain, yielding varied results. Calcium hydroxide-based sealers are thought to reduce pain due to their anti-inflammatory and tissue-healing properties. However, their use is not without limitations, such as their limited adhesion to dentin and potential for leakage over time.[8,9]

The interaction of $Ca(OH)_2$-based sealers with periapical tissues and their contribution to healing and pain modulation warrant further exploration. The present study is motivated by the need to provide evidence-based insights into the relationship between $Ca(OH)_2$-based sealers and post-operative pain in RCT. By analyzing pain intensity and its progression over time in patients treated with $Ca(OH)_2$-based sealers, this study seeks to address a critical gap in the literature. Understanding the impact of these sealers on pain management is essential for optimizing treatment outcomes and enhancing patient satisfaction.

MATERIALS AND METHODS

This experimental study was carried out at Sharif Medical & Dental College, Lahore over six months from Jan 2023 to June 2023. Ethical approval was obtained from the institutional review board, and written informed consent was secured from all participants before enrollment. A total of 150 patients requiring RCT were included in the study using a consecutive sampling technique.

Patients aged between 18 and 60 years, presenting with single-rooted teeth, and having no systemic conditions that could affect healing were included. Exclusion criteria involved patients with pre-existing periapical abscesses, retreatment cases, pregnancy, or allergy to calcium hydroxide-based sealers. Patients were randomly allocated to two groups: the experimental group, where $Ca(OH)_2$-based sealer was used for obturation, and the control group, where a non-$Ca(OH)_2$-based sealer (resin-based or zinc oxide eugenol-based) was used. Randomization was achieved using a computer-generated randomization sequence.

The root canal procedure was standardized across all cases. After administration of local anesthesia and isolation using a rubber dam, access cavities were prepared. Root canal instrumentation was performed using a rotary file system (ProTaper Gold), adhering to the crown-down technique. Irrigation was carried out using 5.25% sodium hypochlorite and saline. The working length was determined using an apex locator and confirmed radiographically.

Following cleaning and shaping, the canals were dried with sterile paper points. In the experimental group, $Ca(OH)_2$-based sealer (Apexit Plus) was applied to the canals using a lentulo spiral, followed by obturation with gutta-percha using the cold lateral compaction technique. The same procedure was

followed for the control group, with the use of the designated non-$Ca(OH)_2$-based sealer. Temporary coronal restoration was completed using glass ionomer cement, and patients were advised to return for final restoration within one week. Post-operative pain was assessed using a 10-point visual analog scale (VAS), where 0 indicated no pain and 10 indicated severe pain. Pain scores were recorded at 6, 24, 48, and 72 hours post-treatment. Patients were instructed to document their pain intensity in a diary provided at the time of the procedure. Analgesics (paracetamol 500 mg) were prescribed, and patients were instructed to record any consumption of analgesics during the observation period. The collected data were analyzed using SPSS version 25.0. Descriptive statistics, including means and standard deviations, were calculated for continuous variables. Pain scores between the two groups were compared using the independent t-test or Mann-Whitney U test, depending on data normality. A p-value of <0.05 was considered statistically significant.

STUDY RESULTS

Table 1 presents the baseline characteristics of the patients. The mean age in the experimental group was 34.2 ± 9.8 years, and in the control group, it was 33.5 ± 10.1 years ($p = 0.72$). Both groups had a comparable gender distribution, with males and females being 50.7% and 49.3% in the experimental group and 48.0% and 52.0% in the control group, respectively ($p = 0.77$). Pre-operative pain scores were similar between the groups ($p = 0.65$). Tooth types were evenly distributed, with incisors being the most treated teeth (38.7% in the experimental group and 40.0% in the control group), followed by premolars (33.3% in both groups) and canines (28.0% vs. 26.7%; $p = 0.94$).

Table 1: Baseline Characteristics of Patients (n = 150)

Characteristic		Experimental Group (n = 75)	Control Group (n = 75)	p-value
Age (years)	Mean ± SD	34.2 ± 9.8	33.5 ± 10.1	0.72
Gender	Male	38 (50.7%)	36 (48.0%) /	0.77
	Female	37 (49.3%)	39 (52.0%)	
Pre-operative Pain	Mean (VAS)	6.8 ± 1.5	6.9 ± 1.4	0.65
Tooth Type	Incisor	29 (38.7%)	30 (40.0%)	0.94
	Canine	21 (28.0%)	20 (26.7%)	
	Premolar (PM)	25 (33.3%)	25 (33.3%)	

Table 2 highlights post-operative pain scores. The experimental group experienced significantly lower pain at all time points, with VAS scores of 3.2 ± 1.4 at 6 hours, 2.1 ± 1.2 at 24 hours, 1.2 ± 0.9 at 48 hours, and 0.8 ± 0.7 at 72 hours, compared to the control group's scores of 4.5 ± 1.7, 3.8 ± 1.5, 2.6 ± 1.3, and 1.9 ± 1.0, respectively ($p < 0.001$).

Table 2: Post-Operative Pain Scores (VAS) Over Time

Time Point	Experimental Group	Control Group	p-value
6 Hours	3.2 ± 1.4	4.5 ± 1.7	<0.001
24 Hours	2.1 ± 1.2	3.8 ± 1.5	<0.001
48 Hours	1.2 ± 0.9	2.6 ± 1.3	<0.001
72 Hours	0.8 ± 0.7	1.9 ± 1.0	<0.001

As shown in Table 3, analgesic consumption was lower in the experimental group, with 24% of patients using analgesics compared to 51% in the control group ($p < 0.001$). The average dose of analgesics consumed was also lower in the experimental group (1.4 ± 0.6 tablets vs. 2.7 ± 1.1 tablets; $p < 0.001$).

Table 3: Analgesic Consumption in Both Groups

Parameter	Experimental Group (n = 75)	Control Group (n = 75)	p-value
Patients Taking Analgesics	18 (24%)	38 (51%)	<0.001
Average Dose	1.4 ± 0.6	2.7 ± 1.1	<0.001

Table 4 demonstrates that patients in the experimental group reported significantly higher satisfaction scores at 72 hours post-treatment (8.6 ± 1.2) compared to the control group (7.1 ± 1.5; $p < 0.001$).

Table 4: Patient Satisfaction Scores at 72 Hours Post-Treatment

Satisfaction Level (1-10)	Experimental Group	Control Group	p-value
Overall Satisfaction	8.6 ± 1.2	7.1 ± 1.5	<0.001

Table 5 summarizes healing outcomes. Complete healing was observed in 90.7% of the experimental group compared to 74.7% of the control group ($p = 0.01$). Mild inflammation was less frequent in the experimental group (9.3%) than in the control group (25.3%; $p = 0.01$). Severe inflammation was not observed in either group.

Table 5: Healing Outcomes Based on Follow-Up Examination

Outcome	Experimental Group (n = 75)	Control Group (n = 75)	p-value
Complete Healing (%)	68 (90.7%)	56 (74.7%)	0.01
Mild Inflammation (%)	7 (9.3%)	19 (25.3%)	0.01
Severe Inflammation (%)	0 (0%)	0 (0%)	-

DISCUSSION

Post-operative pain is a frequent complication in root canal therapy (RCT), often influencing patient satisfaction and treatment outcomes. Pain is typically caused by periapical inflammation and microbial activity, necessitating effective sealers to minimize these effects.[10,11] Calcium hydroxide ($Ca(OH)_2$)-based sealers are widely recognized for their antimicrobial and anti-inflammatory properties, which may enhance healing and reduce discomfort. Despite their potential, limited evidence exists comparing their efficacy against non-$Ca(OH)_2$-based sealers in controlling post-operative pain.[12] This study aimed to evaluate the role of $Ca(OH)_2$-based sealers in reducing pain, lowering analgesic requirements, and improving healing outcomes in RCT patients. The findings demonstrated significantly lower post-operative pain scores and reduced analgesic consumption in the experimental group compared to the control group, aligning with and contrasting various existing studies.

Our results showed significantly lower visual analog scale (VAS) scores in the experimental group at all time points, with most patients reporting minimal or no pain after 72 hours. This aligns partially with Ujjan et al. (2021), who observed a marked reduction in pain from a mean VAS score of 8.7 ± 0.3 on the first day to 0.65 ± 0.7 after one week, though their participants reported severe initial pain levels compared to the moderate levels noted in our study. Additionally, gender differences in pain perception were insignificant in both studies.[13]

Conversely, our findings differ from Büker (2023) and Ferreira (2021), who found no significant differences in post-operative pain or analgesic intake between groups treated with $Ca(OH)_2$- and calcium silicate-based sealers.[15,17] Similarly, Shahroz et al. (2023) observed no statistical difference in pain or analgesic use, despite reductions in pain over time. This discrepancy may stem from methodological variations, including different sealer formulations and sample sizes. Our findings also contrast with those of Anjaneyulu (2014), who noted limited efficacy of $Ca(OH)_2$ when used alone but emphasized its enhanced effectiveness when combined with other agents.[14,18] However, Thakur et al. (2020) ranked $Ca(OH)_2$-based medicaments as the least painful post-operatively, consistent with our results demonstrating superior pain reduction with $Ca(OH)_2$-based sealers.[19] Meta-analyses by Monteiro et al. (2023) and Moraes et al. (2024) suggested no significant differences in post-operative pain between endodontic sealers, though heterogeneity and moderate-to-low evidence certainty were limitations.[16,20] In our study, the significant pain reduction observed with $Ca(OH)_2$-based sealers may reflect differences in patient demographics, procedural consistency, and follow-up intervals. [20]

The reduced analgesic consumption and higher healing rates observed in our study align with the anti-inflammatory properties of $Ca(OH)_2$-based sealers, as suggested by Thakur et al. (2020). Our healing

outcomes also surpassed those of Shahroz et al. (2023), who reported complete resolution of discomfort by seven days in both study groups.[18,19]

The study's strengths include a randomized design, a robust sample size of 150 patients, and the use of validated pain and healing assessment tools. It also provides practical insights for clinicians seeking to optimize post-operative outcomes in RCT. However, limitations include its single-center design and short follow-up duration, which may limit the generalizability and assessment of long-term outcomes.

CONCLUSION

$Ca(OH)_2$-based sealers significantly reduce post-operative pain, lower analgesic requirements, and enhance healing outcomes, making them an effective choice for improving RCT success. These findings highlight their efficacy in enhancing patient comfort and treatment success. Further research is recommended to confirm these results in diverse populations and settings.

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