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Original Research Article

Effect of calcium hydroxide combinations as intracanal medicament for managing post-operative pain in symptomatic apical periodontitis cases: A randomized double blinded study

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Abstract

Introduction: Postoperative pain is a frequent challenge in root canal treatment. Alleviation of pain during endodontic procedure can be achieved using intracanal medications with combinations. Calcium hydroxide ($Ca(OH)_2$) is an effective intracanal medicament, and its performance depends on the vehicle used. Alleviation of pain during endodontic procedure can be achieved using intracanal medications with combinations.

Aim & Objective: This study aims to compare the pain-relieving effectiveness of calcium hydroxide (CH) when combined with normal saline, lidocaine, and dexamethasone.

Methods and Materials: 45 patients diagnosed with irreversible pulpitis and symptomatic apical periodontitis in mandibular molars having pain score greater than 50 on visual analogue scale (VAS) of 100 mm were included. After preparing the root canals, the patients were randomly assigned to one of three groups with the help of scientific random number table. (n=15 in each group): Group A: CH mixed with saline, Group B: CH with lidocaine Hydrochloride and Group C: CH mixed with saline. Postoperative spontaneous pain levels were recorded daily for one week using the VAS. Statistical analysis was performed using one-way ANOVA, chi-squared test, and Mann-Whitney U tests, with a significance level set at $p = 0.05$.

Results: Calcium hydroxide with lidocaine HCl experienced significantly less pain compared to the other groups during the first three days ($p < 0.05$). However, after one week, there were no significant differences in postoperative percussion pain levels between the three groups ($p > 0.05$).

Conclusion: The combination of calcium hydroxide and lidocaine may be an effective combination for alleviating pain during root canal treatment.

Key message: The study demonstrates that the use of calcium hydroxide combinations as an intracanal medicament significantly reduces post-operative pain in patients with symptomatic apical periodontitis, providing an effective treatment option for managing pain after endodontic procedures.

Keywords: Calcium hydroxide, Dexamethasone, Intracanal medicament, Lidocaine, Root canal therapy, Postoperative pain.

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1. Introduction

Root canal treatment (RCT) is performed to relieve pain and eliminate infections in teeth. Endodontic pain often results from inflammation in the periradicular tissues, which may be caused by over-instrumentation, the release of irritants entering the root canal during treatment, or the persistence of microbial pathogens due to insufficient disinfection.[1] The severity of postoperative discomfort can vary depending on microbial load, host immune response, and procedural factors. Pain management during and after RCT is therefore a critical component of successful endodontic therapy, as postoperative pain can significantly influence patient satisfaction, compliance with follow-up appointments, and overall perception of dental care quality.

Calcium hydroxide ($Ca(OH)_2$) is one of the most widely used intracanal medicaments in endodontics due to its broad spectrum of biological and antimicrobial properties, which include protein denaturation, neutralisation of bacterial endotoxins, and inhibition of microbial enzyme activity.[2] With a high pH (approximately 12.5), $Ca(OH)_2$ creates an environment that is hostile to most endodontic pathogens,

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thereby reducing microbial load and promoting periapical healing. The effectiveness of $Ca(OH)_2$ is influenced not only by its intrinsic antimicrobial capacity but also by the vehicle in which it is carried. The vehicle determines the rate of ionic dissociation, depth of penetration into dentinal tubules, and duration of the medicament's activity. Aqueous vehicles such as distilled water and saline allow for faster ion release but may have a shorter duration of effect, whereas viscous or oily vehicles can provide sustained release but may reduce immediate antimicrobial potency.[3] Consequently, identifying a vehicle that can optimise both rapid and prolonged therapeutic effects remains an area of active research.

Lidocaine hydrochloride (HCl) is a commonly used amide-type local anaesthetic in dentistry, valued for its rapid onset and ability to produce reversible loss of sensation at the site of application.[4] In clinical practice, it is frequently applied to injection sites or wound surfaces for localized anaesthesia. When considered as a potential vehicle for calcium hydroxide, lidocaine offers an intriguing dual benefit: in addition to serving as a medium for Ca^{2+} and OH^- ion release, it could provide localized anaesthetic action within the root canal, potentially attenuating nociceptive signalling during the early postoperative period. This may translate into greater patient comfort and reduced need for systemic analgesics in the initial days following instrumentation.

Corticosteroids are potent anti-inflammatory agents capable of modulating both acute and chronic inflammatory processes. In endodontics, they may be applied locally within the root canals as intracanal medicaments or administered systemically to reduce postoperative inflammation and swelling.[5] Dexamethasone, a long-acting synthetic corticosteroid, has demonstrated efficacy in inhibiting the synthesis of inflammatory mediators such as prostaglandins and cytokines, thereby reducing pain and tissue inflammation. When used as a vehicle for $Ca(OH)_2$, dexamethasone may offer a synergistic effect—providing antimicrobial benefits through the hydroxyl ions while simultaneously mitigating periapical inflammation via corticosteroid action. This combination may be particularly beneficial in teeth diagnosed with symptomatic apical periodontitis or irreversible pulpitis, where inflammatory processes are pronounced.

No previous study has directly compared postoperative pain outcomes when lidocaine hydrochloride and dexamethasone are employed as vehicles for calcium hydroxide under standardized clinical conditions. Given that different vehicles can significantly alter the physicochemical properties, diffusion characteristics, and clinical performance of $Ca(OH)_2$, a comparative evaluation is warranted. This study was therefore designed to assess and compare the effects of calcium hydroxide in combination with saline, lidocaine, or dexamethasone on postoperative pain in mandibular molar teeth requiring RCT.

2. Material and Methods

This double-blind clinical trial was approved by the Ethical Committee (IEC/Cons/08/24) and registered with the Central Trial Registry of India (CTRI REF/2024/09/092622). Conducted in the Department of Conservative Dentistry and Endodontics, a power analysis using G*Power version 3.0.1 determined a minimum sample size of 45 subjects (15 per group) for 80% power, effect size 0.5, and significance level 0.05. A blinded researcher (Researcher A) created the random allocation, and another blinded researcher (Researcher B) performed the treatments. Patients were unaware of their group assignment. Sample size was calculated using G*Power version 3.0.1 for 80% power, effect size 0.5, and significance level 0.05. The minimum required sample was 45 subjects (15 per group).

Before starting the procedure, informed consent was obtained from all the patients. Inclusion criteria were based on the following factors:

1. Mandibular molar teeth diagnosed with either irreversible pulpitis or symptomatic apical periodontitis were included in the study. Irreversible pulpitis was confirmed by a prolonged response to cold testing using Roeko Endo-Frost spray (Coltene Whaledent, Langenau, Germany). Symptomatic apical periodontitis was confirmed by the presence of tenderness to percussion and radiographic evidence of periapical radiolucency. As the aim of the study was not to compare these diagnoses separately, both categories were analyzed together as a single study cohort
2. Patients presenting with spontaneous or percussion pain scoring ≥50 mm on a 100 mm Visual Analogue Scale (VAS) prior to initiation of treatment.
3. Patients aged 18 years and above.
4. Teeth with periapical index (PAI) scores of 1 or 2, as classified by Ørstavik et al.

The following criteria **were** applied to determine exclusion:

1. Patients on preoperative analgesics and antibiotics within the past month.
2. Sinus tract, tooth swelling, or periodontal pockets larger than 3 mm.
3. Teeth with severe damage; teeth with ankylosis or fractured roots; teeth with root resorption, bruxism, or RCT-treated tooth.
4. Immunocompromised patients, pregnant and lactating mothers.
5. Patients above the age of 60 years.

Before treatment, patients marked their baseline pain intensity on the VAS. Following diagnosis, local anaesthesia was administered using 2% lignocaine with 1:80,000 epinephrine (Xicaine, ICPA Health Products, India). After rubber dam isolation, access cavity preparation was performed.

Working length was determined using an electronic apex locator (X-Smart®, Dentsply Sirona, USA) and was verified with periapical radiography, set at 1 mm short of the apex. Root canals were cleaned with 2 ml of 2.5% NaOCl between instrument changes and were enlarged using K-files sequentially. The final preparation was completed to a size three files larger than the initial file. Final irrigation was performed with 5 ml NaOCl, followed by a saline rinse, and canals were dried with paper points.

Simple randomisation was used without blocking or stratification. Random allocation was performed using a scientific random number table by a blinded researcher (Researcher A), while another blinded researcher (Researcher B) performed the treatments. Participants were kept unaware of group allocation. Groups were:

1. Group A: Calcium hydroxide with 0.9% NaCl (saline).
2. Group B: Calcium hydroxide with lidocaine HCl (21.33 mg/ml) + adrenaline (0.0225 mg/ml) (Xicaine, ICPA Health Products Ltd, India).
3. Group C: Calcium hydroxide with dexamethasone phosphate (4 mg/ml) (Dexaphos, Brooks Laboratories, America).

The calcium hydroxide paste (0.12 g powder + 0.14 ml liquid) was mixed to a consistent texture and was placed into the canal using a lentulo spiral, 2 mm short of the working length. The pulp chamber was sealed with Cavit (3M ESPE, Germany).

Pain intensity was recorded daily for 7 days using the VAS. Rescue medication (aceclofenac 100 mg + paracetamol 325 mg + serratiopeptidase 15 mg; Zerodol-SP, Ipca Laboratories Ltd, India) was prescribed if needed, and intake was recorded.

After 1 week, patients were recalled for completion of root canal treatment using gutta-percha and AH Plus sealer (Dentsply Sirona, York, PA, USA) by the single cone technique, followed by final restoration.

2.1. Statistical methods

Data analysis was performed using SPSS version 21 (SPSS Inc, Chicago, IL). Descriptive statistics were expressed as mean ± standard deviation. Data normality was tested using the Shapiro–Wilk test. Intergroup comparisons were conducted using the Kruskal–Wallis H test, with the Mann–Whitney U test for post-hoc pairwise analysis.

The full trial protocol, de-identified participant data, and statistical analysis plan were available from the corresponding author upon request. No interim analyses or stopping guidelines were implemented, as the study was conducted to its predefined completion.

3. Results

Of the 45 patients in the study, 23 were male (51.1%) and 22 were female (48%). Demographic details are given in **Table 1**. The distribution of male and female patients across the three groups is shown in **Table 1**. No statistically significant difference in gender distribution was observed between groups ($p > 0.05$), and gender did not influence postoperative pain outcomes. Over the 7-day study, five patients (33.33%) in Group A (saline), ten (66.66%) in Group B (lidocaine), and five (33.33%) in Group C (dexamethasone) reported no pain. Four patients (26.6%) in Group A, none in Group B, and two (13.3%) in Group C used escape drugs. Significant pain reduction **was** observed between Group A (saline) and Group B (lidocaine) during the first three days ($p < 0.05$). Overall, significant pain reduction was noted in the first two days, but differences between groups after one week were insignificant ($p > 0.05$) (**Table 2**). VAS scores (**Figure 1**) showed the lowest mean pain in the lidocaine group. All calcium hydroxide combinations reduced pain after 7 days, with lidocaine and calcium hydroxide being most effective in the first three days. No postoperative swelling, pain on palpation, or sinus tract was observed, and no patient required an unscheduled visit for severe symptoms.

Table 1: Comparison of mean age between three study groups

	Calcium hydroxide with Saline	Calcium hydroxide with Lidocaine	Calcium hydroxide with Dexamethasone	P value
Age	36.33 ± 10.92	39.6 ± 12.92	35.93 ± 12.18	>0.05
Gender				
Female	5 (33.3%)	8 (53.3%)	9 (60%)	>0.05
Male	10 (66.7%)	7 (46.7%)	6 (40%)	

Table 2: Overall intergroup comparison between three study groups in relation pain VAS scores

	Day 1 Mean (SD)	Day 2 Mean (SD)	Day 3 Mean (SD)	Day 4 Mean (SD)	Day 5 Mean (SD)	Day 6 Mean (SD)	Day 7 Mean (SD)
Group A (Calcium hydroxide + Saline)	2.73 (2.89)	2.0 (2.42)	1.2 (2.07)	0.6 (1.59)	0.46 (1.24)	0.73 (1.33)	0.53 (1.18)

Group B (Calcium hydroxide +Lidocaine)	0.33 (0.89)	0.26 (0.7)	0.0 (0.0)	0.13 (0.51)	0.33 (0.89)	0.13 (0.51)	0.53 (1.12)
Group C (Calcium hydroxide + Dexamethasone)	1.86 (2.41)	0.66 (1.63)	0.4 (1.05)	0.33 (0.89)	0.33 (0.89)	0.2 (0.56)	0.66 (0.97)
p value (overall)†	p =0.018*	p =0.023*	p =0.056	p = 0.511	p = 0.920	p =0.140	p = 0.929
A vs B‡	p =0.014*	p =0.024*	p =0.048*	p =0.481	p =0.933	p =0.165	p = 1.00
A vs C‡	p =0.543	p =0.101	p =0.245	p =0.785	p =0.933	p =0.238	p = 0.941
B vs C‡	p =0.158	p = 0.804	p =0.696	p =0.872	p =1.00	p =0.977	p= 0.941

*p<0.05 – significant difference
† Overall comparison among three groups done using Kruskal Wallis H test
‡ Pairwise comparison between groups done using Mann Whitney U test

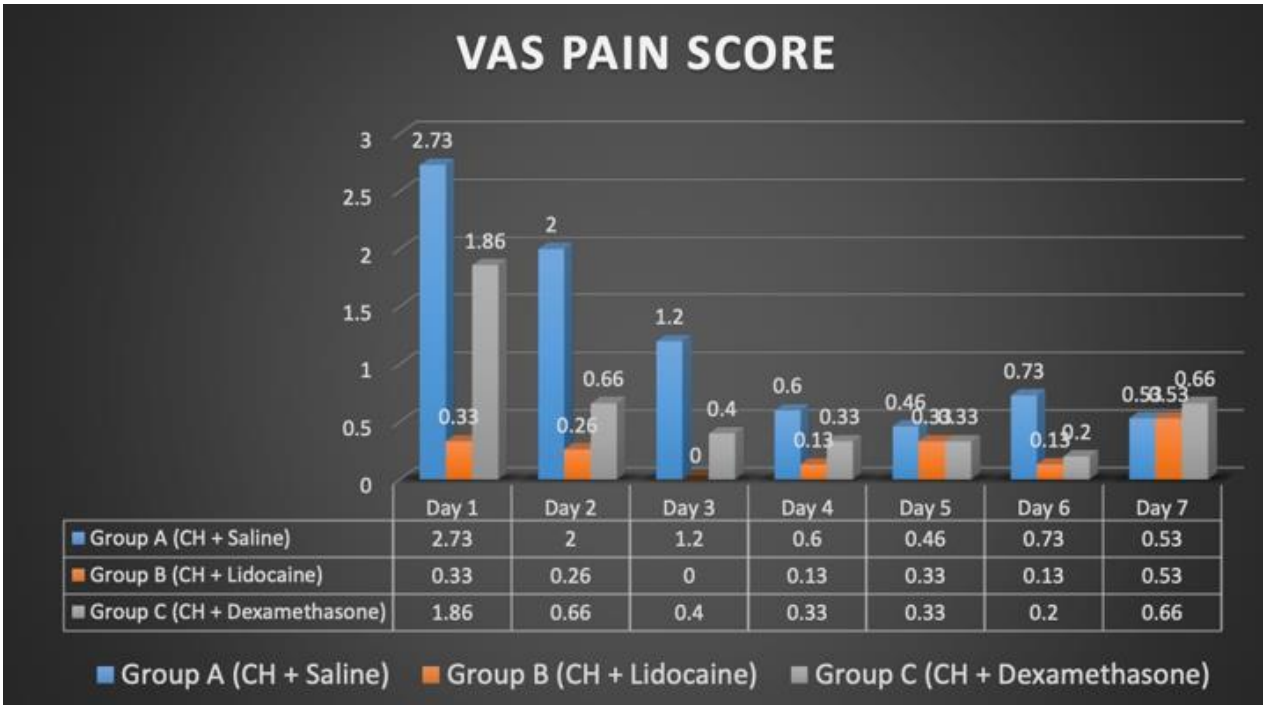

Figure 1: Post-operative pain scores over 7 days. Group A (CH + Saline) shows gradual pain reduction. Group B (CH + Lidocaine) maintains the lowest scores. Group C (CH + Dexamethasone) shows moderate pain relief.

4. Discussion

This clinical trial aimed to assess which combination of calcium hydroxide is more efficient in terms of pain reduction when mixed with different vehicles in symptomatic apical periodontitis cases. The results showed that calcium hydroxide combined with lidocaine produced the greatest pain reduction during the first three postoperative days, with no significant differences between groups after one week.

Calcium hydroxide can be mixed with three types of vehicles: (1) aqueous, (2) lubricating, and (3) viscous. Viscous carriers provide long-term stability, while aqueous vehicles enable rapid ion release. Non-aqueous vehicles may reduce its effectiveness as a root canal dressing. [6] Common aqueous vehicles—such as normal saline, distilled water, and chlorhexidine—affect ionic dissociation, antimicrobial action, and pH.[6-8]

Calcium hydroxide releases hydroxyl ions, creating an alkaline environment that raises pH, modifies tissues, reduces microbial load, alters bacterial cell walls, and denatures toxins—effects linked to pain relief.[9] The pH may be influenced by local anaesthetics; however, Stamos et al. reported that calcium hydroxide–lidocaine mixtures remained distinctly alkaline, comparable to calcium hydroxide with saline.[10] Other studies confirm that altering anaesthetic pH does not affect calcium hydroxide stability.[11]

The superior early analgesic effect of the lidocaine combination may be attributed to its dual action: rapid ionic dissociation from the aqueous medium enhancing calcium hydroxide's antimicrobial effect, and the local anaesthetic action reducing nociceptive transmission.[3] These findings are consistent with Arslan et al., who also reported reduced postoperative pain with calcium hydroxide–lidocaine mixtures in symptomatic teeth.[12]

Dexamethasone, as an anti-inflammatory corticosteroid, can reduce inflammatory mediator synthesis and periapical tissue inflammation. [5] A systematic review by Moskow et al.[13] concluded that intracanal corticosteroid application is safe, as only minimal amounts enter the canal, limiting systemic effects. Local delivery allows direct action on inflamed periapical tissues.[14] Ghanbarzadegan et al.[15] reported that calcium hydroxide with dexamethasone reduced pain more effectively than with saline during the first four days. Similarly, Yousaf et al.[16] found it most effective in the first three days, with no significant differences between groups after one week.

This study compared dexamethasone and lidocaine as vehicles for calcium hydroxide due to their distinct yet complementary mechanisms in postoperative pain control. Lidocaine acts as a local anaesthetic, blocking sodium channels to provide immediate analgesia, while dexamethasone is a corticosteroid that suppresses inflammatory mediators for sustained relief. Both are aqueous solutions that facilitate rapid hydroxyl ion release from calcium hydroxide, influencing its antimicrobial and anti-inflammatory action. Although each combination has been studied individually, no direct clinical comparison exists, making this investigation novel and clinically relevant.

Analgesic use after treatment was included in the analysis, although it may have influenced outcomes by altering the inflammatory response. Notably, no patients in the lidocaine group required analgesics, compared with two in the dexamethasone group and four in the saline group.

Endodontic therapy alone can reduce pain in patients with preoperative symptoms.[17] In this study, all groups showed pain reduction, which may reflect both the effect of intracanal medicaments and the natural resolution following canal preparation. The peak antimicrobial activity of calcium hydroxide after one week may also have contributed to similar outcomes across groups.

Complete removal of calcium hydroxide from canals is challenging, and no single method has been proven fully effective.[18] While sonic activation was used, residual material likely remained, consistent with studies showing it is less effective than passive ultrasonic irrigation.[19]

The single- versus multiple-visit debate remains unresolved. Single visits are generally appropriate for irreversible pulpitis and vital pulp cases,[20] while necrotic pulps with or without periradicular periodontitis may benefit from an inter-appointment dressing to reduce bacterial load.[21] However, outcomes for single- and multiple-visit treatments in necrotic teeth are comparable.[22] In this study, two visits were chosen to allow assessment of calcium hydroxide with different vehicles on postoperative pain.

5. Conclusion

This study concludes that when calcium hydroxide is mixed with dexamethasone, lidocaine, or saline, it is effective for postoperative pain reduction in endodontic treatment, with lidocaine and calcium hydroxide being most effective in the first few days. Additional larger sample size studies are necessary to assess the impacts of various vehicles with calcium hydroxide on postoperative pain in various clinical settings.

6. Author Contribution

1. Rohit Kochhar – concept, design, definition of intellectual content, clinical studies, data acquisition, data analysis, manuscript preparation, manuscript editing, and manuscript review.
2. Anneysha Bhattacharyya – concept, design, definition of intellectual content, literature search, clinical studies, data acquisition, manuscript preparation, manuscript editing, and manuscript review.
3. Manju Kumari – concept, design, data acquisition, statistical analysis, manuscript preparation, manuscript editing, and manuscript review.
4. Mansi Punjabi – clinical studies, data analysis, , manuscript editing, and manuscript review.

7. Ethical Approval

ECR/1413/Inst/PB/2020.

8. Source of Funding

None.

9. Conflict of Interest

None.

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