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EFFECTIVENESS OF VARIOUS MIXTURES OF CALCIUM HYDROXIDE MEDICAMENT IN MITIGATING INTER-APPOINTMENT PAIN IN MANDIBULAR MOLAR ENDODONTIC TREATMENT

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ABSTRACT

Objective: *To compare efficacy of calcium hydroxide mixed with 2% chlorhexidine and calcium hydroxide mixed with 1 ml normal saline in terms of inter-appointment pain in permanent mandibular molars.*

Materials and methods: *A triple blind clinical study was carried out at the Department of Operative Dentistry in the Armed Forces Institute of Dentistry over a period of six months. Sample size was estimated n=80 by using World Health Organization calculator. Thus 80 patients were divided into 2 groups through central randomization. In group-A, calcium hydroxide (0.5 g) mixed with 1ml of 2% chlorhexidine whereas in group-B calcium hydroxide (0.5 g) mixed with 1ml normal saline were placed as intra canal medicament. Pain levels at 24 hours were recorded according to the VAS criteria.*

Results: *The mean age of patients in group A was 34.4±7.5 years, with a gender distribution consisting of 22 males (55%) and 18 females (45%). Conversely, group B had a mean age of 34.4±7.5 years, with a gender distribution of 27 males (67.5%) and 13 females (32.5%).Statistically significant differences were observed in the mean inter-appointment Pain Visual Analog Scale (VAS) scores recorded at 24 hours between the two groups. Specifically, group A exhibited a mean level of pain reduction of 1.48±1.21, whereas group B had a higher mean level of pain reduction of 3.15±1.35 (p<0.001) on VAS scale.*

Conclusion: *The intracanal medication regimen comprising calcium hydroxide combined with 2% chlorhexidine has shown statistically significant difference in alleviating inter-appointment pain compared to the regimen of calcium hydroxide mixed with normal saline.*

Keywords: *Intra-canal medicament, Inter-appointment pain, Calcium hydroxide, Chlorhexidine*

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INTRODUCTION

Pain management is crucial for successful dental treatment, with interappointment pain being a common issue in endodontics.[1,2] This pain can result from inflammation, microbial activity, or mechanical irritation during root canal procedures.[3] Effective pain management is essential for patient trust, compliance, and treatment success.

Pain perception varies among individuals, necessitating reliable pain assessment tools like the Visual Analog Scale (VAS) to evaluate pain severity. This scale is categorized as no pain, mild pain which is pain or slight discomfort bearable by the patient without the need of analgesics, moderate intensity pain which is relieved by taking analgesics and severe intensity pain which is categorized as intense pain not relieved even

after taking analgesics.[4,5] Interappointment pain can escalate to postoperative endodontic pain, which is characterized as pain that emerges following the initiation of endodontic treatment. This subsequent discomfort can significantly erode patient's confidence in dental interventions.[6] Addressing and effectively managing both interappointment and postoperative pain are paramount not only for ensuring patient comfort but also for fostering trust and satisfaction in dental care and treatment outcomes.[6]

Proficient chemo-mechanical preparation may decrease bacterial load, thus an intracanal medicament with broad spectrum anti bacterial action is vital especially in cases with ongoing infection.[6,7] Calcium Hydroxide (CaOH) has been a preferred intracanal medicament since the 1920s due to its broad-spectrum antibacterial properties and reduced cytotoxicity compared to other alkaline metals like Sodium Hydroxide (NaOH) and Potassium Hydroxide (KOH).[7,8] With a highly basic pH ranging from 12.5-12.8, CaOH releases OH- ions in aqueous mediums, altering the biological properties of bacterial lipopolysaccharides in gram-negative cell walls and disrupting membrane transport mechanisms, leading to bacterial cell toxicity.[9] Despite its efficacy, CaOH may not be effective against all microbial strains, such as E. faecalis and Candida albicans, leading to persistent pain and treatment challenges. Moreover its limited penetration into dentinal tubules can compromise its therapeutic efficacy.

The choice of vehicle used with CaOH can influence its efficacy. Various vehicles, including aqueous (e.g., saline, water, CHX) and viscous substances (e.g., glycerine, polyethylene glycol), have been explored to enhance the solubility and antimicrobial capacity of CaOH.[10] However, the comparative effectiveness of these vehicles in reducing interappointment pain remains inconclusive, particularly in specific regions with limited research on this topic.

Local studies are essential as they can account for regional variations in patient demographics, microbial profiles, and treatment protocols, which may influence the outcomes of endodontic treatments. By conducting a focused local study, researchers can generate region-specific data that can guide clinicians in selecting the most effective and cost-efficient aqueous medium to mix with CaOH, ultimately improving treatment outcomes, patient satisfaction, and the overall quality of endodontic care in the region. Due to scarcity of local literature and regional studies on this subject, our study aims to evaluate the efficacy of two distinct aqueous vehicles, normal saline and 2% Chlorhexidine (CHX), when combined with CaOH to determine their potential in reducing inter-appointment pain and enhancing therapeutic outcomes in endodontic treatment of permanent mandibular molars.

METHODOLOGY

A triple-blind clinical trial was conducted at the Department of Operative Dentistry, Armed Forces Institute of Dentistry, spanning six months from January 2, 2023, to July 2, 2023. Ethical approval for the study was obtained from the institution's review board. Based on the mean (Group 1 = 3.65, Group 2 = 5.6) and standard deviations (Group 1 = ±2.293, Group 2 = ±2.590) of previous study, (11) sample size was estimated n=64 by using Openepi.com with confidence interval 95% and margin of error 5%. To reassure our results and equal distribution of patients in both groups, we increased the number of samples to 80. Patients were allocated into two groups, the total of 80 patients (40 patients in each group) were examined. Participants were allocated to Group A and Group B through central randomization to mitigate bias. The study adopted a triple-blind design, ensuring blinding of participants, assessors, and group allocation. Coded labels were employed instead of names during data presentation to assessors, and both participants and assessors remained unaware of the group receiving the experimental treatment. The inclusion criteria encompassed patients of both genders, aged between 16-50 years, absence of any systemic disease, exhibiting clinical and radiological signs of teeth with symptomatic necrosis, irreversible pulpitis, and apical periodontitis with closed apex necessitating endodontic treatment, lack of any kind of resorption, non-use of antibiotics and pre-treatment analgesics. Exclusion criteria comprised individuals with a history of allergic or toxic reactions to intracanal medicaments, those taking medications potentially influencing pain perception or inter-appointment pain score analysis, those who failed to sign the consent, unwillingness to co-operate, not registering pain in the relevant form, pregnancy, non-restorable teeth, allergy to analgesics, suffering from a systemic disease, a history of chronic use of analgesics, drugs or alcohol and patients who failed to anesthetize after repeating block twice. Patients meeting the selection criteria were invited to participate in the study by the principal investigator based at the Department of Operative Dentistry, Armed Forces Institute of Dentistry. Following informed consent, comprehensive medical and dental histories were recorded. Clinical and digital intraoral periapical radiographic assessments were conducted to evaluate the pulpal and periapical status of the target tooth. Data pertaining to patients' age, gender, and the treated tooth were documented. On the initial visit, after administration of topical benzocaine, inferior alveolar nerve block was administered using 2% Lidocaine with epinephrine (1:100,000) to anesthesize mandibular molars (upto two cartridges of anesthetic solution). Access opening was performed using high-speed dental handpiece and a

round carbide or diamond bur (e.g., #2 or #4 round bur). Pulp chamber was exposed and the canal orifices were located. A straight-line access was achieved and any remaining roof or pulp tissue was removed to facilitate instrumentation and cleaning of the root canals followed by confirmation of working length through apex locator (J Morita) and periapical radiographs. Preparation of canals was performed using standardized technique; cleaning and shaping were done by step back method and with handy K-files (Mani, Togichi, Japan) with simultaneous irrigation using 2.5% Sodium Hypochlorite. For drying, paper points were utilized. Group A received 0.5 g of CaOH combined with 1 ml of 2% CHX as intracanal medicament, while Group B received CaOH combined with normal saline, following the same preparation protocol. The patients were categorized by an assistant according to random numbers table. The dentist, patient and statistical analyst did not know the groups. Two different medicaments including CH (Golchai, Iran) with chlorhexidine 2% (Maquira, Brazil), and normal saline 0.9% (Samen, Iran) were prepared by an assistant with the same module and proportion for patients (0.12 g powder plus 0.14 mL liquid) on a glass slab and provided to the dentist. It was placed in the canal with lentulo (Thomas, France) for one week. The tooth was temporarily restored with CAVIT. Patients were provided with a pain registration based on VAS for pain assessment and instructed to record their pain levels at 24 hours during the subsequent visit. The forms presented to the patients included a scale of 0 to 170 mm such that 0 mm was related to no pain, 1-54 mm was related to mild pain, 55-113 mm was related to moderate pain and 114-170 was related to severe pain. Meanwhile, the patients were asked to record the amount of their used analgesics by the 2nd day. In case of severe pain between visits, NSAIDs were prescribed based on medical history. To improve inter examiner agreement and calibration; two endodontists were trained for observing and recording the VAS scores of patients. Reassessment was performed to negate unanimity in case of any disagreement. The inter-examiner reliability was assessed, yielding a high consistency level of 0.9, indicative of strong agreement among examiners. Data were systematically recorded on a structured Performa. Data entry and analysis were conducted using SPSS software (version 23). Double-data entry was ensured where two independent individuals enter the same data to identify discrepancies and errors. Both individuals were blinded to the study outcomes. Normality of data was tested using Shapiro Wilk test. Descriptive statistics were applied for quantitative variables, while frequency and percentage were computed for qualitative variables. The independent sample T-test was utilized to compare pain levels between Group A and Group B, with a significance level $P \leq 0.05$ was considered statistically significant.

RESULTS

Total number of patients recruited in the study were 80 (40 patients per group). In A group patients were given CaOH with CHX while group-B received CaOH with normal saline. The age range of participants was between 20–50 years with mean age 34.4±7.5 years. Age distribution of patients in both groups is presented in figure.1. The study subjects comprised males 22 in number (55%) and females 18 in number (45%) in group-A while 27 males (67.5%) and 13 females (32.5%) in group-B. The mean level of interappointment pain in group A after 24 hours was 1.48±1.21, whereas group B had a higher mean level of interappointment pain of 3.15±1.35 ($p<0.001$)on a VAS scale between 0 and 10.Comparison of Inter-appointment pain (VAS at 24 hours) is mentioned in table 1.Statistically significant difference was noted in reduction of inter-appointment pain at 24 hours between the two groups. With patients in group A experiencing greater pain reduction as compare to patients in group B.

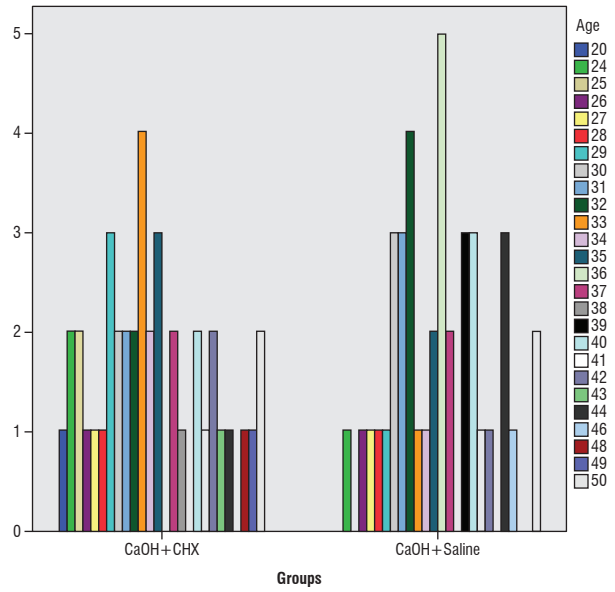

Fig 1: Age Distribution in Groups

TABLE 1: COMPARISON OF INTER-APPOINTMENT PAIN (VAS AT 24 HOURS)

Group	VAS score at 24 hrs		P value
	Mean	SD	
Group-A (Calcium hydroxide with chlorhexidine) (n=40)	1.48	1.21	P<0.001
Group-B (Calcium hydroxide with normal saline) (n=40)	3.15	1.35	

DISCUSSION

CaOH is the preferred substance as an intracanal drug in the treatment of root canal therapy.[12] CaOH is mixed with many vehicles such as common salt, cresatine, glycerin, propylene glycol, chlorhexidine and water. Biological and bacterial properties of calcium hydroxide are affected by the carrying vehicles. Vehicles with which it is mixed, also impact distribution capacity of calcium hydroxide.[12] Vehicles enhance solubility of calcium hydroxide upon tissue contact and promote effective release of Ca2+ and OH- ions, to improve antimicrobial and tissue-altering properties in endodontic therapy.

Findings in current study revealed that there was significant improvement in mean inter-appointment pain at 24 hours when intracanal medicament used was CaOH mixed with 2% CHX as compared with CaOH combined with normal saline as (P<0.001). In a similar study performed by Khattak et al (2014), they also reported that the CaOH mixed with CHX was more effective in decreasing interappointment pain during endodontic treatment as compare to CaOH mixed with saline.[11] Study conducted by Punathil S et al (2020) also showed superior antimicrobial effectiveness of CaOH mixed with CHX as compare to when CaOH was mixed with povidone-iodine or saline.[13] In their study they also showed that CHX did not affect the alkalinity of CaOH. Gome et al evaluated 2% CHX gluconate gel effectiveness along with CaOH against Enterococcus faecalis as intracanal medicaments in vitro, they find the results that CHX and CaOH combination was effective in antibacterial activity with maximum antibacterial action demonstrated after 24 and 48 hours and then reducing between 7 and 15 days.[14]

De Souza-Filho et al also evaluated against selected microorganisms the efficacy of CHX gluconate gel (2%) and CaOH as intracanal medications.[15] The results of their study demonstrated maximum microbial inhibition induced by CHX gel (2%) alone followed by CaOH and 2% CHX gel combination. Chlorhexidine eliminate microorganisms within 30 seconds to two hours.[15]

In another study, Gomes et al (2006) concluded that when mixed with 2% CHX, CH showed superior antimicrobial activity than CH used in addition to sterile water.[16] The effectiveness of CHX implies to its robust and continuous adhesion. CHX is believed to enhance the properties of CH by reducing amounts of endotoxin in root canals. CHX has been described to improve CaOH properties to reduce endotoxin in root canals and consequently interappointment pain.[17] Various studies have shown an improved antibacterial action of CaOH when used with CHX.[18]

Effect of saline as a vehicle is controversial as in one study it slightly reduce the antibacterial action of CaOH due to its rapid diffusion and unavailability of hydroxyl ions which are primarily responsible for antibacterial activity.[19] According to another study done by Khattak et al (2014) showed mean experienced pain was greater with calcium hydroxide mixed with normal saline.[11]

In a systematic review and meta-analysis conducted by Ahmed MZ et al (2020), it was concluded that when used as interappointment medication the combination therapies of CaOH such as CaOH-dexamethasone, and CaOH-lidocaine HCl appear to be more efficient in reducing post-operative pain at 24 hours than using CaOH alone.[20] But in their review between the combinations of CaOH along with either CHX, propolis and antibiotics no significant differences was noted in reducing inter appointment pain.[20]

Contrary to the results of our work, Luciane Dias et al (2007) , Tanomaru et al (2003) and Silva et al (2004) have shown in their research papers that CHX has reduce efficacy when reducing inter-appointment pain.[21-23] The findings of a study by Souza et al. in (2008) shows that Ca(OH)2 had antimicrobial activity only by direct contact against most tested microorganisms and its less effective when used in combination with CHX.[15]

Our findings revealed that the combination of Ca(OH)2 with 2% CHX resulted in a more significant reduction in inter-appointment pain compared to Ca(OH)2 mixed with normal saline. This observation aligns with previous studies suggesting that CHX may enhance the antimicrobial and therapeutic properties of Ca(OH)2 due to its broad-spectrum antimicrobial activity and substantively within the root canal system. However, it is essential to acknowledge that the current study has certain limitations, including a relatively small sample size, potential variability in patient pain perception, and the lack of long-term follow-up to assess the sustained efficacy and clinical outcomes of the tested formulations.

Based on the findings from this study and existing literature, it is recommended that future research endeavors should focus on investigating the optimal mixing ratios, application techniques and combinations of Chlorhexidine (CHX) with various vehicles. This exploration aims to enhance the biological and antibacterial properties of Calcium Hydroxide (CaOH) when used as an intracanal medicament in root canal therapy.

Future studies should also consider evaluating the antimicrobial efficacy, tissue compatibility, and overall safety profile of different aqueous vehicles and their impact on treatment outcomes, patient satisfaction, and the quality of endodontic care. By addressing these research priorities, we can potentially optimize overall performance of CHX mixed with different carrying

vehicles in root canal therapy.

CONCLUSION

The combination of calcium hydroxide (CaOH) with 2% chlorhexidine as an intracanal medication yielded a statistically significant reduction in inter-appointment pain at 24 hours compared to CaOH mixed with normal saline.

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