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ORIGINAL ARTICLE

Healing Outcome of Different Aqueous-based Calcium Hydroxide Intracanal Medicament in Patients with Pulpal Necrosis and Symptomatic Apical Periodontitis: A Randomised Controlled Trial

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ABSTRACT

Objective: This study aimed to assess and compare the healing outcome associated with different aqueous-based calcium hydroxide intracanal medicaments in patients with pulpal necrosis and symptomatic apical periodontitis.

Methods: Seventy five patients with pulpal necrosis and symptomatic apical periodontitis in permanent mandibular molar teeth were selected as the part of this study. The participants were randomly allocated to three groups, each comprising 25 patients, based on the type of intracanal medicament used during the treatment procedure. Group 1 consisted of calcium hydroxide (CH) mixed with 0.9% saline (NS), Group 2 contained CH combined with 2% lidocaine, and Group 3 included CH with 2% chlorhexidine (CHX). The Periapical Index Score was utilized to assess the healing of periapical lesions in pre-operative and post-operative periapical radiographs at 3-month intervals for 12 months. The Kruskal-Wallis test was used to determine the significance, with Post Hoc Dunn tests for multiple comparisons.

Results: At the 12-month follow-up, the CH+CHX group demonstrated significantly improved periapical healing, with a mean PAI score of 1.57 ± 0.66, compared to CH+LA (2.27±0.63) and CH+NS (2.48±0.79), with Kruskal-Wallis $p<0.05$. The mean time to achieve a healthy periapical status (PAI ≤2) was shortest in the CH+CHX group (8.10±3.28 months), followed by CH+NS (8.23±3.28 months) and CH+LA (8.25±3.31 months), with the multivariate Log-Rank test indicating a statistically significant difference among the groups ($p<0.05$).

Conclusion: The findings of this study indicate that CH when combined with 2% CHX as an aqueous vehicle demonstrated superior healing of periapical lesions in patients with pulpal necrosis and symptomatic apical periodontitis compared to saline or lidocaine.

Keywords: Calcium hydroxide, chlorhexidine, root canal medicament, periapical lesion

HIGHLIGHTS

- The combination of calcium hydroxide with 2% chlorhexidine showed noticeably higher healing rate of periapical lesions compared to saline or lidocaine.
- A robust methodology with 75 participants randomised into three groups ensured a reliable comparison of different aqueous-based calcium hydroxide formulations.
- This study demonstrated that the choice of intracanal medication affects the healing outcome in patients with pulpal necrosis and symptomatic apical periodontitis.

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INTRODUCTION

Apical periodontitis refers to inflammation of the periodontium at the root apex, which can be acute or chronic, caused by an immune-mediated inflammatory response to the infection located within or adjacent to the root canal system (1, 2). It results in loss of bone structure in the apical and periapical regions of the infected tooth (3). As the necrotic root contents lie beyond the body's natural defence mechanism, intervention

is necessary to treat such infections (4). Non-surgical endodontic therapy is considered the most conservative and treatment of choice for pulpal necrosis and symptomatic apical periodontitis (3). The primary aim of root canal therapy is to eradicate inflamed and infected pulpal tissue, fostering an environment that promotes healing, and thereby prevents the advancement of periapical pathology, eventually supporting the long-term survival of teeth (5).

The root canal system undergoes significant ecological changes during an endodontic therapy, which plays an important role in eliminating the microflora. Chemo-mechanical preparation focuses on eliminating necrotic pulpal tissue and infected dentin, with mechanical instrumentation combined with antimicrobial irrigation effectively eradicating most microorganisms within the root canal system. However, some microorganisms may persist, necessitating the use of an inter-appointment intracanal dressing to achieve thorough disinfection of the root canal system prior to obturation (6).

The use of an intracanal medicament is recommended in the treatment of pulpless teeth for several advantages: (a) to eradicate residual bacterial within the root canal; (b) to inhibit bacterial regrowth between appointments; and (c) to serve as a physicochemical barrier, preventing reinfection of the root canal and restricting nutrient availability to any remaining bacteria. Since they remain in the canal longer than irrigants, they can potentially reach bacteria residing in hard-to access areas within root canal system (7).

Calcium Hydroxide (CH), first introduced by Hermann in 1920 is widely utilized in endodontics as an intracanal medicament because of its strong alkaline nature and potent antibacterial activity against oral pathogens (7, 8). Its mechanism of action is attributed to the release of hydroxyl ions, which elevate the pH of the surrounding environment, leading to the inactivation of bacterial lipopolysaccharides found in the outer membrane of Gram-negative bacteria (9). The choice of vehicles combined with CH powder plays a crucial role in the dissociation process as they impact the rate of ionic dissociation, which in turn affects the solubilization and resorption of the paste at different rates by the periapical tissues and within the root canal (10). Typically, three types of vehicles are employed in the preparation of CH paste: viscous, aqueous, and oily (11).

Various aqueous vehicles that have been used to mix CH powder are distilled water, local anesthetic solution (LA), normal saline solution, normal saline (NS), chlorhexidine (CHX) gluconate, and more to enhance the antimicrobial activity of CH. These components encourage a high degree of solubility when the paste interacts with tissues and tissue fluids (11). Some water-soluble compounds that release Ca^{2+} and OH^{-} ions progressively over a long period of time are known as viscous vehicles. These include glycerine, propylene glycol, and polyethylene glycol. In contrast to aqueous vehicles, they have a lower solubility (11). Oily vehicles, such as camphor, olive oil, silicon oil, and metacresyl acetate have inadequate diffusion and solubility. Their major limitations include decreased alkalinity, slower ion release, limited antimicrobial action, and challenging removal, increasing the chance of canal blockage (11).

The rate of ionic dissociation is inversely proportional to the viscosity of vehicle (9). In clinical scenarios, an aqueous vehicle containing CH paste is indicated when rapid ionic release is required at the onset of treatment, while a viscous vehicle is utilized for controlled and sustained ionic release (12).

While CH is a commonly used intracanal medicament for patients with pulpal necrosis and symptomatic apical periodontitis, most existing studies have largely focused on its efficacy to reduce post-operative pain or bacterial load (13, 14). However, there is currently no universally accepted protocol regarding the optimal clinical protocols and materials used during root canal therapy (14).

A notable gap in the literature pertains to the limited clinical evidence evaluating the impact of different vehicles used for intracanal medicaments on periapical healing. Given that the vehicle can influence the dissociation, diffusion, and antimicrobial effectiveness of CH, understanding this interaction is crucial for optimising therapeutic outcomes in endodontic treatment.

This randomised controlled trial was designed to test the hypothesis that the type of aqueous vehicle - NS, LA, or CHX, when used in combination with CH, significantly affects the rate and extent of periapical healing in patients with pulpal necrosis and symptomatic apical periodontitis.

MATERIALS AND METHODS

Study Design, Trial Registration, and Ethical Approval

The study was officially registered in the Clinical Trials Registry of India (Ref no. CTRI/2024/06/069197) and was approved by the Institutional Ethical Committee OF Manav Rachna Dental College I (MRIIRS/MRDC/FDS/IEC/2023/23) dated 16.05.2023. Both verbal and written informed consent were acquired from the participants. The study followed the CONSORT guidelines (Fig. 1). This study was carried out at the Department of Conservative Dentistry and Endodontics of Manav Rachna Dental College in accordance with ethical guidelines by following the Declaration of Helsinki's principles.

Sample Size Calculation

A sample size of 75 participants (25 per treatment group) was recommended for the present study based on the assumptions and estimates derived from prior studies. With an effect size of d=0.3683 and a statistical power of 80% (1- β =0.80), this sample size was determined to achieve a 95% confidence level (15).

Recruitment and Eligibility Criteria

Inclusion criteria

- Healthy individuals between 18–45 years of age with endodontic diagnosis of pulpal necrosis and symptomatic apical periodontitis in mandibular molar teeth were included in the study.
- Thermal testing (Endofrost; Coltene, Whaledent Pvt Ltd, Mumbai, India) and electric pulp testing (Digitest; Parkell Inc. Edgewood, NY, USA) were utilized to evaluate pulp sensitivity. The diagnosis was confirmed by the lack of pulpal bleeding during the access opening.

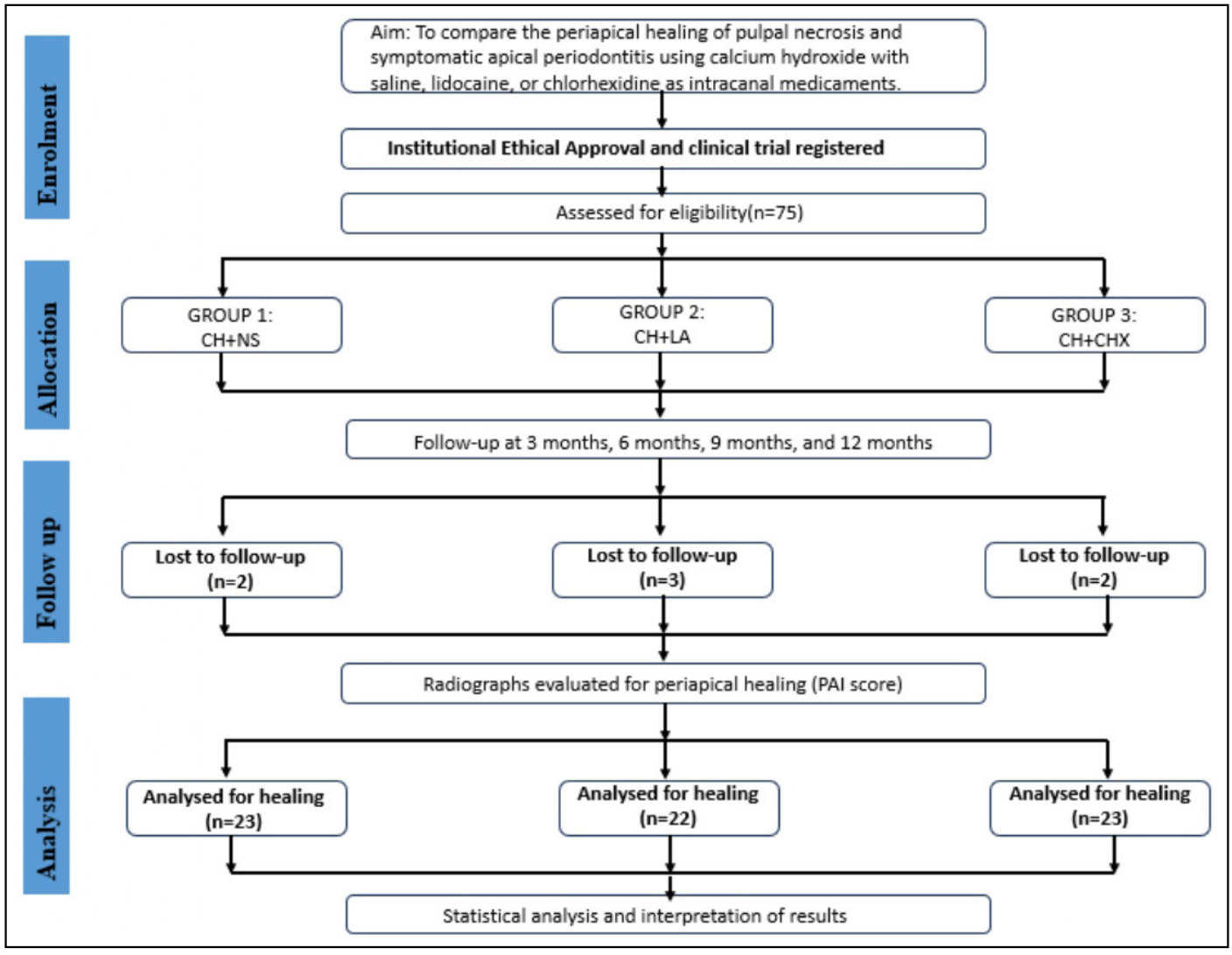

Figure 1. CONSORT flowchart of the study.

CH+NS: Calcium hydroxide and normal saline, CH+LA: Calcium hydroxide and local anesthetic solution, CH+CHX: Calcium hydroxide and chlorhexidine.

- Teeth were tender on percussion with periapical score (PAI) of more than or equal to 2.

Exclusion criteria

- Patients with systemic disorders, periodontal conditions or pregnant patients.
- Patients taking steroids or antibiotics.
- Patients with a history of allergy to any of the components of local anesthesia, CHX, EDTA or sodium hypochlorite.
- Previously endodontically treated or initiated teeth.
- Severely damaged or mutilated teeth.
- Patients not willing to participate in the study and did not sign the consent form.

Randomisation and Blinding

Block randomisation method was carried out to obtain a list of numbers from Research Randomizer Software (https://www.randomizer.org/). This online tool randomly allocated 75 participants into 3 groups (n=25), sealed, sequentially numbered, opaque envelopes were prepared before recruitment. During the treatment, the intracanal medicament was freshly prepared by an assistant and provided to the operator to ensure blinding. Both the operator and the patient were blinded to the specific medicament used. Additionally, outcome assessment was performed by two independent evaluators who were also blinded to the treatment allocation. Therefore, this study followed a triple-blind design, minimising potential bias at the levels of patient care, treatment administration, and outcome evaluation.

Clinical Procedure

Before the clinical procedure, a pre-operative periapical radiograph was recorded to match the inclusion criteria of PAI score more than or equal to 2. A single operator carried out all clinical procedures in compliance with accepted standards. Local anesthesia was administered with 2% lidocaine and 1:80,000 adrenaline (Lignospan Special; Septodont, Maidstone, UK).

The tooth was isolated under a rubber dam, and the access cavity was prepared using a sterile round diamond point. Pulp extirpation was carried out, and apical patency was established. Working length was measured using apex locater (Root ZX Mini; J Morita Corp., Kyoto, Japan) and a #10 K-file (Mani Inc., Tochigi, Japan) and confirmed by radiograph. Biomechanical

TABLE 1. Demographic factors analysis

	Calcium hydroxide and normal saline	Calcium hydroxide and chlorhexidine	Calcium hydroxide and local anesthetic solution	p value
Age distribution (Kruskal-Wallis test)				
Female	30.15±9.54	30.25±6.98	29.08±6.41	0.9275
Male	27.83±6.93	25.00±6.95	28.17±6.19	0.3700
Gender distribution (Chi-Square-test)				
Female	12	13	13	0.9481
Male	13	12	12	
Tooth Number distribution (Chi-Square-test)				
36	8	5	7	0.9573
37	7	7	7	
46	4	6	6	
47	6	7	5	

preparation of canals was performed using the crown-down technique with ProTaper Gold rotary files (Dentsply Maillefer) upto #F2 for mesial canals and #F3 in larger distal canals. For larger distal canals, it was prepared up to size 35 and 0.04 taper. During preparation, a copious irrigation with 3% NaOCl was used, and the canals were flushed for 1 minute with 2 ml of 17 % EDTA using a 30G side-vented needle placed at 1 to 2 mm short of the working length.

Study interventions

The canals were dried using paper points and the freshly prepared intracanal medicament was placed with a size #25 lentulo spiral (Dentsply Maillefer, Oklahoma, USA) that was 25 mm long and at 2 mm short of the working length. According to the randomisation and allocation of groups, the subjects were divided into 3 groups:

Calcium Hydroxide & saline group (CH+NS):

A slurry like paste with P/L ratio of 1:1 was prepared with CH powder (Prevest Denpro; Digiana, Jammu, India) with 0.9% of NaCl (BRAUN Medical Pvt Ltd, Mumbai, India).

Calcium Hydroxide & local anaesthesia group (CH+LA):

A slurry-like paste of CH and 2% Lidocaine (Lignospan Special, Septodont, Maidstone, UK) with a P/L ratio of 0.25mg/0.15ml was used.

Calcium Hydroxide & chlorhexidine group (CH+CHX):

A slurry-like paste of CH and 2% CHX (Prevest Denpro Ltd, Samba, India) in a P/L ratio of 1:1 was used.

The access cavity was then temporarily sealed with Intermediate Restorative Material (Dentsply Ltd, Weybridge, UK). The patients were recalled after 7 days. All the treated teeth were confirmed to be asymptomatic at the time of the second appointment, indicating resolution of clinical symptoms before the next procedure. During the second appointment, the paste was removed with Hedstrom files (Mani Inc, Brussels, Germany) followed by copious irrigation with 5.25% NaOCl (Septodont, Navi Mumbai, India). Canals were dried using paper points and obturated with gutta-percha and sealer (AH plus; Dentsply Sirona, Gurugram, India). The access cavity was restored with flowable and nanohybrid composite resins. An immediate postoperative radiograph was taken using preset exposure parameters with a Rinn paralleling device (XCP Instruments, Elgin, IL) and processed to maintain angulation consistency and standardization. The patients were instructed to take Ibuprofen 400mg as required. Follow-up clinical and radiographic examinations were performed at every 3-month interval up to 12 months using the same parameters as the initial examination.

Outcome Evaluation

Pre-operative and follow-up radiographs were evaluated by two independent observers (AG and DA) who were unaware of the patient's treatment group, using the PAI scoring system. The final outcome for each tooth was determined based on the root with the highest PAI score. If discrepancies arose, the observers reviewed their assessments together to reach a consensus. Teeth were classified as either healed (PAI ≤2) or improved (with a decreased PAI score).

Statistical Analysis

At a 95% confidence level, statistical analysis was performed using Python 3.11.4 (Python Software Foundation, Wilmington, DE, USA) and Microsoft Excel (Microsoft Corporation, Redmond, WA, USA). This statistical analysis plan involves performing data preprocessing, including cleaning, reduction, and integration, followed by assumption validation for normality using the Shapiro-Wilk test and QQ plot. Descriptive analysis of demographic data was done using mean ± STD. The Kruskal-Wallis test was applied to evaluate the distribution of patients' ages across genders within the three treatment groups and to assess the significance between the three treatment groups (1) CH+NS, (2) CH+LA,(3) CH+CHX across over a 12-month follow-up period with 3-month intervals. This test was employed to assess significance, with Post Hoc Dunn tests for multiple comparisons. For time-period significance, multivariate and pairwise log-rank tests was used. Survival analysis was performed using the Kaplan-Meier curve, with results and interpretations summarized at a 5% significance level.

RESULTS

Out of 25 participants in each group, a total of 7 participants were lost to follow-up: 2 from CH+NS group, 3 from CH+LA group and 2 from CH+CHX group. The results showed no significant difference as the p-values exceeded the significance threshold (0.05), in age among the patients (Table 1), as well as at baseline

TABLE 2. Results of Kruskal Wallis test and Post hoc Dunn test for pairwise comparisons

Time period	CH+CHX	CH+LA	CH+NS	Kruskal Wallis Test p value	CH+CHX vs CH+LA	CH+CHX vs CH+NS	CH+LA vs NS
Pre	2.84±0.62	2.72±0.61	2.84±0.62	0.7290	0.4911	1.0000	0.4911
3 months	2.52±0.59	2.76±0.60	2.84±0.62	0.1492	0.151	0.0627	0.6708
6 months	2.26±0.54	2.70±0.63	2.75±0.74	0.0218*	0.0446*	0.0191*	0.7536
9 months	1.96±0.56	2.41±0.50	2.48±0.79	0.0160*	0.039*	0.0228*	0.8508
12 months	1.57±0.66	2.27±0.63	2.48±0.79	0.0002*	0.0058*	0.0006*	0.5309

*: p<0.05. CH+CHX: Calcium hydroxide and chlorhexidine, CH+LA: Calcium hydroxide and local anesthetic solution, CH+NS: Calcium hydroxide and normal saline

TABLE 3. Results of multivariate and pairwise log-rank test comparing the time taken by treatment groups to achieve a healthy healing score

Treatments	Time (in months) to achieve score <=2	Multivariate log-rank test p value	CHX vs LA pairwise log-rank test p value	CHX vs SALINE pairwise log-rank test p value	LA vs SALINE pairwise log-rank test p value
CH+CHX	8.10±3.28	0.00032*	0.0050*	0.0050*	0.5100
CH+LA	8.25±3.31				
CH+NS	8.23±3.28				

*: p<0.05. CH+CHX: Calcium hydroxide and chlorhexidine, CH+LA: Calcium hydroxide and local anesthetic solution, CH+NS: Calcium hydroxide and normal saline

and 3-month follow-up. In contrast, the p-values at 6, 9, and 12 months were all less than 0.05, indicating significant differences between the three treatment groups as shown in Table 2.

The Post Hoc Dunn test (Table 2) results indicated no statistically significant difference between the CH+LA group and H+NS group across all time points. However, significant differences were observed between CH+CHX vs. CH+LA group and CH+CHX group vs. CH+NS group, as their p-values were below the significance level (0.05). Additionally, compared to the CH+LA group and the CH+NS group, the CH+CHX group appears to be a more effective intracanal medicament.

A Multivariate Log-Rank test (Table 3) was used to assess the time taken by different treatment groups to achieve a healthy healing score (≤2). With a p-value <0.05, it can be concluded that there are significant differences between treatment groups in the time required to reach a healthy healing score. Specifically, the Pairwise Log-Rank test (Table 3) indicated that the CH+CHX treatment group showed significant differences when compared with the CH+LA and CH+NS group. Descriptive statistics further revealed that the CHX group achieved healthy healing in the quickest time compared to the LA and NS group.

To determine the probability of achieving healthy healing in the shortest time, the Kaplan-Meier curve was utilized. For this analysis, an event was considered to occur if the PAI score had reduced to 2 or less. The Kaplan-Meier curve demonstrated (Fig. 2) that the CH+CHX group had the highest probability of achieving healthy healing within the minimum time period when compared to the other groups.

Figure 3 illustrates the changes in periapical radiolucency observed in the CH+CHX treatment group over the 12-month follow-up period.

DISCUSSION

The healing process depends on restoring the structure and function of areas influenced by intrinsic or extrinsic factors (16). It begins with an inflammatory response, which helps control and manage tissue damage. It progresses toward resolution as the immune system effectively clears the underlying immunogen responsible for triggering the tissue reaction, ultimately restoring homeostasis (17). Inflammation in the periapical region is triggered as a defence mechanism to neutralize the antigen. This inflammatory response also stimulates bone resorption, creating space for the infiltration of immune cells. These immune cells then organize into a structured barrier, effectively isolating and containing the infection (16). Bone resorption and formation are continuous processes governed by the coordinated activity of osteoclasts, osteoblasts, and osteocytes, influenced by systemic and local factors. However, during apical periodontitis, bone homeostasis is disrupted, leading to an accelerated rate of bone resorption (18).

The approach to managing apical periodontitis is influenced by the presence of periapical pathosis and its progression over time (19). The ideal healing process of apical periodontitis should be asymptomatic, marked by the restoration of periradicular tissue integrity, the absence of radiographic abnormalities, and the biological sealing of the foramina through cementum deposition, ensuring complete structural and functional recovery (20). Most periapical lesions heal following meticulous non-surgical endodontic treatments. To evaluate the healing potential, a follow-up period of at least 6 to 12 months after root canal therapy is recommended (21).

A range of therapeutic factors (e.g. biomechanical preparation, quantity and type of irrigant solution, intracanal dressing, root canal filling, apical limit of obturation or expansion of the apical foramen), systemic condition of the patient and physi-

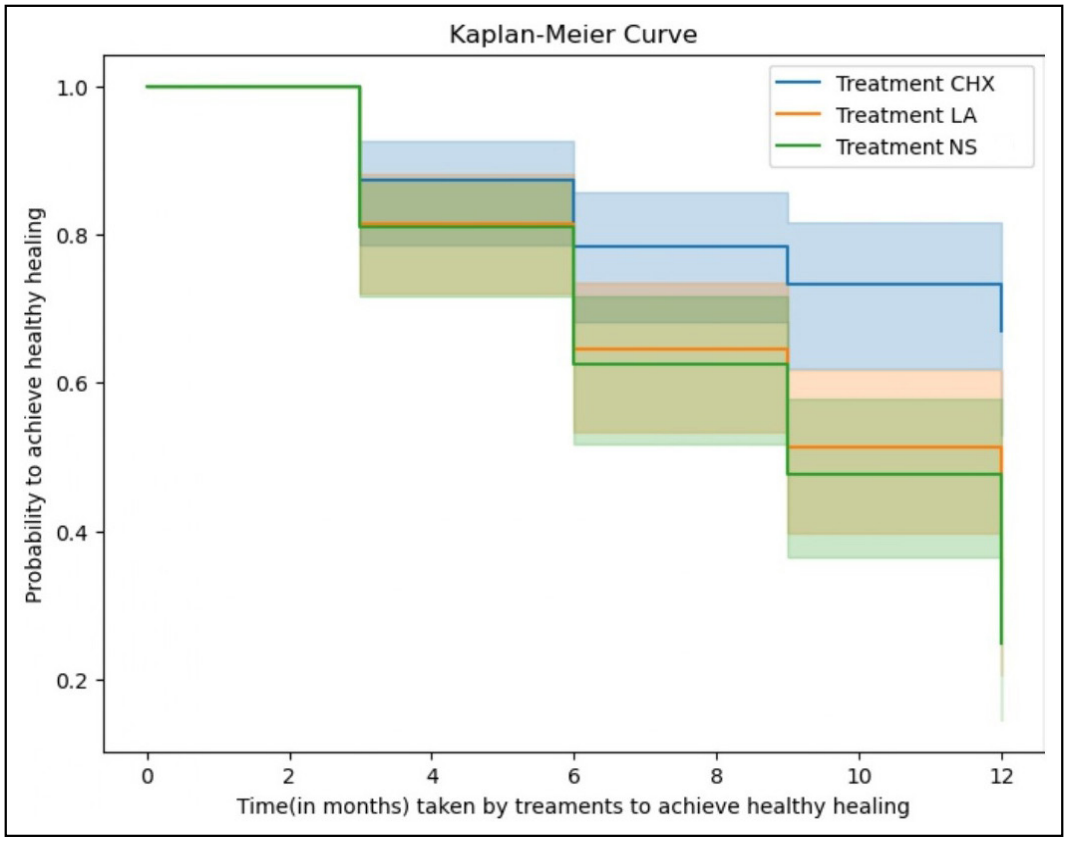

Figure 2. Kaplan-Meier Curve illustrating the probability of different treatments in improving healing scores over various time

CHX: Chlorhexidine, LA: Local anesthetic solution, CH+NS: Calcium hydroxide and normal saline, NS: Saline

ology (e.g. chronic diseases or age) can disturb the periapical healing process and affect the prognosis of treatment.

Various medications have been formulated and utilized as intracanal dressings (22). CH is a widely used intracanal medicament in non-surgical root canal treatment. Numerous studies have highlighted its effectiveness in eliminating bacteria, promoting healing, and facilitating the resolution of periapical lesions when applied after thorough canal preparation and irrigation (23). The high pH of CH, resulting from the release of hydroxide ions, disrupts the structural integrity of bacterial cytoplasmic membranes. Additionally, it indirectly affects anaerobic microorganisms in the root canal through an interaction reaction between calcium ions and aqueous carbon dioxide. Furthermore, CH facilitates the degradation of bacterial lipopolysaccharides, contributing to its antimicrobial efficacy (16). Based on the published research, CH as an intracanal medicament significantly affects the healing of periapical lesions (24).

Despite its numerous indications and advantages, CH also has certain limitations (25). Research indicates that *Enterococcus faecalis* can resist the effects of CH for approximately ten days, while its antimicrobial action remains minimal against facultative anaerobes and Candida species but highly effective against obligate anaerobes (26, 27).

CHX is a cationic biguanide with peak antimicrobial efficacy in a pH range of 5.5 to 7.0 (28). It functions by interacting with the negatively charged phosphate groups on microbial cell walls and the molecule's positive charge. This disruption alters the cell's osmotic balance, increasing cell wall permeability and allowing CHX molecules to penetrate the bacteria (29, 30). At 0.2% concentration, CHX causes leakage of potassium and phosphorus, while at 2%, it becomes bactericidal by causing the cytoplasmic contents to precipitate, leading to cell death (30).

Local anesthetics like lidocaine and prilocaine have been explored for their potential use as intracanal medicaments in root canal therapy owing to their antimicrobial, anti-inflammatory, and analgesic properties (31, 32). However, there is a lack of extensive literature on its antimicrobial properties. A study demonstrated that mixing CH with lidocaine HCl can effectively reduce postoperative pain in teeth with irreversible pulpitis and symptomatic apical periodontitis (33). Hence, the present study employed lidocaine as an aqueous vehicle along with CH as an intracanal medicament for the management of periapical lesions.

This study aimed to evaluate and compare the healing outcomes among three different groups based on aqueous-based combinations of CH as an intracanal medicament: CH+0.9% NS, CH+ 2%LA, and CH+2%CHX. Systemically healthy patients of age 18–45 were enrolled in the study to avoid the confounding influence of age-related factors on the healing outcomes of periapical lesions and to control the systemic influences on the periapical healing. This study was designed to establish a baseline score for healing in systemically healthy patients.

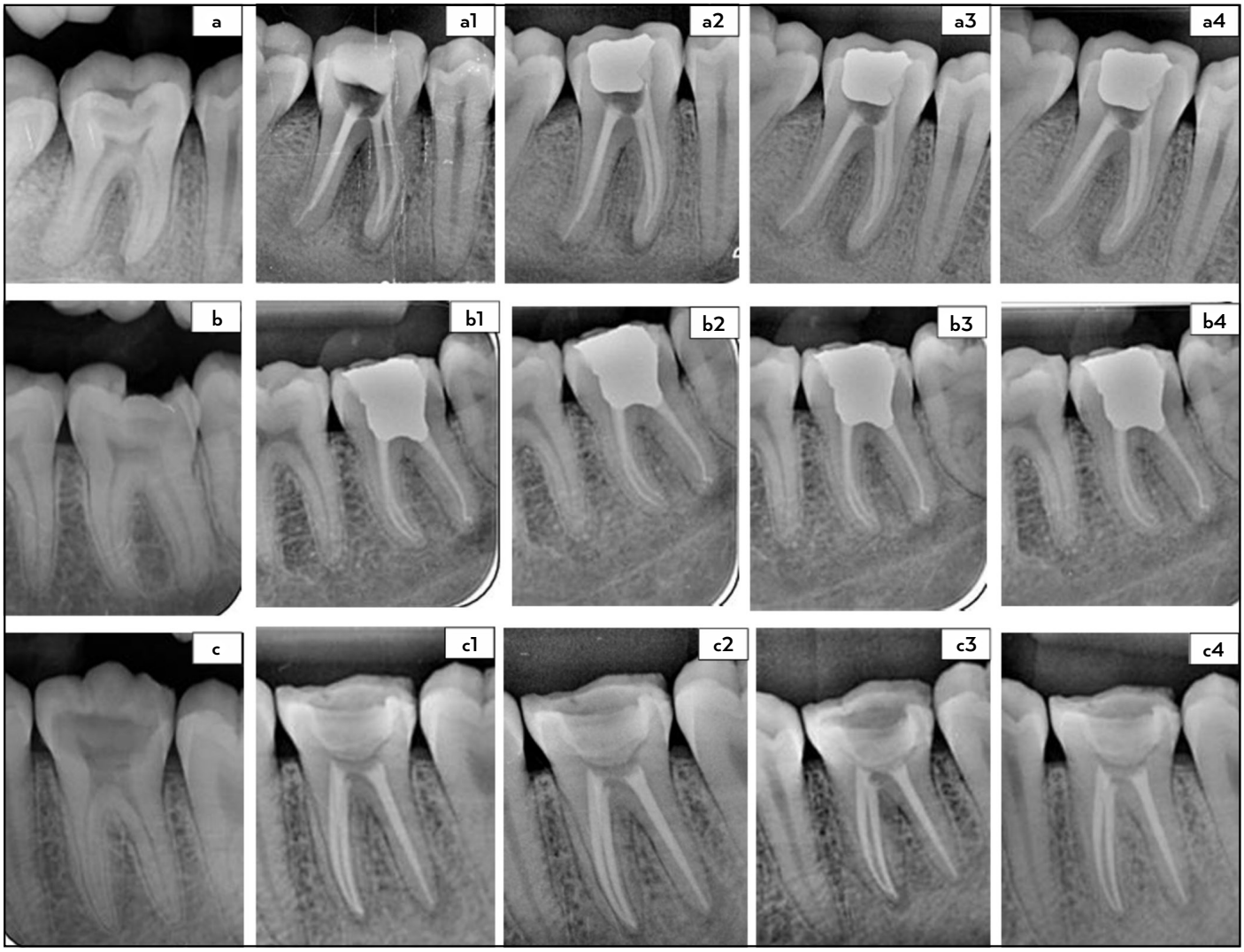

Figure 3. Preoperative and postoperative radiographs for CH+CHX treatment group. (a-c) Preoperative radiograph showing periapical lesion. (a1, b1, c1) 3-month postoperative radiograph. (a2, b2, c2) 6- month postoperative radiograph. (a3, b3, c3) 9- month postoperative radiograph. (a4, b4, c4) 12- month postoperative radiograph

CH+CHX: Calcium hydroxide and chlorhexidine

The presence of systemic disease may influence baseline score variations associated with different aqueous vehicles and introduce confounding effects due to systemic medications that could potentially alter the healing of periapical lesions.

The anatomical structure of mandibular molars is frequently complicated, including multiple bifurcations and trifurcations in the apical third, as well as fins, isthmuses, and accessory canals. These features may hinder the periapical healing resulting in lower success rates compared to single-rooted teeth. Therefore, in the current study, specifically mandibular molars with pulpal necrosis and symptomatic apical periodontitis were included to assess the treatment outcomes in some of the most challenging clinical situations (34).

In the present study, the intracanal medicament was placed for one week, as the literature suggests that applying CH for this duration is highly effective in bacterial elimination, achieving complete (100%) elimination of bacteria from the root canal system (35).

The healing outcome in the current study was assessed radiographically using PAI score, a standardized system for evaluating periapical health and determining the success of endodontic treatment. The PAI scale ranges from 1 to 5, based on comparisons with reference radiographs, reflecting the severity of periapical pathology (36).

Given that the significance level was set at $p \leq 0.05$, the statistical analysis revealed no significant differences among the groups at baseline and the 3-month follow-up ($p > 0.05$), indicating comparable initial treatment responses. However, as the follow-up period progressed, significant differences emerged at 6, 9, and 12 months ($p < 0.05$), suggesting a divergence in treatment outcomes over time.

Various studies have demonstrated that CH intracanal dressing has significantly reduced intracanal microbes from root canals with periapical lesions (37). The success rate of root canal treatment after the use of CH as an intracanal medicament ranged from 73.8% to 80.8% (38).

Literature has reported that CHX is more effective than CH in eliminating *Enterococcus faecalis* from dentinal tubules when used as an intracanal medicament (29). Studies have shown that all tested CHX formulations, including a 50:50 combination of CHX and CH, successfully eradicated *Enterococcus faecalis* from dentinal tubules (39). Kaplan-Meier survival analysis reinforces these results, showing that CHX promotes faster and more effective healing than LA or saline, likely due to its strong antimicrobial action.

The emergence of significant differences at later stages indicates that the choice of vehicle may influence the long-term effectiveness of treatment. These findings highlight the potential role of adjunctive agents in modulating the therapeutic properties of CH, possibly affecting factors such as antibacterial efficacy, tissue healing, and inflammatory response.

Nevertheless, there is sparse evidence in the literature regarding the evaluation of periapical radiolucency using different aqueous combinations of CH. Before interpreting the results, it is imperative to recognize the limitations of the study, which includes the relatively small sample size, limited follow-up duration, and the use of periapical radiographs as the primary method for evaluating treatment success.

CONCLUSION

Based on the findings of this study, it can be concluded that the use of different aqueous-based CH intracanal medicaments influences the healing outcome in patients with pulpal necrosis and symptomatic apical periodontitis. Among the tested medicaments, the CH+CHX combination demonstrated a significantly better periapical healing response over time compared to CH+LA or CH+NS. The findings suggest that the choice of vehicle for CH may impact its efficacy in eliminating infection and promoting periapical healing.

Disclosures

Ethics Committee Approval: The study was approved by the Manav Rachna Dental College Ethics Committee (no: MRIIRS/MRDC/FDS/IEC/2023/23, date: 16/05/2023).

Informed Consent: Informed consent was obtained from all participants.

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