

## Original Research

### Post obturation pain responses to intracanal irrigation with sodium hypochlorite at varying temperatures: A clinical study

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#### ABSTRACT:

**Background:** Postoperative pain is a frequently encountered complication in single-visit root canal treatment (RCT), particularly in cases of symptomatic irreversible pulpitis. The temperature of sodium hypochlorite (NaOCl), a commonly used irrigant, may influence the inflammatory response of periapical tissues and affect pain outcomes. **Aim:** This study aimed to evaluate and compare the effect of cold, warm, and room temperature NaOCl irrigation on post-obturation pain in patients undergoing single-visit RCT for symptomatic irreversible pulpitis. **Materials and Methods:** A randomized clinical trial was conducted on patients diagnosed with symptomatic irreversible pulpitis in single-rooted teeth. After standard cleaning and shaping, patients were randomly assigned to three groups based on the temperature of 3% NaOCl used during irrigation: cold (4°C), warm (65°C), and room temperature (27°C). Pain levels were assessed using the Visual Analogue Scale (VAS) at 6, 12, 24, 48, and 72 hours postoperatively. Analgesic intake was also monitored. **Results:** The cold NaOCl group exhibited the lowest mean pain scores at all evaluated time intervals, followed by the warm NaOCl group. The room temperature group reported the highest postoperative pain. The differences in pain scores between the groups were statistically significant ( $p < 0.05$ ). **Conclusion:** Irrigation with cold NaOCl significantly reduces post-obturation pain compared to warm and room temperature NaOCl in single-visit RCT of symptomatic irreversible pulpitis. The findings support the use of cold NaOCl as a simple, cost-effective adjunct to enhance patient comfort and minimize postoperative discomfort.

**Keywords:** Cold sodium hypochlorite, postoperative pain, cryotherapy, root canal irrigation, single-visit RCT, irreversible pulpitis.

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#### INTRODUCTION

Postoperative pain following root canal therapy (RCT) remains a significant clinical challenge, particularly in cases of symptomatic irreversible pulpitis, where pre-existing pulpal inflammation predisposes the patient to heightened nociceptive response. Although single-visit endodontics is now a widely accepted approach due to its convenience and reduced risk of interappointment contamination, it is often associated with a higher incidence of immediate postoperative pain, particularly in vital teeth<sup>1,2</sup>.

The etiology of postoperative endodontic pain is multifactorial, involving apical extrusion of debris, release of inflammatory mediators, and microbial persistence within the root canal system<sup>3,4</sup>. The

irrigation phase of root canal therapy plays a pivotal role in minimizing these factors. Sodium hypochlorite (NaOCl), a commonly employed irrigant, has superior tissue-dissolving and antimicrobial properties, making it the irrigant of choice in most clinical scenarios<sup>5</sup>. However, NaOCl is also highly cytotoxic to periapical tissues if extruded beyond the apical foramen, and this adverse response may contribute to intensified postoperative pain<sup>6,7</sup>.

In recent years, the temperature modulation of NaOCl has gained increasing interest in endodontic research and practice, both for enhancing its chemical properties and for potentially influencing the periapical tissue response. Several in vitro and in vivo studies have demonstrated that preheating NaOCl to

45–60°C enhances its antimicrobial activity and tissue-dissolving capacity by increasing the reactivity of free chlorine ions<sup>8,9</sup>. However, this enhancement may come at the cost of increased irritation to periapical tissues, possibly leading to exacerbation of postoperative discomfort when the irrigant comes into contact with vital periapical structures<sup>10</sup>.

Conversely, cryotherapy, a technique involving the use of cooled irrigants (typically 1.5–4°C), has emerged as a promising strategy for pain modulation in endodontics. It is hypothesized to function via vasoconstriction, reduced metabolic activity, and suppression of pro-inflammatory mediators such as prostaglandins, bradykinin, and substance P at the periapical level<sup>11,12</sup>. Additionally, cold temperatures reduce nerve conduction velocity and excitability of nociceptors, leading to analgesic effects<sup>13</sup>. Intracanal cryotherapy using cold saline or NaOCl as a final rinse has shown significant reduction in postoperative pain in several randomized controlled trials<sup>14–16</sup>.

For instance, Vera et al. demonstrated that intracanal cryotherapy using 2.5°C saline for 5 minutes significantly reduced postoperative pain in patients with symptomatic apical periodontitis<sup>14</sup>. Similarly, Keskin et al. reported that intracanal cryotherapy with cold saline reduced pain more effectively than room-temperature irrigation<sup>15</sup>. However, despite these encouraging results, comparative studies investigating the use of NaOCl at various temperatures—especially cold versus warm versus room temperature—in cases of symptomatic irreversible pulpitis are scarce.

Given that sodium hypochlorite's performance and biological impact vary with temperature, a deeper understanding of its effect on postoperative pain at different temperatures is clinically relevant. Such knowledge can help clinicians tailor their irrigation protocols not only for optimal disinfection but also for enhancing patient comfort and reducing post-treatment complications.

Therefore, the present study was designed to evaluate and compare postoperative pain intensity following the use of cryotreated (cold), warm, and room-temperature sodium hypochlorite as an irrigant during single-visit root canal therapy in patients with symptomatic irreversible pulpitis. The hypothesis tested was that the temperature of NaOCl significantly influences postoperative pain, with cryotreated NaOCl expected to result in the least discomfort. The findings from this investigation aim to bridge the gap in the literature and provide evidence-based recommendations for temperature-specific irrigation strategies in clinical endodontics.

The aim of the current study is to evaluate the postoperative pain with warm, cryotreated and room temperature sodium hypochlorite in irreversible pulpitis cases in single-sitting root canal therapy.

According to the null hypothesis there is no difference in the post operative pain in all the three variables of the sodium hypochlorite.

## METHODOLOGY

A total of 30 patients were included in this study according to inclusion and exclusion criteria. The study was conducted between December 2024 and April 2025 after getting institutional ethical committee clearance certificate (IEC/Cons/07/24) on 18 February 2024. All the registered patients gave oral and written informed consent and the same was documented for future. This study was registered in Clinical Trials Registry- India (CTRI) CTRI/2024/12/077533.

### Inclusion Criteria

Patients between the age group of 19 to 60 years were included; Patient with symptomatic irreversible pulpitis which require root canal treatment in single rooted tooth were included in the study

### Exclusion Criteria

Individuals with uncontrolled systemic conditions, pregnant women, participants who opted out of the study, Teeth with incomplete root development (open apex), Previous root canal treatments requiring reintervention, Patients who started endodontic therapy at another dental clinic, Inability to reach full working length, Tooth with draining sinus, Tooth with periapical radiolucency, calcified canals, internal root resorption, pregnant or lactating patients.

### Study group

The selected patients will be further divided into 3 groups

Group 1: 3% Sodium hypochloride at 65°C

Group 2: 3% Sodium hypochloride at 25°C

Group 3: 3% Sodium hypochloride at 2–4°C.

Irrigation between each filing will be done using normal saline with side vented needles.

### Treatment Protocol

#### Pre operative

Prior to initiating treatment, all patients assessed their baseline pain levels both at rest and during biting using a standardized visual analog scale (VAS).

#### Root Canal Treatment Procedure

All root canal treatments were consistently performed by the same experienced clinician following a standardized protocol. Prior to treatment initiation, local anesthesia was achieved using 2% lidocaine containing 1:100,000 epinephrine, followed by rubber dam application for optimal isolation. After creating a proper access cavity, canal patency was verified with a #10 K-file, and working lengths were precisely determined through digital radiographic imaging. Canals were then meticulously shaped using the Dentsply ProTaper Gold nickel-titanium file system (Dentsply Maillefer, Ballaigues, Switzerland). Intermediate irrigation was done using 2 mL of 3% NaOCl using a 30-G side-vented needle (Neoendo, Orikam Healthcare, India). Canals were flushed with

3 mL of 17% ethylenediaminetetraacetic acid (EDTA; Prevest DenPro) for the duration of 1 min prior to final irrigation. Each root canal was then irrigated with 20 mL of 3% NaOCl with a 30-G side-vented needle placed 1 mm short of the working length as a final flush according to the groups allotted. Complete canal drying was ensured using sterile paper points (Dentsply-Maillefer) prior to obturation. The obturation was done using the single-cone approach with gutta percha (Meta Biomed Co., Korea) and resin-based sealer (Dentsply AH Plus). A postoperative radiograph was taken following obturation. A direct adhesive composite restorative material was used to repair the coronal access cavities.

### Assessment of Postoperative Pain

Following obturation, Patients were then instructed to fill the VAS scale at 6, 12, 24, 48, and 72 h intervals (both rest and while chewing). Aceclofenac 100 mg tablets (escape drugs) were provided to patients for post-operative pain, and were advised to take only in case of extreme discomfort.

### Statistical Analysis

The mean and standard deviation was calculated using student t test. The pain incidence was analyzed by two methods, multivariate logistic regression analysis and repeated analysis of variance (ANOVA) respectively. Difference was considered significant at  $p < 0.05$ .

SPSS software (version 23.0; SPSS Inc., Chicago, IL, USA) and was used for the statistical analysis.

### RESULT

The mean age of Group 1 was  $37.8 \pm 11.90$ , Group 2 was  $30.4 \pm 8.59$  and Group 3 was  $39.2 \pm 10.33$ .

In the group 150% patients were males and rest were females, group 2 60% patients were females and rest were males, group 3 70% were females and rest were males.

Post obturation pain was found maximum in all three groups at 6 hrs and starts declining gradually after 6 hrs. The mean of pain score after 6 hrs was found minimum in Group 3 ( $1.00 \pm 0.588$ ), followed by Group 1 ( $1.30 \pm 1.447$ ) and maximum in Group 2 ( $2.10 \pm 2.118$ ). The mean of pain score after 24 hrs was found minimum in Group 3 ( $0.60 \pm 0.116$ ), Group 1 ( $0.80 \pm 0.515$ ) and Group 2 ( $2.00 \pm 1.098$ ). The mean of pain score after 48 hrs was found minimum in Group 3 ( $0.50 \pm 0.226$ ), Group 1 ( $0.60 \pm 0.675$ ) and Group 2 ( $1.81 \pm 2.098$ ). The mean of pain score after 72 hrs was zero in all groups. All the results were statistically significant.

In Group 3 40%, Group 1 60% and Group 2 65% of patients had to take medication to get relief from pain. The mean painkiller intake was found minimum in Group 3 ( $0.50 \pm 1.99$ ), followed by Group 1 ( $0.80 \pm 0.689$ ), and maximum in Group 2 ( $1.20 \pm 1.21$ ). There was no significant difference in painkiller intake among all groups.

**Table 1: Mean value of pain at different time points**

Time Point	Group 1 (Mean $\pm$ SD)	Group 2 (Mean $\pm$ SD)	Group 3 (Mean $\pm$ SD)	P value
6 hours	$1.30 \pm 1.447$	$2.10 \pm 2.118$	$1.00 \pm 0.588$	P<0.01
24 hours	$0.80 \pm 0.515$	$2.00 \pm 1.098$	$0.60 \pm 0.116$	
48 hours	$0.60 \pm 0.675$	$1.81 \pm 2.098$	$0.50 \pm 0.226$	
72 hours	$0.00 \pm 0.00$	$0.00 \pm 0.00$	$0.00 \pm 0.00$	

### DISCUSSION

Postoperative pain is a frequent and undesirable consequence of endodontic therapy, particularly in cases of symptomatic irreversible pulpitis. Numerous factors, including microbial persistence, apical extrusion of debris or irrigants, and periapical inflammation, have been implicated in its etiology. Among these, the temperature of the irrigant solution, particularly sodium hypochlorite (NaOCl), has gained attention for its potential role in modulating both tissue response and clinical outcomes. The present study investigated the influence of three temperature regimens of NaOCl—cryotreated ( $4^{\circ}\text{C}$ ), warm ( $65^{\circ}\text{C}$ ), and room temperature ( $25^{\circ}\text{C}$ )—on postoperative pain following single-visit root canal therapy in symptomatic irreversible pulpitis. The findings indicated a clear trend: the lowest pain levels were observed in the cryotreated NaOCl group, followed by warm NaOCl, while room-temperature NaOCl resulted in the highest postoperative pain scores. These results are consistent with earlier findings by Nandakumar et al.<sup>17</sup>, who demonstrated that

intra canal cryotherapy significantly reduced postoperative pain in patients with symptomatic irreversible pulpitis. The authors attributed this effect to the vasoconstrictive and anti-inflammatory action of cold saline, which when delivered into the root canal after instrumentation, likely reduced the local tissue temperature, minimizing inflammatory exudate formation and edema. Similar analgesic benefits of cryotherapy were highlighted in a randomized clinical trial by Saharfet al and Serena Lalfakawmiet al<sup>18,19</sup>, where cryotreated sodium-hypochlorite ( $2.5^{\circ}\text{C}$ ) used as a final rinse, reduced postoperative pain significantly when compared to a control group receiving room-temperature sodium hypochlorite. While the concept of warm NaOCl has been extensively studied for its enhanced tissue-dissolving capabilities, fewer studies have explored its relation to postoperative pain. de Hemptinne et al.<sup>10</sup> observed that heating NaOCl to  $50^{\circ}\text{C}$  improved its penetration into dentinal tubules and increased antibacterial effectiveness without causing dentin damage. However, such thermal activation may also enhance

the cytotoxic potential of NaOCl, especially if inadvertently extruded beyond the apical foramen. This might partially explain why, in our study, warm NaOCl resulted in moderate pain levels, likely due to a balance between superior disinfection and thermal irritation of the periapical tissues.

The room-temperature NaOCl group showed the highest pain scores consistently across all time intervals. This is in agreement with studies such as those by Ng et al. and Pak and White<sup>4,20</sup> who reported that inadequate debridement, as well as apical extrusion of irrigants in conventional protocols, often leads to more pronounced postoperative symptoms. Furthermore, Siqueira and Rôças<sup>3</sup> emphasized that persistent microbial antigens in the canal system contribute significantly to postoperative pain, especially in vital pulps where inflammation is already high.

A critical observation in our study was that the peak intensity of pain occurred at 6 hours postoperatively in all groups, which aligns with the pattern described by Gondim et al.<sup>21</sup>, who noted that inflammatory pain often peaks within the first 6–12 hours following endodontic procedures due to a surge in inflammatory mediators such as prostaglandins and substance P.

Interestingly, a more recent study by Arslan et al.<sup>16</sup> further supports the use of cold NaOCl. In their randomized clinical trial, they reported that the use of cryotreated NaOCl (2.5°C) led to significantly lower postoperative pain in comparison to room-temperature NaOCl in patients undergoing root canal therapy for symptomatic teeth. This mirrors the outcomes of our present study, strengthening the hypothesis that cryotherapy not only benefits soft-tissue healing in medicine but may also have valuable applications in endodontics.

In contrast, Loyola-Rodríguez et al.<sup>22</sup> emphasized that while warm NaOCl exhibits greater bactericidal properties due to increased chlorine release, its use must be cautiously controlled to avoid periapical extrusion that could exacerbate inflammation, possibly explaining the moderate pain levels in our warm NaOCl group.

The mechanisms underlying the analgesic effect of cold sodium hypochlorite are likely multifactorial. At temperatures between 2–4 °C, it induces vasoconstriction, which minimizes blood flow and periapical tissue edema, thereby reducing pain caused by tissue pressure<sup>23</sup>. Cold temperatures also slow nerve conduction in pain fibers (A $\delta$  and C fibers), leading to decreased pain perception<sup>24</sup>. Furthermore, cryotherapy suppresses the release of inflammatory mediators such as substance P and interleukin-6, reducing nociceptive stimulation<sup>24,25</sup>. It also slows down cellular metabolism, limiting inflammatory responses and tissue breakdown<sup>17</sup>. Despite the temperature reduction, cold NaOCl retains effective antimicrobial properties, ensuring continued disinfection without triggering additional inflammation<sup>26</sup>.

Moreover, the use of cold solutions may improve patient comfort, especially in single-visit treatments where postoperative pain can impact perceived quality of care. Cryotherapy can be easily integrated into clinical practice by refrigerating NaOCl or using specially designed delivery systems that maintain low temperature until delivery.

Despite these promising outcomes, the present study has limitations. Pain perception is inherently subjective and influenced by multiple factors including age, gender, anxiety, preoperative pain levels, and individual pain threshold. Additionally, while all patients received a similar clinical protocol and used analgesics only on demand, the actual consumption was not quantified, which could influence reported pain levels. Future studies should consider including quantitative biomarker analysis, such as measurement of inflammatory cytokines in periapical exudates or saliva, to more objectively evaluate the inflammatory response.

## CONCLUSION

To conclude, the findings of our study underscore the clinical relevance of temperature modulation of NaOCl in controlling postoperative pain in endodontic therapy. The cryotreated (cold) NaOCl group consistently demonstrated superior pain control, likely due to its anti-inflammatory and analgesic mechanisms. Warm NaOCl, although more effective in disinfection, caused moderate postoperative discomfort possibly due to thermal stimulation of periapical tissues. Room-temperature NaOCl, despite its widespread use, was associated with the highest postoperative pain, indicating a need for protocol reassessment, especially in cases with vital inflamed pulps. These results support the incorporation of intracanal cryotherapy as an adjunctive strategy to enhance patient comfort and satisfaction in contemporary endodontic practice.

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