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Role of Intracanal Cryotherapy in the Management of Postoperative Pain Following Single-Visit Endodontic Treatment: A Randomized Clinical Trial

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Abstract:

Background:

Postoperative pain remains a common concern among patients undergoing root canal treatment, despite the procedure's primary goal of alleviating discomfort caused by pulpal inflammation or infection. The intensity and duration of post-treatment pain can vary significantly among individuals.

Aim:

This study aimed to evaluate the influence of intracanal cryotherapy using cold normal saline (1.5–2.5°C) on postoperative pain following single-visit root canal therapy in teeth diagnosed with symptomatic irreversible pulpitis.

Material and Methodology:

Forty-eight patients fulfilling the inclusion criteria were enrolled and randomly allocated into two groups using a sealed-envelope method. Following local anaesthesia and rubber dam isolation, standard access cavity preparation and chemomechanical debridement were completed. Both groups underwent single-visit root canal treatment; however, the final irrigation protocol differed by temperature. The cryotherapy group received a final rinse with cold saline (2.5°C) for five minutes, whereas the control group received saline at room temperature. Postoperative pain was assessed using a visual analogue scale (VAS) at 6 hours, 24 hours, and 7 days.

Results:

Patients in the cryotherapy group reported significantly lower pain levels at 6 and 24 hours compared with the control group. At the 7-day interval, no statistically significant difference in pain scores was observed between the two groups.

Conclusion:

Intracanal cryotherapy effectively reduces short-term postoperative pain following single-visit root canal treatment, although it does not appear to influence long-term pain perception.

Keywords: *Intracanal Cryotherapy, Postoperative Pain, Single-Visit Endodontics.*

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I. INTRODUCTION

Pain following endodontic therapy is a frequent source of anxiety for patients. Although root canal treatment is designed to eliminate pain by removing inflamed or infected pulpal tissue, a proportion of patients still experience postoperative discomfort. Reported rates of post-endodontic pain range widely in the literature, with the highest intensity typically occurring within the first few hours after treatment and gradually decreasing over time. Factors contributing to postoperative pain include residual microorganisms, extrusion of debris, and mechanical or chemical irritation of periapical tissues. Various strategies have been proposed to manage post-endodontic pain, such as analgesic medications, corticosteroids, occlusal adjustment, intracanal medicaments, and different irrigation activation techniques. However, pharmacological approaches—particularly nonsteroidal anti-inflammatory drugs and opioids—are associated with undesirable systemic side effects. As a result, interest has grown in non-pharmacological methods that may offer pain relief with fewer adverse effects.

II. CRYOTHERAPY

Cryotherapy refers to the therapeutic reduction of tissue temperature, achieved through the removal of heat rather than the direct application of cold. Lowering tissue temperature results in decreased blood flow, reduced metabolic activity, suppression of neural transmission, and modulation of inflammatory responses. These physiological effects form the rationale for using cryotherapy as a pain control strategy.

In endodontics, intracanal cryotherapy has been introduced as a simple, cost-effective adjunct for managing postoperative pain. By reducing inflammation in the periapical region and limiting the release of pain mediators, cold irrigating solutions may help minimize discomfort after root canal treatment. Accordingly, the present randomized clinical trial investigated the effectiveness of intracanal cryotherapy in reducing postoperative pain following single-visit endodontic therapy.

III. MATERIAL AND METHOD

This randomized clinical trial included male patients aged between 20 and 40 years who presented with symptomatic irreversible pulpitis in mandibular premolars with a single root and canal. Patients with systemic illnesses, multi-rooted teeth, retreatment cases, open apices, root resorption, procedural complications, or prior intake of analgesic or anti-inflammatory drugs were excluded.

A total of 48 eligible patients were randomly assigned into two equal groups: the cryotherapy group (Group 1) and the control group (Group 2). Baseline pain levels were recorded using a visual analogue scale. Local anaesthesia was administered, followed by rubber dam isolation and standard access cavity preparation. Working length was determined using an electronic apex locator and confirmed radiographically. Chemomechanical preparation was performed using rotary instruments and 5.25% sodium hypochlorite irrigation.

For the final irrigation, Group 1 received 10 mL of cold (1.5–2.5°C) normal saline delivered to working length over five minutes, while Group 2 received the same volume of saline at room temperature. All canals were obturated in a single visit using gutta-percha and resin-based sealer with a cold lateral compaction technique. Postoperative pain levels were recorded by patients at 6 hours, 24 hours, and 7 days using the VAS.

IV. RESULT

All 48 participants completed the study. Mean postoperative pain scores were calculated for both groups at each evaluation interval. The cryotherapy group consistently demonstrated lower mean pain scores compared with the control group at 6 hours and 24 hours, with the differences being statistically significant. At the 7-day follow-up, pain levels in both groups were minimal, and no significant difference was detected between them.

Statistical analysis using one-way ANOVA and post hoc Tukey tests confirmed that intracanal cryotherapy was effective in reducing early postoperative pain but did not influence pain levels at later stages.

Table 1 One-Way Analysis of Variance (ANOVA) was Used to Determine Statistical Differences Among the Groups.

Group	***6 hours Post-operative (Mean ± SD)***	***24 hours Post-operative (Mean ± SD)***	***7 days Post-operative (Mean ± SD)***
Group 1	2.83 ± 1.34	2.25 ± 0.87	0.42 ± 0.51
Group 2	4.75 ± 1.71	4.08 ± 1.24	0.67 ± 0.78
P- value	0.006	0.000	0.364

Table 2 Comparison of Pain Within Each Group.

Group	***Time Period***	***Mean***	***SD***
Group I (Cryotherapy group) P value	6 hours 24 hours 7 days	2.83 2.25 0.42 0. 00	1.34 0.87 0.51
Group II (Control group) P value	6 hours 24 hours 7 days	4.75 4.08 0.67 0.00	1.71 1.24 0.78

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Table 3 Multiple Comparisons Within Each Group (Tuckey's Test)

Cryotherapy group			
Time Intervals	***Time Intervals***	***Time Intervals***	***Time Intervals***
6 hours Vs 24 hours	6 hours Vs 24 hours	6 hours Vs 24 hours	6 hours Vs 24 hours
6 hours Vs 7 days	6 hours Vs 7 days	6 hours Vs 7 days	6 hours Vs 7 days
24 hours Vs 7 days	24 hours Vs 7 days	24 hours Vs 7 days	24 hours Vs 7 days
Control group			
Time Intervals	***Time Intervals***	***Time Intervals***	***Time Intervals***
6 hours Vs 24 hours	6 hours Vs 24 hours	6 hours Vs 24 hours	6 hours Vs 24 hours
6 hours Vs 7 days	6 hours Vs 7 days	6 hours Vs 7 days	6 hours Vs 7 days
24 hours Vs 7 days	24 hours Vs 7 days	24 hours Vs 7 days	24 hours Vs 7 days

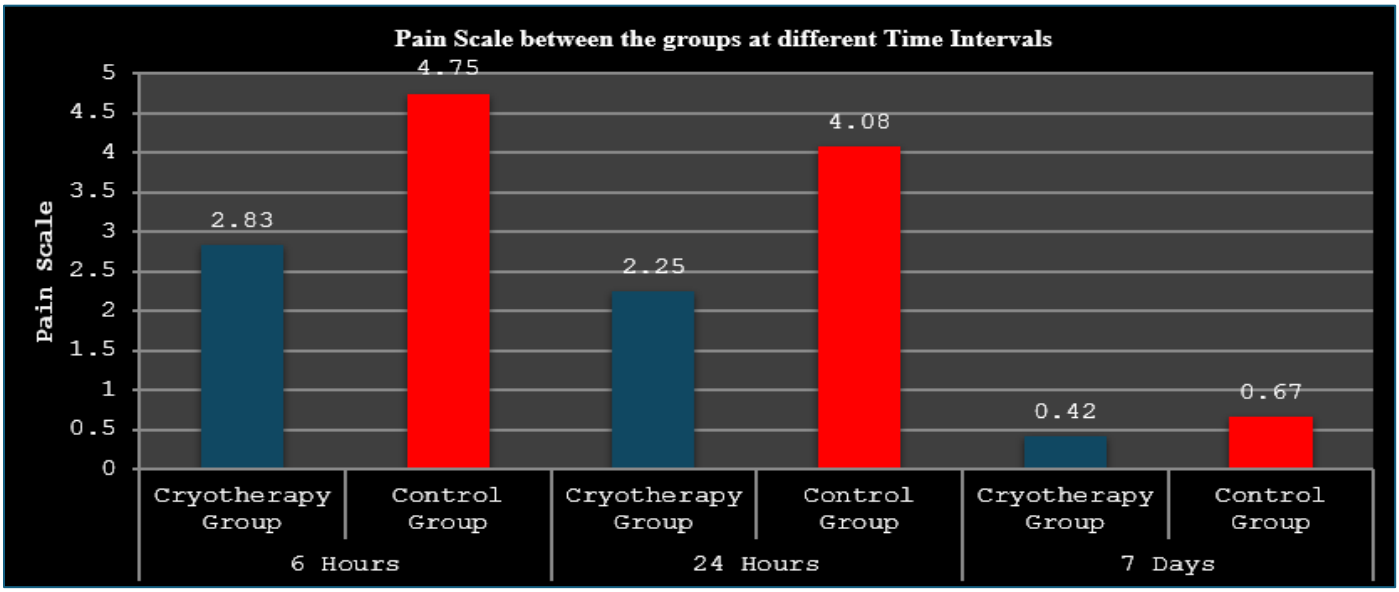

Figure 1: Graphical Representation of Mean Post-Operative Pain of Two Groups at Three Different Time Intervals.

V. DISCUSSION

This randomized clinical trial was carried out to determine the influence of irrigant temperature on post-endodontic pain and to evaluate the effectiveness of intracanal cryotherapy in pain reduction. The findings revealed that patients in the cryotherapy group experienced significantly lower pain levels at 6 hours and 24 hours following the procedure compared to the control group. However, at the 7-day follow-up, no statistically significant difference in pain was observed between the two groups.

Various pharmacological agents, including acetaminophen, antihistamines, steroidal and non-steroidal anti-inflammatory drugs (NSAIDs), salicylic acid, opioids, intracanal medicaments, and long-acting local anesthetics, are commonly prescribed to manage post-endodontic pain. Despite their effectiveness, the adverse effects associated with NSAIDs and current limitations on their usage have increased interest in non-pharmacological alternatives. Among these, cryotherapy has gained attention as a safe and effective method for managing post-treatment pain.[9]

Vera et al. were the first to introduce the concept of intracanal cryotherapy in endodontics. Their study demonstrated that irrigation with saline at 2.5 °C resulted in a reduction of approximately 10 °C in the external root surface temperature. This temperature decrease was sufficient to induce localized anti-inflammatory effects by minimizing periapical edema, slowing the inflammatory response, and decreasing the release of pain mediators.[10]

➢ *The Analgesic Effect of Cryotherapy can be Explained Through Several Physiological Mechanisms:*

- *Reduction in Nerve Conduction Velocity:*

Cold application decreases the conduction velocity of nociceptive sensory nerve fibers, leading to analgesia.[11]

- *Selective Nerve Fiber Deactivation:*

Franz and Iggo reported that myelinated A-delta fibers become inactive at temperatures around 7 °C, while unmyelinated C fibers cease conduction at approximately 3 °C. According to the gate control theory of pain, stimulation of larger myelinated fibers inhibits the transmission of pain impulses carried by C fibers, thereby producing a pain-relieving effect.[12]

- *Cold-Induced Neuropraxia:*

Exposure to low temperatures increases the activation threshold of tissue nociceptors, inhibiting neural signal transmission. This reduction in chemical pain mediators combined with suppressed neural propagation contributes to analgesia.[13]

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- *Alteration of Cellular Activity:*

Cryotherapy restricts leukocyte migration into inflamed tissues. Studies have shown that it increases levels of anti-inflammatory cytokines such as IL-10 while decreasing pro-inflammatory markers including IL-1β, IL-2, and IL-6. Additionally, cryotherapy promotes the release of insulin-like growth factor-1 (IGF-1), which plays a crucial role in tissue repair and regeneration.[14]

To standardize the study and eliminate confounding factors influencing pain perception, cases involving periapical pathology, procedural errors, sealer extrusion beyond the apex, and retreatment were excluded. Inclusion of teeth with pre-existing periapical or preoperative pain could have compromised the accuracy of pain assessment.

In the cryotherapy group, saline at 2.5 °C was selected for final irrigation based on in-vitro evidence indicating that this temperature reduces the root surface temperature by more than 10 °C for a duration of five minutes (Vera et al., 2015).[10] A total of 10 mL of cold saline was delivered using a 30-gauge needle, ensuring that the irrigant remained within the canal for approximately five minutes. To maintain consistency between both study groups, the same volume and needle gauge were used in the control group, with temperature being the sole variable.

A gradual reduction in post-endodontic pain was observed in both groups over time. These results align with the findings of Pak and White (2011), who reported that although post-treatment pain is relatively common, it typically diminishes within 24 hours and continues to decrease thereafter.[3]

Keskin et al. evaluated the effect of intracanal cryotherapy using EndoActivator®-assisted irrigation with 2.5 °C saline and found significantly reduced pain in the cryotherapy group at 24 hours, although no significant difference was noted at 48 hours.[8] Similarly, Jain et al. reported significantly lower pain scores in the cryotherapy group at 6 hours post-treatment in mandibular molars with symptomatic irreversible pulpitis.[15]

In contrast, Abdullah Ahmed Alharthi observed no significant difference in pain intensity between cryotherapy and control groups at 48-hour intervals.[16] The present study supports these findings, as the pain-reducing effect of cryotherapy was not statistically significant at later time points.

Recent meta-analyses assessing the effectiveness of intracanal cryotherapy in endodontic treatment have concluded that cryotherapy significantly reduces post-operative pain at both 6 hours and 24 hours.[4,5] These conclusions are consistent with the outcomes of the current investigation.

Limitations of the present study include the inability to blind the operator due to the perceptible temperature difference of the irrigant within the syringe. However, both the patients and the statistician were blinded to the group allocation. Additionally, the sample size was limited to patients meeting strict inclusion criteria. Finally, pain assessment relied on subjective patient reporting due to the absence of an objective pain-measurement device.

VI. CONCLUSION

Within the limitations of this study, intracanal cryotherapy can be considered an effective non-pharmacological approach for reducing short-term postoperative pain following single-visit root canal treatment. While its impact appears limited to the early postoperative period, the simplicity and safety of this technique make it a valuable adjunct in endodontic practice. Further studies with larger sample sizes and objective pain assessment methods are recommended to validate these findings.

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