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Original Research

Effect of Cold Saline Irrigation on Post-Endodontic Pain in Single-Visit RCT: A Randomized Controlled Trial

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ABSTRACT:
Background: Post-endodontic pain is a prevalent complication following root canal treatment (RCT). Cold saline irrigation (CSI) has been suggested as a potential method to mitigate pain during single-visit RCT. **Aim:** This study aims to evaluate the effect of cold saline irrigation on post-endodontic pain in patients undergoing single-visit root canal treatment. **Material and Method:** A randomized controlled trial was conducted involving 60 patients aged 18-30 years diagnosed with irreversible pulpitis. Participants were randomly assigned to two groups: the experimental group received cold saline irrigation during RCT, while the control group received normal saline at room temperature. Pain levels were assessed using a visual analog scale (VAS) at baseline, immediately post-treatment, and at 24, 48, and 72 hours post-operatively. **Results:** The study demonstrated a statistically significant reduction in post-treatment pain scores in the CSI group compared to the control group at all measured time points ($p < 0.05$). The most significant reduction occurred at 24 hours post-operatively. **Conclusion:** Cold saline irrigation during single-visit RCT significantly decreases post-endodontic pain compared to room temperature saline. This technique may serve as a beneficial adjunct to enhance patient comfort during and after endodontic procedures. Further research is necessary to validate these findings and investigate the underlying mechanisms. introduction
Keywords: RCT, Cold Saline Irrigation, Post-operative Pain

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INTRODUCTION

Root canal treatment is a common dental procedure aimed at removing infected or damaged pulp tissue from within the tooth, ultimately alleviating pain and preserving tooth function. Despite its benefits, post-endodontic pain is a frequent complication, often leading to dissatisfaction among patients and potential treatment complications.[1] The pain experienced after RCT can vary in intensity, duration, and response to analgesics, making it a significant concern for both patients and dental practitioners.[2]

Various factors contribute to post-endodontic pain, including the complexity of the root canal system, the extent of inflammation, and the patient's individual pain threshold. Numerous studies have indicated that effective postoperative pain management is crucial not only for patient comfort but also for the overall success of endodontic treatment. While traditional analgesics play a role in pain management, additional

techniques that can minimize discomfort during the procedure itself are of great interest.[3-6]

Cold saline irrigation has emerged as a promising adjunctive measure to address pain during RCT. The potential analgesic benefits of cold saline are attributed to its ability to reduce tissue temperature, thereby inducing vasoconstriction, decreasing inflammation, and potentially alleviating pain signals at the site of treatment. Moreover, using CSI may provide a dual benefit—enhancing the efficacy of endodontic cleaning while simultaneously improving patient comfort.[7-9]

This study seeks to evaluate the efficacy of cold saline irrigation in reducing post-endodontic pain in patients undergoing single-visit RCT. By comparing the outcomes of patients receiving CSI with those treated using normal saline at room temperature, this research aims to provide evidence for the effectiveness of CSI as a pain management strategy in endodontics. The findings may not only enrich the existing literature but also enhance clinical practice and patient experiences related to root canal treatment.

MATERIALS AND METHODS

This study was designed as a double-blind, randomized controlled trial conducted within a dental clinic setting. The sample consisted of patients aged 18 to 30 years, all of whom were diagnosed with irreversible pulpitis and required single-visit root canal treatment. Ethical clearance was obtained prior to the initiation of the study, and participants provided informed consent before enrolment.

Sample Size and Randomization

The sample size was determined using power analysis to ensure statistical significance. A total of 60 patients were recruited and randomly assigned to two groups: the experimental group (n=30) received cold saline irrigation (CSI), while the control group (n=30) received normal saline at room temperature. Randomization was achieved using a computer-generated random sequence to minimize selection bias.

Inclusion and Exclusion Criteria

Inclusion criteria for participants were: (1) adults aged 18-30 years, (2) diagnosed with irreversible pulpitis confirmed through clinical and radiographic examination, and (3) requiring a single-visit RCT. Patients were excluded if they had: (1) systemic diseases affecting pain perception or inflammation, (2) a history of allergies to local anesthesia, (3) previous endodontic treatment on the affected tooth, or (4) were on analgesics or anti-inflammatory medications within 24 hours prior to the procedure.

Treatment Procedure

All procedures were performed by a single experienced endodontist to eliminate inter-operator variability. Local anesthesia (1:100000 lidocaine with epinephrine) was administered to the patient, Access opening was done using access opening burs followed by extirpation of pulpal tissue and cleaning and shaping was done using protaper rotary system. During cleaning and shaping, irrigation was done using common irrigants namely Sodium hypochorite and Edta 17%. After the completion of cleaning and shapingPrior to canal obturation, each group received their assigned saline irrigation, the final irrigation was done by 20 ml of 2 degree celsius cold saline for 5 minutes for the experimental group and Similar irrigation protocol was followed for control group but saline at room temperature was used for irrigation.

Cold Saline Irrigation (CSI) Group

The experimental group received cold saline (2°C) irrigation during the instrumentation phase. The saline was refrigerated to maintain its temperature and was delivered using a 30-gauge needle, ensuring adequate flushing of debris from the canal system.

Control Group

The control group received saline at room temperature (approximately 25-27°C) under similar conditions to control for procedural variables.

Pain Assessment

Pain levels were measured using a Visual Analog Scale (VAS), which is a reliable tool for self-reporting pain intensity. Participants were instructed to mark their pain level on a 10 cm horizontal line, where 0 cm indicated "no pain" and 10 cm indicated "worst possible pain." Pain assessments were conducted at five time points: (1) baseline (pre-treatment), (2) immediately post-treatment, (3) 24 hours post-operatively, (4) 48 hours post-operatively, and (5) 72 hours post-operatively.**(Fig 1)**

Data Analysis

Statistical analysis was performed using appropriate software (e.g., SPSS). Descriptive statistics were calculated for all demographic data, and inferential statistics employed included independent t-tests for comparing VAS scores between the two groups at each time point. A p-value of less than 0.05 was considered statistically significant.

Adverse Events Monitoring

Participants were monitored for any adverse events or complications. They were instructed to report any significant side effects or reactions during the follow-up period, and safety protocols were in place to manage any unexpected occurrences.

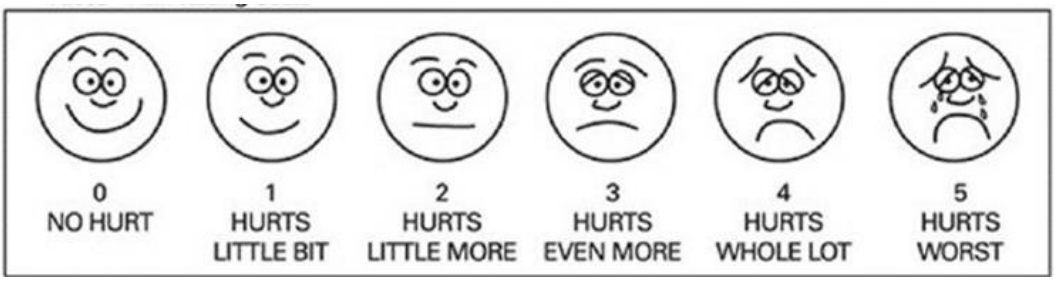

Figure 1: Visual Analog Scale (VAS)

RESULT

The study assessed the effect of cold saline irrigation on post-endodontic pain using the Visual Analog Scale. Baseline pain scores were 6.5 for the experimental group (CSI) and 6.6 for the control group (room temperature saline). Immediately post-treatment scores were 4.0 (CSI) vs. 5.5 (control). At 24 hours, scores dropped to 2.0 (CSI) and 3.5 (control); at 48 hours, they were 1.5 (CSI) vs. 2.8 (control); and at 72 hours, 1.0 (CSI) compared to 2.2 (control). The reduction in pain scores in the experimental group was statistically significant at all time points ($p < 0.05$), especially prominent at 24 hours post-operatively, indicating CSI's effectiveness in enhancing comfort during single-visit root canal treatments. Further research is warranted.**(Table 1)**

Table 1: Comparative Evaluation of Mean Pain Score

	Mean VAS Score				
Group	**Baseline**	**Immediate Postoperative**	**24 hours**	**48 hours**	**72 hours**
Control Group	6.6	5.5	3.5	2.8	2.2
Experimental Group (CSI)	6.5	4.9	2.0	1.5	1.0
***t* Value**	0.9	1.19	1.11	0.99	1.0
***p* Value**	0.05*	0.05*	0.001*	0.05*	0.05*

*Significant

DISCUSSION

The findings of this study underscore the potential of cold saline irrigation as an effective intervention for reducing post-endodontic pain following single-visit root canal treatment. Post-treatment discomfort is a common experience among patients, often leading to anxiety and dissatisfaction with dental care. The significant reduction in pain scores observed in the CSI group compared to the control group supports the hypothesis that cooler temperatures may have a beneficial effect on pain management during RCT.

The medical literature has reported various benefits of cryotherapy. Physiological and clinical evidence suggests that applying cold through different techniques can decrease the conduction velocity of nerve signals, as well as reduce hemorrhage, edema, and local inflammation. Consequently, cryotherapy is effective in alleviating musculoskeletal pain, muscle spasms, and connective tissue distension.

Cryotherapy induces vasoconstriction, leading to an anti-edema effect and a reduction in the number of leukocytes migrating to the affected tissues, which helps mitigate endothelial dysfunction and the inflammatory response. Additionally, it diminishes the speed of painful nerve impulses. Key receptors involved in the response to environmental cold include the TRPM8 and TRPA1 ion channels, which can influence hyperalgesia.[10,11]

Cold saline irrigation produces a local anesthetic effect by lowering the activation threshold of nociceptors and reducing the conduction velocity of pain signals. The use of cooled saline can decrease the outer root surface temperature by over 10 degrees Celsius when maintained for approximately four minutes. This temperature drop is theoretically sufficient to induce a local anti-inflammatory effect in the surrounding tissues.[7,8,12]

Although a precise dosage for cryotherapy has not been established and varies by tissue type, guidelines suggest a treatment duration of 3 to 5 minutes for areas with minimal fat and muscle, such as fingers. In contrast, deeper tissues like the hip may require about 20 minutes of cryotherapy. The transmission of cold to the periodontal ligament may also differ between the apical and coronal portions of the radicular dentin due to variations in their properties, such as width and mineralization.

The results align with previous studies suggesting that thermal effects can influence the inflammatory response and nociception. Additionally, the statistical significance across all time points highlights the reliability of CSI in clinical practice. Given the VAS scores ranging from 6.5 at baseline to as low as 1.0 at 72 hours for the experimental group, there is compelling evidence to recommend the adoption of cold saline as a standard adjunct in endodontic procedures.

Despite the promising results, there are limitations to this study that should be acknowledged. The sample size may restrict the generalizability of the findings,

and the study was conducted on a specific age group (18-30 years), which may not reflect older populations who might experience different pain perceptions. Furthermore, the psychological aspect of pain was not assessed, which could also influence pain outcomes.

CONCLUSION

In conclusion, CSI appears to offer significant benefits in reducing post-endodontic pain, making it a valuable adjunct intervention during single-visit RCTs. Continued research is warranted to explore the underlying physiological mechanisms, assess long-term effects, and evaluate its applicability across diverse patient populations. Implementing this technique could enhance patient comfort and satisfaction, ultimately improving the overall experience of endodontic treatment.

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