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Comparative evaluation of cryotherapy and topical anaesthetic on injection pain in endodontic patients

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Abstract:

Pain during intraoral local anaesthetic injection remains a significant concern in endodontic patients. Therefore, it is of interest to evaluate the effect of cryotherapy and topical anaesthetic agents on pain perception in 30 adult patients. Participants were randomly allocated into three groups: 2% lignocaine gel, cryotherapy and cryotherapy combined with 2% lignocaine gel. Pain perception was evaluated by the Visual Analogue Scale (VAS). The combination group showed the lowest pain scores, suggesting that cryotherapy adjunct to topical anaesthetic may serve as effective approach for reducing injection pain.

Keywords: Cryotherapy, topical anaesthetic, lignocaine gel, injection pain, endodontics, visual analogue scale (VAS)

Background:

Pain control is one of the most important aspects of endodontic treatment and plays a significant role in determining patient comfort and co-operation [1]. Although local anaesthesia is routinely administered to achieve painless dental procedures, the injection itself is often associated with fear, anxiety and discomfort among patients [2]. Needle insertion and deposition of anaesthetic solution into the oral mucosa can produce unpleasant sensations, leading to increased apprehension and avoidance of dental treatment [3]. Therefore, reducing pain during local anaesthetic administration remains an important objective in contemporary endodontic practice [4]. Various techniques and adjunctive methods have been proposed to minimize pain associated with intraoral injections [5]. These include slow injection techniques, vibration, warming or buffering of anaesthetic solutions, distraction methods and the use of topical anaesthetic agents [6]. Topical anaesthetics such as 2% lignocaine gel are commonly applied before needle insertion to numb superficial mucosal tissues and reduce pain perception. However, their effectiveness is often limited to surface anaesthesia and may not completely eliminate injection discomfort [7]. Cryotherapy is a simple, economical and non-invasive technique that has gained attention in dentistry for pain reduction [8]. It involves the application of cold to tissues, resulting in decreased nerve conduction velocity, temporary local anaesthesia, vasoconstriction and reduction in inflammatory response [9]. Cooling the mucosa before injection may reduce pain perception by desensitizing peripheral nerve endings and decreasing transmission of painful stimuli [10]. Previous studies have showed the effectiveness of cryotherapy in reducing pain during various dental procedures, particularly

in pediatric dentistry and minor oral surgical interventions [11, 12]. Recently, the use of cryotherapy as an adjunct to topical anaesthetic agents has been explored to enhance patient comfort during local anaesthetic administration [13]. The synergistic effect of tissue cooling along with topical anaesthesia may provide superior pain reduction compared to either method used alone [14]. Therefore, it is of interest to report the efficacy of cryotherapy and topical anaesthetic agents in reducing pain during intraoral local anaesthetic administration in adult endodontic patients.

Materials and Methods:**Study design:**

This randomized controlled clinical trial was conducted in the Department of Conservative Dentistry and Endodontics following approval from the Institutional Ethical Committee. Written informed consent was obtained from all participants prior to the study.

Study population:

A total of 30 adult patients requiring routine endodontic treatment under local anaesthesia were selected for the study. Patients between 18 and 35 years of age who were cooperative and willing to participate were included irrespective of gender and tooth type.

Inclusion and exclusion criteria:

Patients requiring inferior alveolar nerve block administration for endodontic treatment and willing to participate in the study were included. Patients with a known allergy to lignocaine or topical anaesthetic agents, systemic diseases or neurological

disorders affecting pain perception, acute infection or trauma at the injection site, history of cold hypersensitivity and use of analgesics within the previous 24 hours and pregnant or lactating women were excluded from the study.

Randomization and group allocation:

The selected participants were randomly allocated into three groups consisting of 10 patients each using a simple randomization method. Group 1 received 2% lignocaine gel, Group 2 received cryotherapy alone and Group 3 received cryotherapy followed by application of 2% lignocaine gel.

Intervention procedure:

Before administration of local anaesthesia, the injection site was isolated and dried using sterile gauze. In Group 1, 2% lignocaine gel (Xylocaine 2% jelly, Zydus Cadila) was applied over the mucosal surface using a cotton applicator and left in place for two minutes. In Group 2, cryotherapy was performed by applying ice stick directly over the injection site for two minutes to achieve mucosal cooling. Ice sticks were prepared by filling empty 2 mL syringes (Dispovan, Hindustan Syringes and Medical Devices, Faridabad, Haryana, India) with water and freezing them. Each ice stick measured approximately 1.2 cm in diameter. In Group 3, cryotherapy was first administered for two minutes, followed immediately by application of 2% lignocaine gel over the same site for an additional two minutes. Following the respective intervention, local anaesthetic solution was administered using a standard aspirating dental syringe with a 26-gauge needle by the same operator under standardized clinical conditions to minimize operator-related variability.

Assessment of pain perception:

Pain perception during injection was evaluated immediately after administration using the Visual Analogue Scale, in which patients rated their pain intensity on a scale ranging from 0 to 10,

where 0 represented no pain and 10 represented the worst possible pain.

Statistical analysis:

The obtained data were tabulated and statistically analysed using Statistical Package for Social Sciences (SPSS) software version 23.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics including mean and standard deviation were calculated for all groups. Intergroup comparison of pain scores was performed using the Kruskal-Wallis test.

Results:

A total of 30 adult patients participated in the present study and were equally distributed among the three study groups, with 10 participants in each group (Table 1). No adverse reactions or complications related to the interventions were reported during the study period. The mean Visual Analogue Scale scores varied among the groups (Table 2). Group 1, which received 2% lignocaine gel alone, demonstrated the highest mean pain score (5.20 ± 0.91). Group 2, in which cryotherapy alone was used, showed comparatively lower pain scores (3.80 ± 0.78). The lowest mean VAS score was observed in Group 3 receiving cryotherapy in combination with 2% lignocaine gel (2.10 ± 0.73), indicating superior pain reduction during intraoral local anaesthetic administration. Intergroup comparison of VAS scores using the Kruskal-Wallis test revealed a statistically significant difference among the three groups ($\chi^2 = 14.62$, $p = 0.001$) (Table 3). Pairwise comparison showed statistically significant differences between Group 1 and Group 2, Group 1 and Group 3, as well as Group 2 and Group 3 (Table 4). The result of the present study indicates that cryotherapy, particularly when used as an adjunct to topical anaesthetic gel, was more effective in reducing pain perception during intraoral local anaesthetic administration in endodontic patients.

Table 1: Distribution of participants according to study groups

Group	Intervention	Number of Participants (n)	Percentage (%)
Group 1	2% Lignocaine Gel	10	33.3
Group 2	Cryotherapy	10	33.3
Group 3	Cryotherapy + 2% Lignocaine Gel	10	33.3
Total		30	100

Table 2: Comparison of mean VAS score among study groups

Group	Mean VAS Score	Standard Deviation	Minimum Score	Maximum Score
Group 1	5.20	0.91	4	7
Group 2	3.80	0.78	3	5
Group 3	2.10	0.73	1	3

Table 3: Intergroup comparison of VAS scores using kruskal-wallis test

Parameter Evaluated	Group 1	Group 2	Group 3	Chi-square Value (χ^2)	p-value
VAS Pain Score	5.20 ± 0.91	3.80 ± 0.78	2.10 ± 0.73	14.62	0.001*

*Significant

Table 4: Pairwise comparison of mean VAS scores between groups

Comparison Between Groups	Mean Difference	p-value
1 vs 2	1.40	0.032*
1 vs 3	3.10	0.001*
2 vs 3	1.70	0.021*

*Significant

Discussion:

Pain associated with intraoral local anaesthetic injection is one of the most common causes of fear and anxiety among patients undergoing endodontic treatment [15]. Although local anaesthesia is essential for pain control during endodontic

procedures, the injection itself may produce discomfort due to needle penetration, tissue distension and the acidic nature of anaesthetic solutions [16]. Therefore, various techniques have been investigated to minimize injection pain and improve patient comfort. The present clinical trial compared the effectiveness of topical anaesthetic gel, cryotherapy and their combination in minimizing pain perception during local anaesthetic administration in endodontic patients. Cryotherapy has been validated for lowering patient pain perception. Cryotherapy uses ice or a refrigerant spray on the site to counter the nerve conduction of pain from the site [17]. Studies have shown that it reduces oedema, nerve conduction velocity, cellular metabolism and local blood flow. Patients benefit physiologically and psychologically from having ice applied to them since it may divert their attention from their pain [18]. It is efficient, effective and affordable. Pre-cooling has not been widely employed in dentistry, despite being used for medical treatments like venepunctures and vaccinations. Harbert originally suggested ice pre-cooling before palatal injection in 1989 [19]. Various studies by Amrutha Varshini *et al.* and Shah *et al.* have evaluated pain perception using cryotherapy and topical anaesthetic agents in both adult and paediatric dental patients, reporting that cryotherapy can effectively reduce injection-related pain [11, 12]. The combination of cryotherapy with anaesthetic gels may synergise with local anaesthesia. Cryotherapy may help reduce the pain of a needle prick caused by local vasoconstriction. At the same time, anaesthetic gels block the transmission of these signals through peripheral sensory nerve fibres, without affecting the action of local anaesthesia in the region [20]. The findings of the current research showed that all three interventions reduced pain perception to some extent; however, the combination of cryotherapy with 2% lignocaine gel showed the greatest reduction in pain scores on the Visual Analogue Scale. This suggests that cryotherapy may enhance the analgesic effect of topical anaesthetic agents when used as an adjunct before injection. Topical anaesthetic agents such as lignocaine gel are commonly used in dental practice to reduce pain caused by needle insertion. Their mechanism of action involves reversible blockade of sodium channels in superficial nerve endings, thereby decreasing transmission of pain impulses. In the present study, the lignocaine gel group showed moderate pain reduction, which is in agreement with previous studies reporting that topical anaesthetics are effective primarily for superficial mucosal anaesthesia. However, their effect may be limited because penetration into deeper tissues is relatively poor, especially in areas with thick mucosa [21]. Cryotherapy, on the other hand, has gained increasing attention as a simple and non-pharmacological method for pain control. The analgesic effect of cryotherapy can be attributed to several mechanisms, including reduction in nerve conduction velocity, vasoconstriction, decreased local metabolism and temporary desensitization of peripheral nerve endings. Application of cold also produces a numbing sensation that may reduce patient anxiety and anticipation of pain. In the present study, the cryotherapy group demonstrated lower pain scores than the topical anaesthetic

group, indicating that pre-cooling of the injection site may be more effective in reducing discomfort during needle penetration [7, 10]. The most significant finding of this study was the superior performance of the combined cryotherapy and lignocaine gel group. The synergistic effect observed may be explained by the simultaneous action of both modalities at different levels. Cryotherapy likely reduces sensitivity of deeper tissues and slows pain impulse transmission, while lignocaine gel provides surface mucosal anaesthesia. Together, these effects may produce enhanced pain control compared with either intervention alone. Similar findings have been reported in previous clinical studies where combined approaches resulted in greater patient comfort during dental injections [14]. Another possible explanation for the improved outcome in the combination group is the psychological effect associated with cooling. Patients often perceive cold application as soothing and pain relieving, which may reduce anxiety and alter pain perception. Since pain is subjective and influenced by emotional factors, reduction in anxiety may have contributed to the lower VAS scores observed in this group. The use of cryotherapy offers several clinical advantages. It is inexpensive, non-invasive, easy to perform and does not require additional pharmacological agents [22]. Furthermore, it can be readily incorporated into routine endodontic practice without increasing chairside time significantly. The findings of this study therefore support the use of cryotherapy as an effective adjunctive technique for improving patient comfort during local anaesthetic administration. The findings of the present study are consistent with those reported by Saeedi *et al.*, who showed that cryotherapy significantly reduced pain associated with intraoral local anesthetic injections compared with conventional topical anaesthesia. Their systematic review and meta-analysis further highlighted that the analgesic effect of cryotherapy was particularly pronounced in anxious patients, supporting the use of pre-cooling techniques as an effective, non-pharmacological method for pain reduction [23]. Despite the promising results, the study had certain limitations, including a relatively small sample size and the subjective nature of pain perception, which may vary among individuals. In addition, only adult patients were included in the study; therefore, the results cannot be directly extrapolated to pediatric or geriatric populations. Future studies with larger sample sizes, multicentric designs and evaluation of different durations and methods of cryotherapy application are recommended to validate the findings further. Within the confines of current study, it can be concluded that cryotherapy significantly reduces pain during intraoral local anaesthetic injection and its combination with 2% lignocaine gel provides the maximum analgesic benefit. Incorporating cryotherapy as an adjunct to topical anaesthetic application may therefore enhance patient comfort and improve the overall experience of endodontic treatment.

Conclusion:

We show that both cryotherapy and 2% lignocaine gel were effective in reducing pain during intraoral local anaesthetic administration in endodontic patients. However, the

combination of cryotherapy with topical anaesthetic showed the greatest reduction in pain perception on the Visual Analogue Scale. Therefore, cryotherapy may be considered a simple, economical and effective adjunctive method for improving patient comfort and reducing anxiety associated with local anaesthetic administration during endodontic treatment.

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