Review Article

Chilling Out: Importance of Cryotherapy in Modern Endodontics

Abstract

The word CRYOTHERAPY is a mixture of two words, “cryos” meaning “cold” and “therapeia” meaning “cure”. It widely used in the treatment of sports injury, strains, tendonitis, surgical extractions, periradicular surgeries etc. but now-a-days it is used in endodontics to treat post endodontic pain. This review article is aimed to summarise its historical development, importance, mechanism of action and uses in contemporary era with its limitations. A comprehensive data analysis was done using very popular data base “Google Scholar” only for the year 2024-25. After detailed inspection, conclusion can be drawn that cryotherapy is very beneficial, easy to apply, cost-effective, reduces usage of analgesics and antibiotics and enhances anaesthetic effect and healing response. Although cryotherapy application has some limitations but still it is gaining very popularity amongst endodontists.

Keywords

Cryotherapy, Chilled saline and Endodontics, Cryotherapy and root canal treatment,

Introduction

Post-endodontic pain, or discomfort following root canal treatment, is a common experience among patients. Studies indicate that postoperative pain affects approximately 2.5% to nearly 60% of individuals undergoing endodontic procedures. The pain experience typically exhibits an upward trend between 6- and 12-hour post treatment and reaching to the maximum peaking within 24 hours before diminishing to 11% in the subsequent week.[1,2] Predisposing factors for post-endodontic pain are preoperative pain, tooth morphology (tooth type, presence of periapical lesion, tooth anatomy), patient demographics (gender, age), procedural factors (instrumentation techniques, extrusion of debris), irrigation solutions and number of treatment visits. The difference between studies may be partly explained by the fact that most of the authors assessed and defined post-endodontic pain according to different criteria, using different endodontic materials and techniques.[3] Predominantly two management modalities are adopted to treat post endodontic pain including. Pharmaceutical strategies for pain

management often begin with premedication. This approach involves the administration of analgesics prior to the procedure to preemptively manage pain.[4] The second strategy involves the use of analgesics, specifically non-opioids, which are typically used for dental pain. These strategies together form the cornerstone of pharmaceutical pain management in dentistry.[5,6] Non-pharmacological approach includes behavioral management and audio analgesia. Now-a-days one new therapeutic approach is emerging to manage post endodontic pain. This is known as CRYOTHERAPY.

Methodology

A comprehensive literature review was done using only one data base, Google Scholar for the year 2024-2025. Screening was done by using the keyword chilled saline & Endodontics, cryotherapy and Endodontics, cryotherapy and root canal treatment in single rooted tooth and cryotherapy and root canal treatment in permanent single rooted tooth. During the above said period, only original articles, systematic reviews, case series, and case reports were included which shows direct relation between cryotherapy and endodontic treatment. Interim reports, abstracts, letters, short communications, and textbook chapters were excluded. Only English-language publications were included in the review. Exclusion criteria were interim reports, abstracts, letters, short communications, and textbook chapters and all other articles which do not end on key point.

S No	Keyword	Article obtained
1	chilled saline & Endodontics	1410
2	cryotherapy and Endodontics	400
3	cryotherapy and root canal treatment in single rooted tooth	90
4	cryotherapy and root canal treatment in permanent single rooted tooth	75

After screening the data, only 12 articles were including satisfying the inclusion criteria. These are as following:

S No	Title	Authors	Journal
1	Comparative study to investigate the effect of cryotherapy on post-operative pain using two different preparation techniques (In vivo study)	Ahmad Al-Abdullah, Atef Abdullah and Khetam Al-Marrawi	International Journal of Applied Dental Sciences 2020; 6(3): 163-168
2	A Holistic Approach to Postendodontic Pain Management: A Narrative Review	Algarni HA.	J Pharm Bioall Sci 2024;16:S4262-70.
3	Frequency of Pain in Teeth with	Junaid S, Khan HH, Bhangar F, Shah JA, Hussain SM, Yousaf	Pak Armed Forces Med J 2022; 72(6): 2099-2102.

	Irreversible Pulpitis after a Single Visit of Root Canal Treatment Using Cryotherapy		
4	An Emerging Alternative for Pain Control: Mechanism and Applications of Cryotherapy in Endodontics	Swayangprabha Sarangi, Manoj Chandak, Anuja Ikhar, Mrinal Dayanand and Namrata Jidewar	ijlpr.2023;13(5):P123-P129
5	Cryotherapy in the field of Endodontics: A Literature	Al Bast, Amena and Abiad, Roula S. (2024)	BAU Journal - Science and Technology.2024;5(2):7
6	Efficacy of Intracanal Cryotherapy in Reducing Post-operative Pain in Patients with Symptomatic Apical Periodontitis: An In-Vivo Study	Priyanka, Chauhan K, Bhushan J	Adv Med Dent Scie Res 2020;8(9):6-11
7	Effectiveness of two intracanal irrigation solutions delivered through cryotherapy on post –endodontic pain reduction: A randomised clinical	Manal Mohamed Abdelbaky and Mostafa Shaker.	E.D.J 2024;70: 2965-2974
8	Cryotherapy in Endodontics: A Review	Reem Mohammed Amr Sharaf, Tariq Yehia Abdelrahman and Maram Farouk Obeid	E.D.J.2024;70:4007-4016
9	Effect of Cryotherapy on Postoperative Pain: Randomized Controlled Trial	Jain A, Chauhan S, Bahuguna R, Agarwal A, Sharma R, Khan F. Indian J Dent Sci 2021;13:236-40	Indian J Dent Sci 2021;13:236-40
10	Efficacy of Endodontic Cryotherapy in Alleviating Post-Treatment Pain after	Ingale PC, Sethi S, Babu SS, Rathod K, Sharma R, Khan S	J Pharm Bioall Sci 2024;16:S3667-9.

	Single-Visit RCT: A Randomized Study		
11	Evaluation of postoperative pain with cryotherapy in teeth with symptomatic irreversible pulpitis with symptomatic apical periodontitis after single-visit endodontics: A randomized clinical study	Shah VR, Shah NC, Kishan KV, Kothari MA, Patel JJ, Patel SN. Endodontology 2023;35:118-23.	Endodontology 2023;35:118-23.
12	Comparative evaluation of effect of intracanal cryotherapy and corticosteroid solution on post endodontic pain in single visit root canal treatment	Solomon RV, Paneeru SP, Swetha C, Yatham R.	J Clin Exp Dent. 2024;16(3):e250-6

Review

History

At around 3000 BCE, the early Egyptians were believed to be the ancestral predecessors of cold application for the cure of injuries and to decrease tissue inflammation at the site of trauma.[7] In 1777, John Hunter, explained the cryotherapy effect on local tissue response as characterized by necrosis, vascular stasis, and subsequent optimal healing. James Arnott, in 1851, pioneeringly utilized a salt and ice mixture to freeze and ablate malignant breast tumors. This marked a significant milestone in the practical application of cryosurgery for oncological purposes. Campbell White, in 1899, became the first to employ cryogenic agents in clinical settings. He successfully treated warts and other dermatological conditions with liquid air, demonstrating the versatility of cryotherapy for addressing various skin lesions.[8] In 1908, A.W. Pusey coined the term “cryotherapy” to refer to the treatment of skin lesions with intense cold. Presently, cryosurgery freezes diseased tissues to death, while cryotherapy cools the body’s surface without damaging tissue.[4] In Japan, Yamauchi and his colleagues opened the world’s first cryogenic temperature chamber in 1978. (Farah & Savage, 2006)[9]

In context of Endodontics, the initial contributions to the field of cryotherapy were attempted by Vera et al.[10], who used a final rinse of 2.5°C cold saline solution coupled with an Endovac irrigation device for 5 minutes. Similar studies following these footsteps affirmed that using chilled normal saline solution and following the same protocols presented a reduction in postoperative pain levels following single-visit root canal treatment in teeth having vital

pulps.[11,12,13] Recently, in endodontics, its spectrum of application has been escalating in vital pulp management, where it has been effectively applied in cases of direct pulp capping where there was obvious pulp exposure. Studies reveal that when sterile shavings of water ice (0°C) were applied openly to exposed pulp tissue, the entire tooth surface for the duration of 1 minute, the entire tooth became asymptomatic, vital, and functional for a period of 2 weeks and remained functional for a follow-up tenure of 12-18 months.[14] Although sufficient studies have only been made recently in the branch of Oral Surgery, it has been shown that intraoral cryotherapy application increased the success of Inferior Alveolar Nerve block.[15,16]

Mechanism of Action

Cryotherapy acts on the target tissues through three primary physiological mechanisms:

- Vascular
- Neurologic
- Tissue metabolism

Vascular effect: Cryotherapy relies on a scientific principle called **Joule-Thomson expansion**. This essentially means that when a substance moves from a high pressure zone to a lower-pressure one, its molecules expand and lose energy, resulting in a temperature drop.[9] The rapid release of nitrous oxide from the high-pressure cryoprobe environment to the lower pressure cryotip triggers an adiabatic expansion, leading to a pronounced temperature decrease and subsequent tissue freezing. Cryotherapy employs a multistep protocol involving this rapid freeze thaw cycle, with repetition further potentiating tissue destruction through cellular disruption.[17] Concerning the vascular response, once the tissue is exposed for more than 15 minutes to low temperature, vasoconstriction will occur as initial reflux followed by cold induced vasodilation, this cycle is continuous and repetitive known as "**hunting response"**.[18] Vasoconstriction following vasodilation is triggered by the blood vessels adrenergic elements which reduces the vascular permeability.[18] This reduced permeability is the key factor in decreasing the leakage of fluid into peri-radicular tissues as exudate that occurs during biomechanical preparation thus limiting edema and swelling of the tissue and thus pain.[19] Another effect of the cold application is the prevention of hematoma, that explains its use postsurgical, where following the vasoconstrictor local anesthesia helps to hinder the local blood flow and offset the rebound phenomenon.[18]

Neurologic effect: Regarding the neurologic effect produced by the cold application, it is devised that cooling initiates analgesia by slowing the conduction velocity in a nerve.[20,21] However, this result is more marked in the myelinated nerve fibers (A-delta fibers) paralleled with the unmyelinated fibers (C fibers),[22] as Franz and IggoZ[23] prove. According to the assumption, gate control theory is responsible for endorsing this analgesic outcome of cryotherapy, given that a faster sensory input by the larger myelinated A fibers momentarily closes the gate and hinders the communication of more excruciating impulses of the unmyelinated C fibers.[24,25] In addition, cold application induces neuropraxia, which will further decline the activation threshold of tissue nociceptors, resulting in a transient local anesthetic effect. Thus, the analgesic effect of cooling is produced by an amalgamation of a decreased release of chemical mediators of pain superadded to a slower dissemination of painful neuronal signals.[26] It also activates thermal receptors, which inhibit the transmission of painful stimuli and is known as the "**counterirritant effecť** because it causes cold-induced neuropraxia.[27]

Tissue metabolism: In accordance with **Van't Hoff's principle**, cryotherapy induces vasoconstriction and suppresses cellular metabolic activity via reduced biochemical reaction rates. This cascade of effects minimizes tissue injury by decreasing cellular oxygen consumption and mitigating free radical generation.[4]

The effectiveness of cryotherapy, both in terms of tissue cooling and the body's response, is influenced by four key factors[6,28,29]:

1. Temperature difference between target tissue and cryotherapy (**Fourier's Law),** which states that "per unit area the transfer of heat in a given direction is proportional to the temperature gradient,". this implies that a lower-temperature cryotherapy modality provides more heat energy transfer opportunities, which should subsequently lead to a lower Tsk.

2. Exposure duration

3. Tissue characteristics: The thermal conductivity and specific heat capacity of the treated area determine how easily heat is transferred within the tissue, impacting cooling depth and rate.

4. Cooling agent characteristics: The thermodynamic properties of the chosen agent.[29]

Endorsing the cryotherapy

Then Priyanka, Chauhan K, Bhushan J. E (2020)[31] reported that patients in the control group presented a significantly higher incidence of postoperative pain, intensity, and need for medication intake ($P < .05$). Cryotherapy reduced the incidence of postoperative pain and the need for medication intake in patients presenting with a diagnosis of necrotic pulp and symptomatic apical periodontitis. These findings were also supported by Ahmad Al-Abdullah, Atef Abdullah and Khetam Al-Marrawi (2020)[32] and reported that It was noticed from study results that in groups without cold saline, post endodontic pain presented with highest values after 12 hours of treatment which started to reduce in the after-monitoring periods until it was almost diminished after 1 week. Tthat root canals irrigated with a cold sterile saline solution of 2.5°C for 5 min in the group significantly mitigated post-endodontic pain (80%) when compared with the Control-Group (61.4%). These researches substantiated the findings of Keskin et al.[33], Alharthi et al.[34], Vieyra and colleagues[35] and Gundogdu EC[36]. Jain et al (2021)[37] examined the effect of cryotherapy in experimental group on final irrigation with 10mL cold saline, at a temperature of 1°C–2°C for 2 min after biomechanical preparation in comparison with control group on10 mL physiological saline at room temperature, for 2 min and reported e reported incidence and intensity of POP were significantly lower in patients treated with cryotherapy than those with saline at room temperature. Moreover, none of the patients reported severe symptoms or complications such as swelling or paresthesia. Junaid S, Khan HH, Bhangar F, Shah JA, Hussain SM, Yousaf A.[32] that root canals irrigated with a cold sterile saline solution of 2.5°C for 5 min in the group significantly mitigated post-endodontic pain (80%) when compared with the Control-Group (61.4%). In 2023, Swayangprabha Sarangi, Manoj Chandak, Anuja Ikhar, Mrinal Dayanand and Namrata Jidewar[7] in their review article reported that by demonstrating promising results in reducing postoperative pain, discomfort, and inflammation associated with vital pulp tissue management, cryotherapy is a promising treatment options clinicians can implement in routine endodontic practices. Furthermore, although the long-term prognosis of cryotherapy in vital pulp therapy is recommended, it alludes to bringing down or

diminishing the tissue temperatures for therapeutic purposes. Thus, cryo-treatment is expanding widely in endodontics as a modality that is simple, cost effective, quick, less invasive, and safe to use. It is, therefore, a pleasing adjunct for both patients and caregivers. Shah VR, Shah NC, Kishan KV, Kothari MA, Patel JJ, Patel SN. (2024)[38] suggested a highly statistically significant difference ($P < 0.000$) between the normal saline and cryotherapy groups at an interval of 24 and 48 h. Thus, cold saline is clinically more effective in reducing postoperative pain in patients with symptomatic irreversible pulpitis at an interval of 24 and 48 h than normal saline. Ingale PC, Sethi S, Babu SS, Rathod K, Sharma R, Khan S.(2024)[39] stated that endodontic cryotherapy using cold saline irrigation shows significant efficacy in reducing post-treatment pain after single-visit RCT when compared to normal saline and no additional intervention. These findings suggest that integrating cryotherapy could be a valuable adjunct in endodontic pain management. Cryotherapy was also substantiated by Manal Mohamed Abdelbaky and Mostafa Shaker (2024)[40] also advocated y that cryo helped in pain reduction whether used with CHX or NS. CHX used as a cryo material showed insignificant trend toward effective time dependent pain reduction as compared to NS. This might be because of its substantivity. Pupneja, et al.[41] substantited the use of cryotherapy by stating that the use of analgesics was more in the control group as compared to cryotherapy groups. Cryotherapy is a cheap and practical alternative to control postoperative pain. Both cryotherapy irrigation groups showed the lowest postoperative pain at 24, 48, and 72 h and after 7 days. Al Bast, Amena and Abiad, Roula S. (2024)[42] reported that final irrigation by cold saline (2.5 °C) seemed to lower the root surface temperature inducing local anti-inflammation thus controlling the postoperative pain after root canal treatment. Recently it has been used for hemostasis in vital pulp therapy.

Criticisms of cryotherapy

A major limitation of cryotherapy is its application only in scenarios limited to the resolution of apical periodontitis. It does not hold a significant difference in minimizing post-operative pain levels in cases of irreversible pulpitis.[37] Cryotherapy has been shown to decelerate peripheral nerve conduction.[22] As the temperature decreases, the conduction velocity of nerve fibres decreases until it stops completely. However, Ernst et al. found that the nerve conduction of C fibres could not be decreased via the application of moderate cold.[43]

Conclusion

Cryotherapy is very useful in post endodontic pain reduction as it enhances the anaesthetic effect during the treatment and decreases post endodontic pain and fastens healing. Best thing it limits the use of analgesic and antibiotics but still further research is needed to explore more.

Ethical Consent

No ethical consent is required in this study.

Data Availability

Data is available with the main author on request.

Disclaimer

No artificial intelligence is used in writing this review article.

Hence the objective of this study is to understand the concept of cryotherapy in endodontics and to sketch out a prospective future for the application of cryotherapy in endodontics.

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