**Cryotherapy in 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. 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 popularity amongst endodontists.*

**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 First are adopted to treat post endodontic pain. approach includes pharmaceutical strategies for pain management which 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.

***History***

At around 3000 BC, 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 Later on, 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 tumour. 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 surface of the body without damaging tissue.4 In Japan, Yamauchi and his colleagues9 opened the world’s first cryogenic temperature chamber in 1978. 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℃ cold saline solution coupled with an Endovac irrigation device for 5 minutes. There are many similar studies available following the same protocols presented a reduction in postoperative pain levels after single-visit root canal treatment in teeth having vital pulps.11,12,13 These studies reveal that when sterile shavings of water ice (0℃) were applied openly to exposed pulp tissue then 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 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).22,23 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 effect̋** 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 factors6,28,29:

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 the cryotherapy modality provides more heat energy transfer opportunities, which should subsequently lead to a lower temperature.

2. Exposure duration: Vera et al. recommended that 3–5 min of applied cryotherapy is efficient.10

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***

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 32 and stated that in groups without cold saline, post endodontic pain presented with highest values after 12 hours of treatment which started to reduce until it was almost diminished after 1 week. The 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%). The results of these studies were in favour of previous studies (Keskin et al.33, Alharthi et al.34, Vieyra and colleagues35 and Gundogdu EC36). In 2021, Jain et al37 examined the effect of cryotherapy in experimental group when final irrigation was done with 10mL cold saline at a temperature of 1°C–2°C for 2 min and in control group with 10 mL physiological saline at room temperature for 2 min. They reported that incidence and intensity of post endodontic pain 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.et al. 32 reported that root canals irrigated with a cold sterile saline solution of 2.5°C for 5 min significantly mitigated post-endodontic pain (80%) when compared with the Control-Group (61.4%). In 2023, Swayangprabha Sarangi et al.7 reported that the cryotherapy is very effective in reducing postoperative pain, discomfort, and inflammation associated with vital pulp tissue management. In 2024, Shah VR et al.38 suggested a highly statistically significant difference between the normal saline and cryotherapy groups at an interval of 24 and 48 hrs. Thus, cold saline is clinically more effective in reducing postoperative pain in patients with symptomatic irreversible pulpitis at an interval of 24 and 48 hrs. than normal saline. Ingale PC et al.39 also stated that endodontic cryotherapy using cold saline irrigation shows significant efficacy in reducing post‑treatment pain after single‑visit root canal treatment 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 that cryotherapy helped in pain reduction whether used with chlorhexidine or normal saline. Chlorhexidine used as a cryo material showed insignificant trend toward effective time dependent pain reduction as compared to normal saline. This might be because of its substantivity. Pupneja, et al.41 supported the use of cryotherapy by stating that the use of analgesics was more in the control group as compared to cryotherapy groups and suggested that the cryotherapy is a cheap and practical alternative to control postoperative pain. Al Bast, Amena and Abiad, Roula S.42 reported that final irrigation by cold saline at 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***

Its application is limited to the resolution of apical periodontitis only. 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

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