Journal Homepage: - www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI: 10.21474/IJAR01/19701
DOI URL: http://dx.doi.org/10.21474/IJAR01/19701

RESEARCH ARTICLE

THE IMPACT AND ROLE OF CRYOTHERAPY IN ENDODONTIC PROCEDURES

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Manuscript Info

Manuscript History
Received: 23 August 2024
Final Accepted: 25 September 2024
Published: October 2024

Key words:-
Cryotherapy, Cold Application, Post - Endodontic Pain, Rotary Endodontics Niti-Files

Abstract

In the fields of medicine and dentistry, Cryotherapy is an effective method to relieve edema, pain, bleeding and inflammation. Cryotherapy has been used extensively in dentistry to treat pain after intraoral surgery. The objective of this paper is to study how cryotherapy is used in endodontics in relieving and preventing post-endodontic pain in clinical procedure, effect on root canal irrigation, vital pulp therapy, to improve the cutting efficacy of Ni-Ti rotary endodontic instruments, to increase the success rateof Inferior alveolar nerve block.

Introduction:-

The essential step in root canal therapy is to prevent and relieve post-endodontic pain. According to Hargreaves and Hutter (1), this excruciating state is predictable, particularly in teeth that have symptomatic apical periodontitis, pulp necrosis, and preoperative pain and discomfort.

Previous studies have shown that pulp therapy and Pulp space therapy causes more severe postoperative pain compared to other dental operating treatments(2). Between 3-58% of patients experience pain both during and after endodontic therapy (3).

Since one of the main causes for tooth extraction is prolonged discomfort following root canal therapy, management of post-endodontic pain is a main problem for dentist(4). A number of methods have been demonstrated to be effective in managing pain during endodontic treatment, such as occlusal reduction (5), long-acting anesthetic delivery (6), prophylactic analgesic and corticosteroid premedication prior to endodontic treatment (7).

A network meta-analysis on the effectiveness of oral premedication determined that effectiveness of nonsteroidal anti-inflammatory drugs was less forreducing pain after a nonsurgical root canal procedure, based on the evidence(8).

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Furthermore, there is a higher chance of side effects, such as gastrointestinal distress and other systemic side effects, while using NSAID. Concurrently, conflicting results have been observed regarding the efficiency of intracanal medication and occlusal reduction in lowering postoperative pain after root canal therapy. Concurrently, there are contradictory findings on the effectiveness of occlusal reduction and intracanal medicine in reducing pain following root canal procedure (9).

Cryotherapy was investigated by Felho et al. as a potential treatment for trismus, pain, and swelling in the dental field. They concluded that while there was a statistically significant improvement in lowering pain and swelling, but no significance reduction in trismus (10). According to Bleakley, cold therapy appeared to be effective in lowering pain and inflammation in the short term (11).

Cryotherapy:

The terms cryotherapy is derived from the Greek word cryos, meaning “cold and “therapeia” denoting “cure” (12). Despite referring to the local or general application of low temperatures in medical therapy, it really includes the extraction of heat (13) as opposed to the application of cold.

James Arnott was the first to record and test this freezing method in 1851 by utilizing a mixture of salt and ice in malignant disease (14), while the ancient Egyptians were the first to use cold to cure injuries and reduce inflammation (the earliest reports date back to 3000 BCE).

According to clinical and physiological evidence, applying cold through a variety of techniques, such as direct application of ice, ice chips, melted ice water, ice massage, coolant sprays, whirlpools, ice baths, or a pre-packaged chemical ice pack at the site of injury, can reduce the conduction velocity of nerve signals, hemorrhage, edema, and local inflammation (15). As a result, it is effective in reducing muscular spasm, pain, and distension of connective tissue (16).

In the past, it has mostly been used to treat lower back pain, tendonitis, sprains, sports injuries, and arthritic pain and swelling (17). The duration of recovery following short-term abdominal, gynecological, and hernia surgeries (18). Moreover, dysplastic tissue has been destroyed with it. For this reason, the National Cancer Institute called it cryosurgery(19).

Cryotherapy has been used in dentistry after intraoral excisional surgical procedures, periodontal surgery, extractions, and implant implantation (10) and has demonstrated beneficial effects in lowering discomfort, edema, and arthritis related to temporomandibular joint diseases. Endodontics uses cryotherapy to lessen pain and inflammation prior to, during, and after vital pulp therapy following nerve blocks, periradicular procedures, and root canal treatment.

In order to lessen the possibility of file separation, rotary endodontic files with improved cyclic fatigue resistance benefit greatly from cryogenic treatment. Furthermore, it significantly enhances the superelasticNiTi endodontic file's cutting efficiency. When used in conjunction with bioceramic materials, cryotherapy has recently shown promise as a supplement to hemostasis in vital pulp therapy (20). The idea of cryotherapy, its physiological effects and mechanism, and its numerous endodontic uses are all covered in this page.

Physiological Effect of Cryotherapy

Three fundamental physiological reactions occur when heat or cold is applied:

1. vascular responses
2. neuronal responses
3. a rise or fall in cellular metabolic activity (21).

For example, the first reaction is vasoconstriction, which is followed by cool-induced vasodilatation if tissue is exposed to a lower temperature for more than fifteen minutes (22). The histamine-like chemical "H" is the source of this vasodilation. The phrase "hunting response" describes this continuous, repetitive cycle of vasodilation and constriction.

Similarly, Van't Hoff's law states that by limiting metabolic reactivity, cryotherapy causes vasoconstriction and impedes cellular metabolism. In turn, this reduces the need for oxygen and the generation of free radicals, limiting the extent of tissue damage (23).

Antiedema effects are produced by vasoconstriction, and pain relief follows temperature drop due to a blockage of nerve terminals caused by the cold application. Fluid leakage periapically is the most frequent issue that arises during biomechanical preparation. Because vasoconstriction reduces permeability, which limits tissue edema and swelling, it plays a crucial role in reducing pain (20).

By activating thermoreceptors with temperature-sensitive nerve endings, cryotherapy prevents nociception from entering the spinal cord. Cooling reduces the speed at which nerve impulses travel, resulting in analgesia. However, according to Franz and Iggo's et al., myelinated A-delta fibers totally deactivate at around 7°C, but non-myelinated C-fibers deactivate at about 3°C. This impact is more noticeable in myelinated nerve fibers (A-delta fibers) than in unmyelinated fibers (C fibers (24).

As a neurological reflex brought on by the blood vessels' adrenergic components, vasoconstriction comes after vasodilation and reduces vascular permeability, which pulls the cell wall together (25). Analgesia's neurologic effect is directly correlated with the nociceptive sensory nerve fibers' nerve conduction velocity (26).

Applying cold can cause analgesia by inducing the release of neuroeffective agents like endorphins (27). By binding to opioid receptors in the medullary dorsal horn, endorphins prevent nociceptive impulses from reaching the central nervous system.

Furthermore, applying cold may lower the threshold at which tissue nociceptors—specialized nerve endings that become active following tissue damage—activate, producing a local anesthetic effect known as "coldinduced neuropraxia" (23).

Cryotherapy's Impact on Root Canal Irrigation

Cryotherapy was first used in root canal irrigation by Vera et al. in 2015. They used Endovac (Kerrdental, KerrHawe SA, Bioggio, Switzerland) in conjunction with a final rinse at 2.50 C for five minutes of application time, and they measured the temperature change of the extracted teeth's external root surface. Based on their observations, a 4-minute duration of a drop in temperature of more than 100C may be sufficient to cause an anti-inflammatory effect in the periradicular tissues (29).

In order to determine the extent of post-endodontic pain and evaluate the effects of utilizing either room-temperature or cold normal saline as a final irrigation, Al-Nahlawi et al. According to the study, final rinsing the canal with saline at room temperature or cold was the most effective method of managing post-endodontic discomfort(30).

The impact of a final irrigation of 2.5°C cold saline on postoperative pain after a single-visit root canal procedure for teeth with vital pulp was assessed in another study by Keskin et al. (2017). The results of the study indicate that, in comparison to the control group, postoperative discomfort might be considerably reduced by employing 2.5°C cold saline irrigation as a final irrigant (31).

Gundogdu et al. evaluated the impact of intracanal, intraoral, and extraoral cryotherapy on postoperative pain in molar teeth with apical periodontitis symptoms(32). In comparison to the control group, all cryotherapy administrations led to decreased VAS scores for pain during percussion and lower levels of postoperative pain.

Forty individuals who had either irreversible pulpitis with apical periodontitis or irreversible pulpitis and asymtomatic apical periodontitis participated in a randomized control trial by Duaa S. Bazaid et al.The study concludes that intracanal cryotherapy is useful in lowering postoperative pain in patients with apical periodontitis and irreversible pulpitis. However, patients with irreversiblepulpitis and asymtomatic apical periodontitis are not affected(33).

In a study, Emad et al. investigated aimed to evaluate how intracanal cryotherapy affected the expression of interleukin-6 (IL-6) and postendodontic discomfort in patient with symptomatic apical periodontitis. The research

findings indicate that intracanal cryotherapy led to a decrease in postoperative pain levels and IL-6 expression in comparison to the control group (34)

Jain and colleagues (35) assess the impact of cryotherapy on post-operative pain (POP) in patients on mandibular premolar after endodontic treatment diagnosed symptomatic irreversible pulpitis with asymptomatic apical periodontitis.The results of the study indicate that the frequency and intensity of post-endodontic discomfort following endodontic treatment are reduced when cold saline solution is used as the final irrigant.

Cryotherapy's Impact on vital pulp therapy

The pulpal tissue and the entire tooth are then covered with shaved sterile water ice (0°C) either directly or indirectly. The exposed or indirectly exposed pulp should be rinsed with a 17% EDTA solution for one minute after the melted sterile ice has been removed. (36)

For stimulating secretion of matrix, differentiation of odontoblast, and formation of tertiary dentin, EDTA solution is a better choice than sodium hypochlorite since it has been shown to release bioactive growth factors from the dentin. Dental pulp stem cells will adhere, migrate, and differentiate more readily when the dentin is treated with EDTA.

According to a study by Finnegan et al., (37)EDTA stimulates anti-inflammatory, antioxidant responses and also antimicrobial effect. Lastly, a bioceramic material and permanent restoration were used to seal the exposed site. In 2 weeks, the treated teeth started to show no symptoms, and for the next 12 - 8 months, they remained vital, functional, and asymptomatic (38).

Impact of Cryotherapy on Endodontic Instruments

To increase the rotary file's wear resistance, cyclic fatigue resistance, and cutting efficiency, a variety of surface treatment techniques have been suggested which includes boron ion implantation (39)thermal nitridation (40), physical vapor deposition of titanium nitride (41), electropolishing, and cryogenic treatment. Cryogenic treatment (CT), which involves treating materials to extremely low temperatures, has an impact on the metal's entire cross-section as opposed to simply its surface (42).

The temperature of the treatment has been found to distinguish between shallow and deep CT (43). Shallow temperatures of roughly -80°C have been used to evaluate conventional subzero treatments. However, the tool life is extended even at lower temperatures (deep), such as those generated by liquid nitrogen at -185°C and -196°C (44). When the material is immersed in liquid nitrogen, the process is considered wet. Instead of submerging the material, a dry procedure keeps it above the liquid nitrogen level.

The cutting effectiveness and wear resistance of endodontic hand instruments made of stainless steel that had undergone cryogenically treated treatment did not improve. Conversely, NiTi K-files' microhardness increased as a result of deep wet CT(45).

Numerous methods have been put forth to show that characteristics improve following cryogenic treatment. Among these is

(1) a reaction between titanium and nitrogen atoms that forms titanium nitride on the surface.

(2) Lattice strain is caused by the deposition of nitrogen atoms into the interstitial spaces inside the NiTi alloy's atomic lattice (46)

(3) a more complete martensitic transition from the NiTi alloy's austenite phase.

In a study by Vinothkumar et al., the impact of cryogenic therapy on nickel-titanium endodontic instruments was examined the results showed that deep dry cryogenic treatment considerably improves cutting efficiency but not wear resistance. (47)

Yazdizadeh et al. (48) assessed how cryogenic treatment (CT) enhanced endodontic rotary instrument resistance to cyclic fatigue. According to the study's findings, the assessed rotary files' resistance to cyclic fatigue was not enhanced by Deep CT.

Effect of Cryotherapy as Local Anesthetic

The most popular injectable method for achieving pulpal anesthesia in mandibular teeth is inferior alveolar nerve block. But it has a high failure rate, especially in sufferers with irreversible pulpitis(49).

Topçuoglu at al study concluded that use of Preoperative Intraoral cryotherapy expanded the anesthetic efficancy of IANBs in mandibular molar tooth with SIP ,However, supplemental anesthesia techniques may still be required to provide profound pulpal anesthesia in many cases.(50)

Thirty patients were chosen for the study by Gupta et al., and three groups were created; Group 1 (control group) received inferior alveolar nerve block (IANB) with lignocaine (2%) and adrenaline; Group 2 (IANB+small ice pack) received inferior alveolar nerve block with lignocaine (2%) and adrenaline plus small ice packs (packed in sterile gauze); and Group 3 (IANB+Endo Ice) received inferior alveolar nerve block with lignocaine (2%) and adrenaline plus Endo Ice. In mandibular molar teeth with SIP, both intraoral cryotherapy procedures demonstrated enhanced pain relief and a higher success rate for IANBs.

According to the results, cryotherapy may therefore be a helpful supplement to anesthesia in endodontic operations.(51)

Cryotherapy's antibacterial effectiveness against Enterococcus faecalis

In order to evaluate the antibacterial capabilities of cryotherapy in conjunction with 5% NaOCl against E. faecalis, Mandras et al. (52). Using a cooling needle to receive the liquid nitrogen, a dental equipment with a duct and liquid nitrogen (cryogenic liquid) was subjected to cryogenic treatment. They concluded thatthe E. faecalis in the root canal is significantly reduced when the cryo-treated instrument is used in conjunction with irrigation with sodium hypochlorite. Hence, employing regular NaOCl as the final irrigant, cryotreatment supposedly reduces the microorganism

Conclusion:-

In single sitting RCT cases, intracanal cryotherapy might be viewed as an easy, affordable, and safer choice for controlling postoperative discomfort and pain. One novel and promising technique that may be used for multiple purposes like increasing the efficacy of local anesthesia in inferior alveolar nerve block,lowering the root surface temperature, inhibiting Enterococcus faecalis and enhancing the cutting efficiency and wear resistance of Ni-Ti rotary instruments. Additionally, it has demonstrated the ability of cryotherapy to manage pulpal hemorrhage in case of vital pulp therapy. However, more research is needed to offer convincing evidence of its beneficial effects in the field of endodontics.

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