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Cryotherapy: An Emerging Trend in the Field of Endodontics

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Review Article
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ABSTRACT

The field of endodontics is constantly evolving and changing to deliver the best possible treatment for the patient. There is a constant outlook for new and emerging therapies to make patient's experience and dentist's work as comfortable as possible. Cryotherapy is a long-standing approach that has been applied in various fields including endodontics. This review outlines the various application of cryotherapy in endodontics and also emphasizes the need for more research in this therapy in order to avail of the possible benefits of this technique in the treatment of other pulpal and periradicular diseases.

Keywords: Cryotherapy, Postoperative Endodontic Pain, Vital Pulp Therapy, Endodontic Instruments.

Introduction

Post endodontic pain (PEP) management and prevention is an integral part of endodontic treatment. Attempts to acquaint the patient with post-operative pain (PEP) and prescribing medications to control it can increase patient confidence in their dentists, increase patients' pain threshold, and ameliorate their attitude towards further dental treatment.[1,2] According to previously published data root canal treatment (RCT) and, pulp therapy cause more severe and frequent postoperative pain when compared to other dental operative procedure.[3,4]

Elimination of micro-organisms from the infected root canal system by an adequate chemo-mechanical debridement followed by three-dimensional obturation to accomplish a hermetic seal, thereby to provide a favorable environment for periradicular healing is the main rationale of endodontic treatment. However, some patients experience pain or flare-ups following the treatment, in spite of performing root canal therapy with utmost care.[5] Remnants of microorganisms is the main cause of cause for post endodontic pain.[6] Endodontic irrigation, endodontic sealer, guttapercha, and intracanal medication are all factors that can provoke postendodontic pain.[7] The incidence of this post endodontic pain (PEP) was reported to range from 3 - 58%.[8]

Hypothetical mechanisms that may be responsible for swelling and/or pain during endodontic therapy have been presented by many authors. These include chemical, mechanical or microbial injury to the periradicular tissue.[9]

Premedication with prophylactic analgesics and corticosteroids prior to endodontic treatment, occlusal reduction, and administration of long-lasting anaesthesia, are some of the strategies which have been developed for post endodontic pain management.[10,12] Felho et al. 2005 investigated the use of cryotherapy in the dental field in reducing pain, swelling, and trismus. They concluded that there was no significant decrease in trismus, while there was a significant statistical difference in reducing the swelling and pain.[13]

Cryotherapy: The word cryotherapy is originated from the Greek word cryos, meaning "cold.' In physiotherapy, it means lowering or decreasing the temperature of tissues for therapeutic purposes. In reality, cryotherapy does not implicit of implementing cold but rather extracting heat.[14-15] Cryotherapy has been reported to be effective at reducing oedema, pain, inflammation, and recovery time with short term applications in orthopaedic, abdominal, gynaecological and hernia operations.[14,16] In cryotherapy biophysical alterations in the tissues and the magnitude of the temperature change depends on the difference between the application of cold or heat, exposure time, the thermal conductivity of the tissues, and the temperature of the object and type of agent used to apply the heat or cold.[17] An ice pack, gel pack, ice chips, melted ice water, ice massage, prepackaged chemical ice pack, and ice in a washcloth are the modes of cold application.[18] Clinical and physiological evidence suggests that a decrease in the conduction velocity of nerve signals, hemorrhage, edema, and local inflammation can be achieved by applying cold through various methods and is therefore effective in the reduction of musculoskeletal pain, muscular spasm, and connective tissue distension.[14,15]

The Basic Physiological Responses Following the Application of Either Heat or Cold Are:

(i) Increase or decrease in local blood flow, (ii) Stimulation or inhibition of neural receptors in the skin and subcutaneous tissues, and (iii) an increase or decrease in cellular metabolic activity.[16]

According to Van't Hoff's law, cryotherapy causes vasoconstriction and slows down cellular metabolism by limiting biochemical reactions which minimize the degree of tissue damage, thereby reducing the oxygen demand of cells and limiting the production of free radicals in tissues. Vasoconstriction produces antiedema effects, and pain reduction is achieved after temperature reduction because of a blockade of the nerve endings resulted from the cold application.[15,16] The intensity of the vasoconstriction effect reaches the highest value at a temperature of 15°C and it has been reported that lowering the body temperature decreases peripheral nerve conduction, and in particular, when it reaches about 7°C there is complete deactivation of myelinated A-δ fibres whereas deactivation of nonmyelinated C-fibre occurs at about 3°C, as proved by Franz and Iggo.[14]

Effect of Cryotherapy in Root Canal Irrigation

In dentistry, a cold application has been frequently employed for postoperative pain control following intraoral surgical procedures. Vera et at were the first to enlighten on cryotherapy in endodontics. They used a final rinse with 2.50 C cold saline combined with Endovac (Kerrdental, KerrHawe SA, Bioggio, Switzerland) for 5 minutes of application time and measure the change in temperature of the external root surface of extracted teeth.[16] They concluded that a reduction of more than 100C in the external root surface temperature sustained for 4 minutes which may be enough to produce a local anti-inflammatory effect in the periradicular tissues.[19] Another study conducted by CangulKeskin et al where the effect of 2.5°C cold saline irrigation as final irrigant on postoperative pain after single-visit root canal treatment of teeth with vital pulps was done, but they used a side-vented, positive-pressure 31-G NaviTip needle (South Jordan, Utah) instead of negative apical pressure to negate its additional effect on reducing postoperative pain, it also concluded that cryotherapy reduced postoperative pain following single-visit root canal treatment in teeth with vital pulps and suggest the use of cryotherapy for postoperative pain control in single visit root canal treatment.[20] A study was done by Al-Nahlawi., et al.indicated that the use of intracanal cryotherapy technique with negative pressure irrigation eliminates postendodontic pain after single-visit RCTs.[21] However, A. A. Alharthi et al. reported that the final flushing of the canal with saline either cold or at room temperature was effective for post-endodontic pain control.[22]

Duaa S. Bazaid et al studied the effect of cryotherapy on reducing postoperative pain was compared in irreversible pulpitis with and without apical periodontitis It was seen that cold saline used as a final rinse using a 27-G side vented needle had an effect on reduction of postoperative pain degree in patients with irreversible pulpitis with apical periodontitis. But it does not affect patients with irreversible pulpitis without apical periodontitis.[23]

Effect of Cryotherapy in Vital Pulp Therapy

Vital pulp cryotherapy is the placement of sterile shaved ice on vital pulpal tissue that has been directly or indirectly exposed by a carious lesion. Recently vital pulp cryotherapy has been used in order to control pulpal bleeding. Shaved sterile water ice (0°C) was placed over the direct or the indirect exposure of the pulpal tissue along with the entire tooth. The shaved sterile water ice was produced by the freezing of sterile water and was then placed it in an ice shaving device. After approximately 1 minute, it was removed with a high-speed suction, following the removal of melted ice the exposed area was rinsed with 17% EDTA.[24] EDTA irrigation should be preferred instead of sodium hypochlorite as EDTA has shown to release a number of growth factors that promote matrix secretion, odontoblastic differentiation, and tertiary formation. Apart from this it promotes also promote the adhesion, migration, and differentiation of dental pulp stem cells.[25,26] After the exposed or indirect exposed pulp was treated with shaved sterile ice and EDTA, it was then covered with a bioceramic material followed by, a permanent restoration. The treated teeth became asymptomatic after 2 weeks after 12–18 months follow up the tooth remained vital, asymptomatic, and functional.[24] However, more studies are required in order to determine the long term results of this therapy.

Effect of Cryotherapy on Endodontic Instruments

Historically, In order to improve the surface hardness and thermal stability of the metal cryogenic treatment of metal during manufacture had been advocated.[27] It is a supplementary procedure of subjecting superelastic NiTi and stainless steel to subzero temperatures and then allowing the metal to slowly warm to room temperature.[28,30] It has been classified depending upon the treatment temperature into shallow cryogenic treatment and deep cryogenic treatment.[31] Deep cryogenic treatment is more advantageous when compared to traditional shallow cryogenic treatment.[32,33]

Bramipour et al investigated cryogenic treatment on stainless steel endodontic instruments found no effect of cryogenic treatment on the precutting efficiency and post treatment efficacy of stainless steel endodontic instruments and concluded that cryogenic treatment did not affect the wear resistance of the files.[34] SimilarlyBerls also didn't find difference in the wear resistance of stainless steel hand file.[35]

Kim et al conducted a study to investigate the effect of cryogenic treatment on NiTi endodontic instruments. They found that cryogenic treatment to endodontic NiTi files had increased microhardness, however this increase was not clinically detected in terms of cutting efficiency.[36] In contrast to this study Vinothkumar et al reported significant increase in the cutting efficiency without affecting the wear resistance on cryogenic treatment of super elastic NiTi files.[37] This difference may be due to the method and timing of cryogenic treatment. In the later dry deep cryogenic treatment was given for 24 hours, unlike in former where instruments were totally immersed for 10 minutes in liquid nitrogen.[38]

Supplementary cryogenic treatment was performed in an attempt to increase the volume of martensite and increase cyclic fatigue resistance and cutting efficiency of new martensitic shape memory (SM) nickel-titanium (NiTi) alloy, especially for smaller-size instruments. It was seen that DCThad drastically increased the cyclic fatigue resistance with a 24-hour soaking time by 13% and with a 6-hour soaking time only 1%. Nonetheless, the soaking time did not similarly influence cutting efficiency.[39]

Effect of Cryotherapy as Local Anesthetic

An inferior alveolar nerve block (IANB) is the standardized injection technique used for achieving regional anesthesia for mandibular molar teeth. However, an IANB does not always result in successful pulpal anesthesia, especially in patients with symptomatic irreversible pulpitis (SIP).[40] Preoperative intraoral cryotherapy application after an IANB did not provide profound pulpal anesthesia for about 45% of mandibular molars with SIP. However, intraoral cryotherapy might be preferred as a simple and cheap auxiliary application to increase the success rate of IANBs in patients with SIP.[41] Nociceptors are stimulated by various chemical mediators, and this stimulation may result in pain. Cryotherapy slows down neural signals and reduces the release of the chemical mediators that are responsible for pain conduction. Cryotherapy also induces a local anesthetic effect by lowering the activation threshold of nociceptors and the conduction velocity of pain signals.[42]

Conclusion: Intracanal cryotherapy can be considered as a simple, cost-effective, and non-toxic therapeutic treatment option for postoperative pain control in single visit RCT cases. However, numerous research studies should be conducted in the near future to investigate the possible benefits of this technique in the treatment of other pulpal and periradicular diseases. Cryotherapy is an innovative and promising method that can be considered to reduce, swelling, discomfort, and post-operative pain encountered after endodontic treatment and surgeries. It has also shown the potential to control pulpal bleeding in the case of vital pulp therapy. However further studies are required to provide strong evidence to prove its therapeutic effect in the field of endodontics.

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