International Journal of Dental Sciences
www.dentaljournal.in
E-ISSN: 2663-4708, P-ISSN: 2663-4694
Received Date: 28-07-2020 Accepted Date: 14-08-2020; published: 28-08-2020
Volume 2; Issue 3; 2020; Page No. 15-17

Cryotherapy and its applications in endodontics

Dhanya Valsan
Department of Conservative Dentistry and Endodontics, Sree Anjaneya Institute of Dental Sciences, Calicut, Kerala, India

Abstract
Cryotherapy is a simple therapeutic procedure that has been successfully used for many years, in medicine and dentistry. The use of cryotherapy in the field of endodontics appears to be promising and there is the need for more research in this area to avail all the possible benefits of this technique. This article discusses the concept of cryotherapy, its physiologic responses and various applications in the field of endodontics.

Keywords: cryotherapy, postoperative endodontic pain, endodontics, vital pulp therapy

Introduction

Cryotherapy is a therapeutic procedure commonly used in medicine and dentistry, reported to be effective at reducing oedema, pain, hemorrhage and inflammation. The term cryotherapy is derived from the Greek word "cryos" denoting "cold" [1]. The concept of cryotherapy refers to lowering or decreasing the tissue temperature for treatment purpose [2, 3]. The local application of low temperature was probably first used as a means of analgesia by the ancient Egyptians. James Arnott in 1851 was the first to report and demonstrate this freezing therapy by using a mixture of salt and ice to destroy cancerous growths [4].

Cryotherapy has been recommended after physical injuries and various surgical procedures [5, 6]. Also referred to as cryosurgery in medicine, it has been used to destroy dysplastic tissue by freezing and re-thawing process. Cryosurgery could also be used to produce an extended, but reversible, nerve block in the management of intractable facial pain. This clinical application of cryosurgery is known as cryoneurotomy, and is used for the treatment of intractable neurogenic pain in the pre-auricular region [7].

In dentistry, cryotherapy has been used after intraoral excisional surgery, periodontal surgery, after extractions and implant placement and was found to be effective in reducing swelling, pain, and discomfort [3, 8]. Ice pack, gel pack, ice chips, melted ice water, ice massage, prepackaged chemical ice pack, and ice in a washcloth are the various modes of cold application or rather heat abstraction [9]. Cryotherapy is also used in the field of endodontics, mainly to reduce the post-operative pain and inflammation.

Physiological Effects of Cryotherapy

The basic physiological responses after cryotherapy are i) temperature change ii) vascular -increase or decrease in local blood flow, ii) neurologic- stimulation or inhibition of neural receptors in the skin and iii) tissue metabolism- an increase or decrease in cellular metabolic activity [3, 10].

The temperature change, works on the principle of conduction and following the same principle, deeper structures lose heat to more superficial tissues that were cooled. Hence cryotherapy actually does not imply cooling the target tissue but rather extracting heat from the tissue of higher temperature to the subject of lower temperature [2]. The amount of temperature change in treated areas depends on various factors like differences in temperature between the tissue and the cold agent, size and shape of the cold pack (how well it conforms to the tissue), duration of cold, tissue thickness, anatomic location of intended cryotherapy, and mode of therapy [9, 11]. Thermal conductivity of the region being treated also affects the results.

On exposure to a reduced temperature longer than 15 minutes cryotherapy results in vasoconstriction of blood vessels. This initial vasoconstriction is followed by cold-induced vasodilatation [9]. This cycle of vasoconstriction and vasodilation is known as the "hunting response [10]. Vasoconstriction decreases vascular permeability, which reduces the amount of fluid leaking into periradicular tissue as exudate or transudate, thereby, reducing tissue edema and swelling [9].

Pain reduction after temperature reduction occurs because cooling induces analgesia by slowing the velocity of nerve conduction [3]. According to Franz and Iggo, the myelinated nerve fibers (A-delta fibers) is completely deactivated at about 7○C, whereas the unmyelinated fibers (C fibers) is completely deactivated at about 3○C [11]. It is also presumed that gate control theory is responsible for the analgesic effect of cryotherapy by providing a faster sensory input by the larger myelinated A fibers to temporary close the gate and impede the transmission of the more painful impulses of the unmyelinated C fibers [3, 12]. Cold application may also induce analgesia by stimulating the release of neuroeffective agents such as endorphins. Endorphins bind to opioid receptors in the medullary dorsal horn, thus inhibiting nociceptive transmission of impulses to the central nervous

system [3]. Thus, the analgesic effect of cooling is produced by a combination of a decreased release of chemical mediators of pain and a slower propagation of neural pain signals.

Cryotherapy decreases tissue blood flow and cell metabolism by more than 50%. This slows down the rate of 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 and prevents tissue hypoxia and further tissue injury [3, 15].

Applications of Cryotherapy in Endodontics

1. Post-operative pain

Pain is the major reason for patients' visits to dental clinics and pain control is a challenging clinical situation. Some dental treatments may result in postoperative pain causing patient discomfort. Postendodontic pain is a common, unpleasant situation that occurs even when the endodontist has followed acceptable standards of treatment. The incidence of this post endodontic pain (PEP) was reported to range from 3 - 58% and is found to occur especially in teeth with preoperative pain and/or pulp necrosis [13]. Therefore, management of postoperative pain is crucial in endodontic practice.

Periapical tissue inflammation is one of the major causes of postoperative pain. Post endodontic pain can be affected by multitude of factors like condition of pulpal and periapical tissues, presence of periapical radiolucency, preoperative pain, microbial factors etc [11, 14, 15]. Inadequate root canal instrumentation, hyper-occlusion, missed canals, extrusion of apical debris all can contribute to PEP [16]. Irrigants, guttapercha, endodontic sealer, and intra canal medication are other factors that can cause irritation and post-endodontic pain [17].

Post endodontic pain can be prevented by correct working length determination, proper biomechanical preparation, judicious selection and optimum use of intracanal irrigants [10]. The use of magnifying loupes and endodontic microscopes enables to perform endodontic procedures with utmost precision, thereby improving the outcomes [18]. Long-lasting anesthesia, occlusal reduction, use of a negative apical pressure irrigation device, can also result in a significant reduction of post endodontic pain levels [19, 20]. Another approach to pain control is prescribing medications (prophylactic analgesics and corticosteroids) either preoperatively to achieve pre-emptive analgesia or postoperatively. Lasers and cryotherapy also have been suggested to avoid post endodontic pain [3].

In endodontic literature, only a few studies have investigated the use of intracanal cryotherapy. Vera *et al.* reported in an in vitro study that, cold saline solution (2.5°C) when employed as a final irrigant for 5 mins resulted in more than 10°C reduction of external root surface temperature sustained for 4 mins, which may be enough to produce a local anti-inflammatory effect in periradicular tissues [21].

C Keskin, *et al.* (2016) assessed the effect of 2.5°C cold saline irrigation as a final irrigant following biomechanical preparation of root canals and found that the use of intra canal cryotherapy reduced the postoperative pain after single visit root canal treatment in patients with irreversible pulpitis [22]. Another study reported that cryotherapy reduced postoperative pain after single-visit root canal treatment in teeth with vital pulps [23].

Al-Nahlawi, *et al* (2016), evaluated the effects of intracanal cryotherapy and negative pressure irrigation (Endo Vac) on postoperative pain after vital single visit RCT and the authors concluded that clinically intracanal cryotherapy eliminated postoperative pain and negative pressure improved its effect [23].

The effect of cryotherapy on reducing postoperative pain was compared in irreversible pulpitis with and without apical periodontitis. The results revealed that cryotherapy only made a difference in patients diagnosed with apical periodontitis, whereas in patients with only irreversible pulpitis, there was no significant difference in the incidence of postoperative pain between the cryotherapy group and the control group [24]. Alharthi *et al* reported the ineffectiveness of cryotherapy in previously asymptomatic cases without periapical pathosis [25].

2. Vital pulp therapy

There is lack of adequate information in the endodontic literature regarding the use of cryotherapy in vital pulp therapy. Recently, cryotherapy has been reported to be applied for the control of pulpal hemorrhage in direct pulp capping. Shaved sterile water ice (0○C) was applied directly to exposed pulp tissue and the entire tooth surface for the duration of 1 minute and then removed by high speed suction and irrigated with 17% EDTA for 1 minute. EDTA solution was used in place of sodium hypochlorite, as it has been shown to release bioactive growth factors from the dentin, thus stimulating matrix secretion, odontoblast differentiation, and tertiary dentin formation. EDTA also promotes the adhesion, migration, and differentiation of dental pulp stem cells, whereas sodium hypochlorite can kill the dental pulpal stem. This was followed by sealing of the site of exposure with a bioceramic material and placing permanent restoration. The treated teeth became asymptomatic after 2 weeks and remained asymptomatic, vital, and functional over a follow-up period of 12–18 months [26]. More clinical studies are however required to determine the long-term prognosis of vital pulp cryotherapy.

3. Nerve block

The effect of preoperative intraoral cryotherapy application on the success rate of inferior alveolar nerve blocks were studied by Topcuoglu *et al*. [27]. They concluded that intraoral cryotherapy increased the potency of inferior alveolar nerve blocks, especially in teeth with symptomatic irreversible pulpitis, however, supplemental anesthesia techniques may still be required to provide pulpal anesthesia in many cases.

4. Cryotherapy of Endodontic Instruments

The separation of endodontic rotary instruments in the canal without any warning is a challenging clinical situation. Cryogenic treatment of metals during manufacture had been advocated since very long time for improving the surface hardness and thermal stability of the metals [3, 28]. It has been classified depending upon the treatment temperature into shallow cryogenic treatment and deep cryogenic treatment [29]. The deep cryogenic treatment is considered to be more advantageous when compared to traditional shallow cryogenic treatment due to its increased cutting efficiency, overall strength of the metal and release of internal stresses of alloy. Moreover, unlike surface treatment techniques, cryogenic treatment affects the entire cross section of the metal rather than only the surface. Hence, cryogenic treatment might be useful for strengthening rotary endodontic files [3]. However, further studies have to be conducted to clarify its effects.

Conclusion

In the endodontic literature, cryotherapy is regarded as a simple, effective therapeutic procedure that can used for reducing postoperative pain, edema encountered after endodontic treatment and for controlling haemorrhage during vital pulp therapy. However further studies are required to provide strong evidence to prove the benefits of this technique in the field of endodontics.

References

1. Vera J, Ochoa-Rivera J, Vazquez-Carcaño M, Romero M, Arias A, Sleiman P. Effect of intracanal cryotherapy on reducing root surface temperature. J Endod. 2015; 41:1884-1887.
2. Belitsky RB, Odam SJ, Hubley–Kozey C. Evaluation of the effectiveness of wet ice, dry ice, and cryogen packs in reducing skin temperature. Phys Ther. 1987; 67:1080-4.
3. Fayyad DM, Abdelsalam N, Hashem N. Cryotherapy: A New Paradigm of Treatment in Endodontics. J Endod. 2020; 46(7):936-942.
4. Nayeema S, Subha DR. Cryotherapy–a novel treatment modality in oral lesions. Int JPharm Pharm Sci. 2013; 5:4-5.
5. McMaster WC. A literary review on ice therapy in injuries. Am J Sports Med. 1977; 5:124-126.
6. Olson JE, Stravino VD. A review of cryotherapy. Phys Ther. 1972; 52:840-853.
7. Bansal A, Jain S, Gupta S. Cryosurgery in the treatment of oro-facial lesions. Indian J Dent Res. 2012; 23(2):297.
8. Laureano Filho JR, de Oliveira e Silva ED, Batista C, Gouveia FM. The influence of cryotherapy on reduction of swelling, pain and trismus after third molar extraction. J Am Dent Assoc. 2005; 136:774-8.
9. Gary Greenstein: Therapeutic efficacy of cold therapy after intra oral surgical procedures: A literature Review. J. Periodontol. 2007; 78:790-800.
10. Saravana Karthikeyan Balasubramanian and Divya Vinayachandran. "Cryotherapy"– A Panacea for Post-Operative Pain Following Endodontic Treatment". Acta Scientific Dental Sciences. 2017; 1:01-03.
11. Merrick MA, Jutte LS, Smith ME. Cold modalities with different thermodynamic properties produce different surface and intramuscular temperatures. J Athl Train. 2003; 38:28-33.
12. Salmassy DA, Pogrel MA. Liquid nitrogen cryosurgey and immediate bone grafting in the management of aggressive primary jaw lesions. J Oral Maxillofac Surg. 1995; 53:784-90.
13. Franz DN and Iggo A. "Conduction failure in myelinated and non-myelinated axons at low temperatures". The Journal of Physiology. 1992(1968):319-345.
14. Melzack R, Wall PD. Pain mechanisms: a new theory. Science. 1965; 150:971-9.
15. Sathorn C, *et al*. "The prevalence of postoperative pain and flare- up in single-visit and multiple-visit endodontic treatment: a systematic review". International Endodontic Journal. 2008; 41(2):91-99.
16. Ng YL, Glennon J, Setchell D, Gulabivala K. Prevalence Of And Factors Affecting Post-Obturation Pain In Patients Undergoing Root Canal Treatment. Int Endod J. 2004; 37:381-91
17. Ali A, Olivieri JG, Duran- Sindreu F, Abella F, Roig M, Garcia-Font M. Influence Of Preoperative Pain Intensity On Postoperative Pain After Root Canal Treatment: A Prospective Clinical Study. J Dent. 2016; 45:39-42.
18. Alves Vde O. Endodontic flare-ups: a prospective study. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2010; 110(5):e68-e72.
19. Siqueira JF Jr, Barnett F. Interappointment pain, mechanism diagnosis and treatment. 2004; 7(1):93-109.
20. Low JF, Dom TNM, Baharin SA. Magnification in endodontics: A review of its application and acceptance among dental practitioners. Eur J Dent. 2018; 12(4):610-616.
21. Parirokh M, Rekabi AR, Ashouri R, *et al*. Effect of occlusal reduction on postoperative pain in teeth with irreversible pulpitis and mild tenderness to percussion. J Endod. 2013; 39:1-5.
22. Al-Nahlawi T, Hatab TA, Alrazak MA, Al-Abdullah A. Effect of Intracanal Cryotherapy and Negative Irrigation Technique on Postendodontic Pain. J Contemp Dent Pract. 2016; 17(12):990-996.
23. Vera J, Ochoa-Rivera J, Vazquez-Carcaño M, Romero M, Arias A, Sleiman P, *et al*. Effect of Intracanal Cryotherapy on Reducing Root Surface Temperature. J Endod. 2015; 41(11):1884-1887.
24. Keskin C, Özdemir Ö, Uzun İ, Güler B. Effect of intracanal cryotherapy on pain after single-visit root canal treatment. Aust Endod J. 2017; 43(2):83-88.
25. Vieyra JP, Enriquez FJ, Acosta FO, Guardado JA. Reduction of post endodontic pain after one visit root canal treatment using three irrigating regimens with different temperature. Niger J Clin Pract. 2019; 22:34-40.
26. Bazaid DS, Kenawi LM. The effect of intracanal cryotherapy in reducing postoperative pain in patients with irreversible pulpitis: a randomized control trial. Int J Health Sci. 2018; 8:83-8.
27. Alharthi AA, Aljoudi MH, Almaliki MN, *et al*. Effect of intra-canal cryotherapy on post– endodontic pain in single-visit RCT: A randomized controlled trial. Saudi Dent J. 2019; 31:330-5.
28. Bahcall J, Johnson B, Xie Q, *et al*. Introduction to vital pulp cryotherapy. Endod Pract US. 2019; 1:14.
29. Topçuoglu HS, Arslan H, Topçuoglu G, Demirbuga S. The effect of cryotherapy application on the success rate of inferior alveolar nerve block in patients with symptomatic irreversible pulpitis. J Endod. 2019; 45:965-9.
30. Molinari A, Pellizzari M, Gialenella S, *et al*. Effect of deep cryogenic treatment on the mechanical properties of tool steels. J Mater Process Technol. 2001; 118:350-5.
31. Vinothkumar TS, Miglani R, Lakshminarayananan L. Influence of deep dry cryogenic treatment on cutting efficiency and wear resistance of nickel-titanium rotary endodontic instruments. J Endod. 2007; 33(11):1355-1358.