CRYOTHERAPY IN ENDODONTICS: A CRITICAL REVIEW

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ABSTRACT

In medicine, cryotherapy is used to destroy tissue of both benign and malignant lesions by the freezing and rethawing process. In dentistry, cold application has been frequently ,employed for postoperative pain control following intraoral surgical procedures. The purpose of this paper is to review the applications of cryotherapy in endodontics including its effects on post-endodontic pain, effectiveness against endodontic infections, hazardous effects on dentin and efficacy on cutting efficiency of Ni-Ti rotary instruments, etc.

Keywords: Root canal therapy, Enterococcus faecalis, cryotherapy, endodontic pain, successful local anaesthesia, fracture resistance, dentin, root surface temperature

INTRODUCTION

The term cryotherapy is derived from the Greek word cryos, meaning "cold." Although it refers to the local or general use of low temperatures in medical therapy, cryotherapy actually does not imply implementing cold but rather extracting heat. The magnitude of the change in temperature and biophysical alterations in the tissues depends upon the differences in the temperature of the object and the heat or cold application, exposure time, thermal conductivity of the tissues and type of heat or cold agents employed. The clinical implication of this type of therapy in human tissues causes changes in the host's local temperature.[1,2]

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MECHANISM OF ACTION OF CRYOTHERAPY

Cryotherapy is the use of extreme cold to freeze and remove abnormal tissue. It works by reducing the blood flow to a particular area, which can significantly decrease the inflammation degree and swelling that causes pain, especially around a tendon or a joint. It can temporarily reduce the activity of sensory nerve fibres that can also relieve the pain. When the body is vulnerable to extreme cooling, the blood vessels are

narrowed and flow less to swelling areas.[3–5] Once outside the cryogenic chamber, the vessels expand and an increased presence of Interleukin-10 is established in the blood. The cryotherapy chamber involves exposing individuals to freezing dry air (below −100 C) for two to four minutes.[4,6] The intense cold used in cryotherapy can be produced using different substances such as liquid nitrogen, liquid nitrous oxide and argon gas. During cryotherapy, liquid nitrogen or high-pressure argon gas flows into a needle-like applicator or cryoprobe.[6]

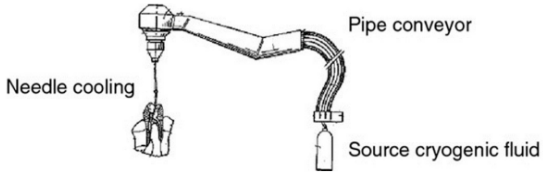

FIGURE. A dental instrument for treating teeth, provided with a needle cryogenic cooling, which receives the fluid from the refrigeration pipe conveyor. (Drawing courtesy of Giuliana Banche, PhD.)[23]

METHOD USED TO APPLY CRYOTHERAPY IN THE ROOT CANAL

The dental instrument used for cryotherapy is equipped with a conduit of a conveyor capable of being connected to a source of fluid and a needle cryogenic cooling, which receives the fluid from the refrigeration pipe conveyor. The needle is made of a flexible material and has a smaller outer diameter (0.25 mm) than the size of the entrance inside a tooth canal so that it can be inserted into the canal tooth itself, where the cryogenic fluid is blown

CRYOTHERAPY IN ENDODONTICS

1]EFFECT ON POST-ENDODONTIC PAIN

In a randomized, multicentre clinical trial, Vera et al.[12] showed that cryotherapy reduced the incidence of postoperative pain and the need for medication in patients presenting with a diagnosis of necrotic pulp and symptomatic apical periodontitis. Keskin et al.[11] revealed a significant reduction in postoperative pain in the cryotherapy group compared with the control group. Teeth with vital inflamed pulp were included in their study; however, they did not differentiate between

asymptomatic and symptomatic pulpitis nor did they differentiate between cases with and without apical periodontitis. In a randomized controlled trial, Alharthi et al.[13] found that the room temperature saline as final irrigation showed comparable results to intracanal cryotherapy in previously asymptomatic cases without periapical pathosis. A randomized prospective clinical trial showed that all the cryotherapy applications (intracanal, intraoral and extraoral) resulted in lower postoperative pain levels and lower visual analogue scale (VAS) scores of pain on percussion versus those of the control group.[14] Another clinical trial compared the effect of intracanal cryo treated sodium hypochlorite and room-temperature sodium hypochlorite on postoperative pain after root canal treatment. Results demonstrated that the cryotherapy group showed a statistically significant reduction in postoperative pain levels at all tested time intervals and reduced analgesic intake at six hours postoperatively.[15] In another study, Al-Nahlawi et al.[6] indicated that the use of intracanal cryotherapy technique with negative pressure irrigation eliminates post-endodontic pain after single-visit root canal treatment (RCT). In a systematic review, Sadaf et al.16 evaluated the effect of intracanal cryotherapy on postoperative pain after root canal therapy in patients with pulpal or peri radicular pathosis. Findings showed that, compared with controls, intracanal cryotherapy significantly reduced postoperative pain at six and 24 hours after the procedure. However, there was no significant effect on pain at 48 and 72 hours and seven days after the procedure. In a recent systematic review, Monteiro et al.[17] showed that intracanal cryotherapy application reduced postoperative endodontic pain after six and 24 hours.

2]EFFECT ON THE SUCCESS OF LOCAL ANAESTHESIA

Despite the fact that inferior alveolar nerve block (IANB) is the standardized injection technique used for achieving regional anaesthesia for mandibular molar teeth, it does not always result in successful pulpal anaesthesia, especially in patients with symptomatic irreversible pulpitis (SIP).[18] Preoperative intraoral cryotherapy application after an IANB did not provide profound pulpal anaesthesia 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.[19]

3]EFFECT ON FRACTURE RESISTANCE OF

ENDODONTICALLY TREATED TEETH

Keskin et al.[20] evaluated the effect of intracanal cryotherapy on the fracture resistance of endodontically treated teeth. Findings showed that application of intracanal cryotherapy as a final irrigant reduced the vertical fracture resistance of prepared roots when compared to the control group.

4]EFFECT ON REDUCING ROOT SURFACE TEMPERATURE

Vera et al.21 assessed a new methodology to reduce and maintain external root surface temperature for at least four minutes. Findings showed that although significant differences were found between the initial and lowest temperatures in both the control and experimental irrigation procedures, the experimental intervention reduced it almost 10 times that of the control. When maintaining a -10 C temperature reduction over four minutes, the teeth in the experimental group also sustained significantly better results.

5]EFFECT ON ENTEROCOCCUS FAECALIS

Enterococcus faecalis is the species most often implicated in persistent root canal infections because of its several virulence factors that make it difficult to eradicate from the canals.22 Mandras et al.23 indicated that cryo-instrumentation after NaOCl irrigation significantly reduced the number of bacteria in the root canal compared to NaOCl alone, without the total elimination of Enterococcus faecalis. The cryogenic fluid (liquid nitrogen), by suitably varying the duration of the treatment, can reach the desired depth and provide immediate freezing of bacterial cells and their subsequent cryodestruction. The process of freezing and thawing induces injury in microorganisms, in part, through membrane or cell wall disruption, leakage of intracellular constituents and changes in protein conformation.24 Yamamoto and Harris20 showed that in a test executed applying the freezing and thawing technique (30 s ‘ON’, 30 s ‘OFF’ and 30 s ‘ON’) using liquid nitrogen, the bacteria in vitro are significantly reduced with respect to the situation before the treatment.

6]EFFECT ON CUTTING EFFICACY OF NI-TI ROTARY INSTRUMENTS

Historically, the cold treatment of metals during manufacture had been advocated as a means of improving the surface hardness and thermal stability of the metal.25 The

optimum cold treatment temperature range lies between -60 C and -80 C for tool steels depending upon the material and on the quenching parameters involved.25 For the past 30 years, researchers have reported substantial benefits from subjecting metals for industrial applications to a cryogenic process.25–27 Cryogenic treatment involves submersing metal in a super-cooled bath containing liquid nitrogen (-196 C/ -320 F)25,26 and then allowing the metal to slowly warm to room temperature. This cryogenic treatment is used to treat a wide range of metal components, including high-speed steel and hot-work tool steel.27,28 The cryogenic treatment was shown to have more beneficial effects than the traditional higher temperature cold treatment.29 The benefits include increasing cutting efficiency as well as the overall strength of the metal.25,27 Cryogenic treatment is an inexpensive treatment that affects the entire cross section of the metal rather than just the surface in contrast to surface treatment techniques,26 such as ion implantation and vapor deposition. Currently, two mechanisms are believed to account for the change in the properties from cryogenic treatment for steel. The first is a more complete martensite transformation from the austenite phase following cryogenic treatment.[28] The second is the precipitation of finer carbide particles within the crystalline structure.[27] Controversy exists as to which mechanism is responsible.There are few studies on the cryogenic treatment of Ni-Ti rotary files. Kim et al.[30] evaluated the effects of cryogenic treatment on the composition, microhardness or cutting efficiency of Ni-Ti rotary instruments. According to their findings cryogenically treated specimens had a significantly higher microhardness than the controls. Furthermore, both cryogenically treated and control specimens were composed of 56% Ni, 44% Ti, 0% N (by weight) with a majority in the austenite phase. In another study, Vinothkumar et al.[31] showed that deep dry cryogenic treatment increased the cutting efficiency of Ni-Ti instruments significantly but not the wear resistance. George et al.[32] found that deep cryogenic treatment improved the cyclic fatigue resistance of Ni-Ti rotary files significantly.

CONCLUSION

In endodontics, cold has been used for multiple purposes including controlling postoperative endodontic pain, increasing the success rate of local anesthesia, enhancing the fracture resistance of the endodontically treated teeth, decreasing the temperature of the root surface, acting against specific bacteria like Enterococcus faecalis and enhancing the cutting efficiency of Ni-Ti rotary instruments

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