

Emerging role of cryotherapy and steroids in management of local anaesthetic failure

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Emerging role of cryotherapy and steroids in management of local anaesthetic failure

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ABSTRACT

Endodontic pain is a disruptive event to all clinicians and patients. When performing dental treatment on teeth with clinically healthy pulps, efficient and adequate local anaesthesia is the fundamental basis for dental pain control. Nevertheless, when managing patients with acutely inflamed pulps, local anaesthesia is actually much less efficient. Clinical trials have reported that an IANB injection of a local anaesthetic solution is inefficient in 30 to 80% of patients diagnosed with acute irreversible pulpitis. Therefore, pain management of lower molars with symptomatic irreversible pulpitis is usually a challenge to the endodontist. Many efforts have been made to implement various pharmaceutical and non-pharmaceutical agents to control the inflammatory processes leading to pulpal pain. These agents chiefly included NSAIDs and synthetic steroids, along with other modalities such as cryotherapy and acupuncture. The effect of steroids and cryotherapy on the success rates on IANBs when treating lower molars with symptomatic acute pulpitis was

investigated in a few studies in to increase the efficiency and duration of nerve block in these cases. The goal of this review is to highlight the role of steroids and cryotherapy in increasing the success rate of IANB and to point out the clinical studies concerned with both modalities.

Keywords: Steroids, Cryotherapy, Dexamethasone, endodontic pain

Abbreviations: SIP Symptomatic irreversible pulpitis

NSAIDS Non steroidal anti-inflammatory drugs

SIP Symptomatic irreversible pulpitis

IANB Inferior alveolar nerve block

TTX Tetrodotoxin

CGRP calcitonin g related peptide

GMCSF granulocyte monocyte colony stimulating factor

2 INTRODUCTION

Symptomatic irreversible pulpitis is an inflammatory disease of the pulp implying that the inflamed pulp is unable to heal (AAE, 2016). Teeth with SIP present with occasional or spontaneous pain that may be throbbing or vague, localized, generalized, or transferred to another site, traditionally accompanied with lingering periods of pain after thermal, specifically cold stimulus. The symptoms in molars diagnosed with acute pulpitis are caused by acute inflammatory process of the pulp and because the pulp is unable to expand due to the surrounding hard tissue, this inflammation causes a marked increase of the intrapulpal pressure. Effective, adequate, efficient, and long-lasting local anaesthesia is an urgent prerequisite because ineffective pain control may lead to a traumatic dental procedure instead of a simple expected one [1]. Nevertheless, local anaesthesia is usually inefficient in those cases, irrelevant of the tooth or the local anaesthetic technique being advocated [2]. Reports on the frequency and seriousness of intraoperative pain vary impressively, and this stamped differences can be attributed to varieties within the test sizes, strategies utilized, and the social and ethnic

characteristics of the different populations. Clinical trials have reported that an IANB injection of local anaesthetic solution (1.8 ml) is ineffective in 30 to 80% of patients diagnosed with acute pulpitis so that anaesthetizing those patients fails 8 times higher than healthy unaffected patients [3]. Pain control during endodontic treatment can be accomplished by three main approaches –by decreasing nociceptive impulses from the more distant area, by inhibiting nociceptive impulses transmission in the peripheral neurons and by prohibiting pain perception in the CNS. Local anaesthesia blocks nociceptive impulses that are produced while performing the treatment [4] and this nociceptive input can actually be lowered by administering NSAIDs [5] or steroids [6] as both prohibit prevent the production of prostaglandins at the actual site of insult and/or treatment. Both modalities specifically when a long acting local anaesthetic solution is administered [7] can inhibit pain perception and recognition in the central nervous system after treatment. The present clinical studies report that the using different techniques for pain control are useful; however, there is doubt regarding the most effective anaesthetic protocol to be agreed upon when managing lower molars with pulpitis. Many investigations are still recommended, evaluating patient-based outcomes, to provide evidence-based protocols and more precise protocols. Therefore, the goal of the present review is to have an resolution to this inquiry: "Does the preoperative administration of dexamethasone or cryotherapy increase the efficacy of the standard inferior alveolar nerve block on teeth with symptomatic irreversible pulpitis without the need for premedication?"

MATERIALS AND METHODS

Material and sources collection

The choice of the papers in this article depended on a manual exploration of the related search engines: Egyptian Knowledge Bank, PubMed, Scopus, and Web of Science .The last activity was in April 2024. The following key words were used: cryotherapy, cold therapy, cryotherapy in root canal treatment, steroids, success of inferior alveolar nerve block, endodontic pain.

Inclusion Criteria

Clinical studies, case reports, with all research that investigated cryotherapy and steroids and written in English and published in scientific dental journals were chosen in this article. The approved articles were electronically selected, and the full references were grouped and filtered. The references list of all articles was manually analyzed for more studies inclusion.

Selection of the Studies

Titles of the selected articles were at first grid separately by all three contributors to select the studies that abide to the inclusion criteria. If controversy occurred between them, a discussion was set for brainstorming, and a final decision was made with the aid of the corresponding author. All articles not matching the inclusion criteria previously decided ruled out.

DISCUSSION

Causes of failure of IANB

Many possible causes were mentioned for local anaesthetic failure during endodontic treatment. These reasons were sorted as anatomical and nonanatomical reasons for ease of recognition. Between the anatomical hypothesis, the mylohyoid nerve theory and the central core theory gained much attention, but failure of anaesthesia to provide anaesthetic success in all teeth has favored the non-anatomical causes [8]. The hypothesis well recognized but least expected to be correct is the lowered pH of the inflamed tissues [9]. This theory proposes that the low pH decreases the availability of the basic form of the anaesthetic solution, therefore decreasing the penetrability to the membrane so, providing inadequate anaesthesia. This is not considered to be the most reasonable clarification for inadequate anaesthesia with IANB where the principal site of inflammation isn't actually injected. The most accepted proposed hypothesis for the decreased success rate of local anesthesia can be the more complicated neural processes. Inflammatory process and bacterial insults cause neurons sprouting, more significant release of neuropeptides like subs. P and CGRP, and the release of inflammatory mediators such as PGE₂, PGF_{2a}, IL-1,6, and TNF. This leads to activation and sensitization of nociceptors by reducing their activation thresholds to the point that they discharge in response to the patient's heart beats leading to throbbing pain, and lead as well to stimulation of a larger amount of neurons, leading to a blast of impulse produced from the inflamed tissue to the CNS via many unmyelinated sensory C fibers [10]. A major class of voltage gated sodium channels that are resistant to tetrodotoxin are located on pain receptors. They have higher activation threshold compared to the tetrodotoxin sensitive channels. That's why, they are somehow resistant to many sodium-channel blockers as local anesthetics [11]. These channels are also sensitized by prostaglandins [12] and they explain the reason why local anaesthesia is less efficient in clinical cases of symptomatic irreversible pulpitis.

Criteria of anaesthetic success

In managing teeth with acute irreversible pulpitis, assessing if adequate and efficient local anaesthesia has been achieved before beginning the treatment is mandatory. Anaesthesia through the IANB has classically been checked subjectively by asking if the patient's lip was numb, and objectively by probing the gum surrounding the tooth to be treated or starting treatment and observing the patient's reaction. Nevertheless, those techniques are not very accurate to evaluate if pulpal anaesthesia has been really achieved [13]. More objective tests can be implemented to determine if the pulp was adequately anaesthetized. The use of electric pulp tester and/ or cold sprays have been agreed upon to precisely assess pulpal anaesthesia in teeth with healthy pulps before the beginning of treatment. If the patient didn't react, at that point pulpal anesthesia is affirmed and the patient isn't anticipated to feel pain during the treatment. Nevertheless, in case of symptomatic acute irreversible pulpitis, a negative response to the stimuli does not warrant pulpal anesthesia in all cases [14]. The patient may still report pain while treatment. Therefore, as per Fowler and colleagues, success rates of the inferior alveolar nerve block are estimated as 28% in first molars, 25% in second molars, and 39% in premolars in cases with irreversible pulpitis when patients didn't feel pain or just reported mild pain felt whilst access cavity preparation [15].

Management strategies of local anaesthetic failure

Many clinical trials have suggested approaches to overcome the inadequacy of IANBs for controlling pain in teeth with acute pulpitis, for example implementing different anaesthetic techniques targeting other anatomical landmarks [2,16], using different types and/or increasing the amount of the solution injected[13,17], preoperative prescription of an oral drug as NSAIDs or steroids [18], injecting preoperative submucosal tramadol[6], cryotherapy [19], low-level laser therapy [20], acupuncture[21] and the administration of supplemental buccal and lingual infiltration injections [22], intra-ligamentary [23], and intra-bony injections[24,25]. Our review focuses on 2 anti-inflammatory approaches and discusses their rationale in enhancing the success rate of IANB in lower molars with irreversible pulpitis.

Steroids

Physiological effect of steroids

A recognized approach to antagonize the inflammation and manage pain is drugs prescription that can be either preoperatively to attain precautionary analgesia or rather postoperatively after treatment to lessen the expected or present pain. These drugs include NSAIDs [18], paracetamol [26], and steroids [27]. Steroids have a significant

powerful anti-inflammatory effect (for instance, 25 times as that of hydro-cortisone on pain happening due to sensitization and activation of nociceptors due to multiple inflammatory mediators) [28,29]. Glucocorticoids have various sites of action, and they inhibit the phospholipase enzyme so, they are considered to be strong inhibitors of COX and LOX pathways of arachidonic acid metabolism [30].

Glucocorticoids mediate this inhibition by a variety of cells and factors which are critical in exacerbating the inflammation. This action is due that glucocorticoids affect gene transcription that leading to a decrease in the production of many chemo attractive factors, decrease migration of white blood cells to sites of insult, and finally minimal tissue fibrosis. Steroids as well show significant effects on the immunity by inhibiting the production of cytokines, especially interferon γ , GM-CSF, IL-1, IL-2, IL-3, IL-6 and TNF α . Therefore, this pharmacological action of steroids antagonizes the inflammatory process that cause pain of pulpal origin.

Glucocorticoids also reduce bradykinin mediators via promoting the formation of angiotensin converting enzyme. Bradykinin activates the action of pain receptors and leads to the release of substance P, and CGRP that mediate pain. Moreover, glucocorticoids inhibit the release of neuropeptides thus, inhibit neurogenic inflammation [31]. Glucocorticoids also produce vasocortin that suppresses edema, unlike NSAIDs that cannot mediate this action [32]. The corticosteroids family includes dexamethasone, methylprednisolone and prednisolone. Methylprednisolone and Prednisolone are intermediate-action drugs (relative potency of 5,4 respectively) but, dexamethasone is a long-action one with a relative potency of 25 more than that of endogenous cortisol [33].

Effect of dexamethasone on the success rate of IANB

The effect of dexamethasone on the success rate on IANBs when treating lower molars with symptomatic irreversible pulpitis was investigated in a few studies to enhance the efficiency and duration of nerve block in these cases. Aggarwal et al [34] concluded that buccally supplementally infiltrating 1 mL/4 mg of dexamethazone didn't enhance the success rate of IANB in mandibular molars, and that it didn't significantly differ compared to the control group. Also, Mai Mohamed et al 2020 [35] showed that administrating one dose of 0.5 mg dexamethasone preoperative did not alter the magnitude of pain postoperatively nor the success anesthesia of IANB by administering 2% mepivacaine with 1:100,000 epinephrine in patients with acute irreversible pulpitis.

Kaushik et al [36] assessed the efficiency of anesthesia with 2% lidocaine with 1:200,000 epinephrine against a mixture of 2% lidocaine, 1:200,000 epinephrine and 1 mL of 4 mg dexamethasone (Twin mix) for IANBs in patients with acute irreversible pulpitis affecting the lower molars in a randomized controlled trial. This clinical study showed that the anaesthetic efficiency of Twin mix has been similar to that of 2% lidocaine for IANB.

21 On the other hand, in a randomized, parallel, clinical study, Aggarwal et al. 2021 [27] concluded that intrafilamentary administration of dexamethasone increased the success rate of anaesthesia. In another double-blinded, controlled trial, Aksoy et al. 2021 [6] concluded that dexamethasone administration extended the time interval of anaesthetic action when it was in comparison to that of saline. It was concluded as well in this study that administering dexamethasone by submucosal infiltration provides analgesia rather than an anaesthetic action. Moreover, the administration of dexamethasone in lower molars with symptomatic irreversible pulpitis by this way has been shown to show efficient pain control in management of pain of endodontic origin.

Compared to NSAIDs, Shokri et al 2018 [37] showed that administration of 4 mg of dexamethasone preoperatively or 400 mg ibuprofen 60 minutes before the IANB led to a marked increase in the success of anaesthesia when managing lower molars with acute irreversible pulpitis [37]. This agrees with previous studies by Shahi et al 2012 [38] and Bidar et al 2017 [39]. Moreover, Kumar et al [40] concluded that the administration of a combination of ibuprofen and dexamethasone preoperatively improved the success rate of IANB in mandibular molars with symptomatic acute irreversible pulpitis.

In another prospective randomized, double blinded clinical trial, Aggarwal et al [41] proposed to assess the anaesthetic effect of adding 2 mg of dexamethasone (4 mg/ml) to 2% lidocaine solution (plain, or with 1:80,000 epinephrine). They concluded that adding dexamethasone to 2% lidocaine with epinephrine, when given as an IANB, can increase the anaesthetic success rate when managing lower molars with acute irreversible pulpitis.

Cryotherapy

Physiological action of Cryotherapy

Cryotherapy is a popular approach that is widely used in sport injuries and in surgeries for management of pain and providing postoperative care. Cryotherapy techniques that provide faster cooling of tissues offer some advantage when compared to slower cooling techniques [42]. Likewise, it is generally thought that greater reduction of temperature leads to stronger suppression of metabolism, therefore suggesting that cryotherapy approaches that provide lower temperatures are more efficient. Thermodynamic properties, especially the change of physical state, have a great effect. Ice-based techniques, going through a change of state from the solid to liquid one, absorb greater amount of heat. In a study by Bleakley et al [43], they showed that optimum levels of pain control can be practically obtained by using crushed ice for intervals of 5–15 minutes and that all different approaches of cryotherapy may demand longer periods of time to lower the skin's temperature to necessary levels. In root canal therapy, cryotherapy is

recommended following periapical apicectomies and during root canal irrigation to control the inflammatory processes, therefore, decreasing postoperative pain [44].

The therapeutic effects of cryotherapy are achieved by affecting metabolic, hemodynamic, neuromuscular processes [45]. The hemodynamic effect can be explained by that cold promotes vasoconstriction with an antiedematous effect, leading to a decrease in inflammation by decreasing the number of white blood cells adhering to the capillary endothelial cells and minimizing their transfer to the site of tissue injury [46]. The second is cellular in nature and has to do with slowing down metabolism. By cryotherapy, blood flow to the tissues is well reduced. Therefore, cells use less amount of oxygen and blood flow is decreased due to vasoconstriction, leading to minimal generation of oxygen radicals in tissue, and prevention of hypoxia and extra damage of tissue [47]. The final effect is neurological, such that temperature reduction induces analgesia by slowing nerve conduction velocity. Nevertheless, this affects more the myelinated A-delta neurons which are deactivated completely at approximately 7°C when compared to the unmyelinated C that are deactivated totally at around 3°C as shown by Franze and Iggo [48]. It was as well suggested that gate control theory is accountable for pain reduction caused by cryotherapy as the larger myelinated A fibers provide a faster more pronounced sensory input which temporarily closes the gate and inhibits the unmyelinated C fibers from transmitting the more painful impulses leading to minimal pain sensation.

Effect of cryotherapy on success rate of IANB

The effect of cryotherapy on the success rate on IANB blocks when providing treatment for lower molars with acute irreversible pulpitis has been investigated in a few studies. Intraoral approaches took different forms being applied to the soft tissue or hard tooth structure.

Intraoral soft tissue cryotherapy application in the facial vestibule of lower molars in the form of ice blocks wrapped in gauze increased the efficiency of IANB relative to the control groups as concluded by Topcuoglu et al [19], Gupta et al [49] and El-Heeny et al [50]. However, Endo-ice being sprayed to the crowns of teeth did not provide much efficient pain control during pulp chamber penetration compared to buccal infiltration injection by articane as concluded by Koteeswaran et al [51]. This was agreed upon later by Gopakumar et al [14] who concluded that the application of Endo-ice and intrapulpal ice after IANB significantly increases the effectiveness of pulpal anaesthesia in lower second molars with symptomatic irreversible pulpitis. Aggarwale et al [52] assessed if cooling 2% lidocaine solution with 1:200,000 epinephrine had an analgesic effect, when given as an intraligamentary supplemental injection after a failed IANB. They concluded

that cooling didn't affect the anaesthetic efficiency of intraligamentary supplemental injections, administered after a failed IANB.

CONCLUSION

The previous findings showed that steroids and cryotherapy effectively enhance the success rates of IANBs in teeth with symptomatic acute irreversible pulpitis.

Nevertheless, the success rates yet aren't sufficient as needed to guarantee thorough anaesthesia, the same as concluded by the former studies.

CONFLICT OF INTEREST:

No conflicts of interest related to this study.

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