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REVIEW ARTICLE

Anaesthetising Painful Pulp in Endodontics-A Review

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ABSTRACT

Profound pulpal anaesthesia in endodontics is doorway to successful root canal treatment. It increases patient's cooperation and faith in operator as well as reduces stress on dentist's mind. Anaesthetising a tooth is sometimes challenging and more so in patients with painful pulpal conditions such as acute reversible and irreversible pulpitis, acute exacerbations of pulpal pathologies. This article emphasizes on various anaesthetic strategies which an endodontist can adopt in treating painful pulps.

Keywords: Local anaesthesia, Acute reversible pulpitis, Acute irreversible pulpitis

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INTRODUCTION

Achieving adequate anaesthesia in painful pulps is essential before we approach pulp, Inferior Alveolar Nerve Block or Mandibular Block has usually been used routinely which numbs the soft tissues around the tooth to be treated, but it does not always anaesthetize the inflamed pulp (1) .Vitality tests like electric pulp testing, cold test accurately confirm pulpal anaesthesia in normal pulp but tooth with symptomatic irreversible damaged pulp does not get anaesthetized even though. Electric pulp test or cold test show negative response (2). Patient still experiences pain approaching pulp inspite of profound IANB (Inferior Alveolar Nerve Block)

Nerve Block Anaesthesia

Pulpal anaesthesia of mandibular tooth poses a greater challenge. Anaesthetic success by administering IANB(lip numbness present) was achieved 53% in first molar, 61% in first premolar and 35% in lateral incisors whereas anaesthetic failure occurred in 17% first molar, 11% first premolar and 32% lateral incisors (3). Pulpal anaesthesia takes longer onset time after IANB, in 19 to 27% it took 16 minutes and in 8% cases it took even 30 minutes (4).

Dentist treating a patient of painful irreversible pulpitis usually encounters the problem of ineffective pulpal anaesthesia even the patient's lip is numbed with IANB using 2% lidocaine with 1: 100,000 epinephrine. Research comparing various local anaesthetics like 3% mepivacaine plain 4% prilocaine (5), 4% prilocaine with 1: 200,000 epinephrine, 2% mepivacaine with 1: 20,000 levonordefrin(6), and 4% articaine with 1: 100,000 epinephrine to 2% lidocaine with 1:100,000 epinephrine(7) showed no difference in success rate in patients with normal pulp. Clinical studies involving patients with painful pulps failed to show any difference in success rate by using various types of anaesthetic agents (8).

Studies involving various techniques of anaesthesia administration such as Gow-Gates technique (9), Vazirani-Akinosi (closed mouth) technique were not found any superior to conventional IANB technique (10).Therefore replacing conventional IANB injection with other technique of administering anaesthesia will not improve success in attaining pulpal anaesthesia in mandibular teeth. Hannan *et al* (11) utilized ultrasound to guide an anaesthetic needle to its target for the IANB. It did not result in more successful pulpal anaesthesia even though accurate injection could be attained by this method. Needle tip bevel direction toward or away from mandibular ramus has also been shown not to affect the anaesthetic success of IANB (12).

Increasing the volume or concentration of epinephrine of IANB has also been found not to increase the incidence of successful pulpal anaesthesia (1).

Supplementary Anaesthesia

So why then it is so difficult to achieve pulpal anaesthesia in mandibular teeth having symptomatic irreversible pulpitis. One theory to explain this is that the inflamed tissue has a lowered Ph, which reduces the amount of base form of the anaesthetic needed to penetrate the nerve sheath and membrane. Therefore, there is less ionized form of the anaesthetic within the nerve to produce anaesthesia. Another theory is that the nerve arising from the inflamed tissue have altered resting potentials and reduced thresholds of excitability (13). There are several supplemental injection techniques available to help the dentist, which are reviewed in this article. It should be kept in mind that these supplemental techniques are used best after attaining a clinically successful IANB with lip numbness achieved.

Intraligamentary Injection

Walton and Abbot reported an initial and reinjection success rates of 71% and 92% respectively of periodontal ligament supplemental injections in achieving anaesthesia for root canal procedures. Success of intraligamentary injection depends upon the attainment of back pressure during injection (14). Cohen *et al.* also reported an initial and reinjection success rates of 74% and 96% respectively. PDL injections are usually administered using either normal dental anaesthetic syringe or a high pressure syringe. The anaesthetic agent used was 2% lidocaine with 1: 100,000 epinephrine and injections were limited to mandibular teeth after successful IANB with achievement of lip numbness.

Intraosseous Injection

Intraosseous injection (IO) directly delivers anaesthetic solution into the cancellous bone surrounding the affected tooth. Various systems such as Stabident system, X-tip system and Intra- Flow handpiece use different technique to deposit anaesthetic agent to the targeted tooth. Nusstein and Reader (8) found that a supplemental mandibular intraosseous injection using 1.8 ml of 2% lidocaine with 1:100,000 epinephrine had a 91% success rate in achieving complete pulpal anaesthesia when used after the IANB injection failed in painful pulps suffering with irreversible pulpitis. Parente and colleagues (15) reported a success rate of 79% when they used 0.9 ml of 2% lidocaine with 1:100,000 epinephrine and achieved 91% success when second inraosseous injection was administered. The duration of anaesthesia for intraosseous injection has been reported to last 45 minutes approximately which is sufficient for completion of bio-mechanical preparation in patients of irreversible pulpitis.

Mandibular Buccal Infilteration with Articaine

Hasse *et al* has reported success rate of 88% when mandibular buccal infiltration supplementary injection of 4% articaine with 1:100,000 epinephrine was administered to enhance the success of IANB (16). However, when the buccal infilteration injection was used as a supplement to the IANB in patients diagnosed with irreversible pulpitis, the success rate was only 58% (17) which is much less than that attained with the intraosseous and interligamentary injections.

Intrapulpal Injection

Intrapulpal anaesthesia was found to be very effective when administered under strong pressure, even though it did not work when anaesthetic agent was placed passively in contact with the pulpal tissue. Onset of intrapulpal anaesthesia was immediate but duration of action was found to be 15 to 20 minutes only. Since patient experiences severe pain when the operator is still in dentin and approaching pulp, thus achieving pulpal entry for intrapulpal injection further accentuates pain, therefore patient should be informed before hand to expect moderate to severe pain during the administration of intrapulpal injection (18).

PREMEDICATION

Recent studies have shown favorable results regarding the use of oral medication prior to local anaesthesia in patients suffering with irreversible pulpitis. Ianiro and Jeansonne (19) administered acetoaminophen or ibuprofen in combination with acetoaminophen orally and compared with placebo in patients of acute irreversible pulpitis scheduled for root canal therapy and reported 71 to 76% success in comparison to only 46% with placebo. Lindermann *et al* (20) used sublingual sedative agent to reduce anxiety and increase pain threshold but found it ineffective. They concluded that profound pulpal anaesthesia was still required to eliminate pain during root canal treatment of a tooth with painful pulp having acute irreversible pulpitis.

REASONS FOR FAILURE OF ANESTHESIA

Clinical studies have reported that a single inferior alveolar nerve block (IANB) injection of local anesthetic(1.8 cc) is ineffective in 30–80% of patients with a diagnosis of irreversible pulpitis. Patients with irreversible pulpitis had an 8-fold higher failure of local anesthetic injections in comparison to normal control patients. (21-23).Thus, local anesthetic failures can occur in a substantial proportion of endodontic pain patients.

These failures can be attributed to Operator dependent and Patient dependent variables.

Operator Dependent Variables

As a general rule, in adult patients about 1.0 ml of solution should be deposited for infiltration injections in the maxilla, whereas most regional block techniques require 1.5 ml except palatal blocks and long buccal nerve blocks which require about 0.2–0.5 ml anesthetic solution(24).

Choice of Solution

Lignocaine with adrenaline is the 'gold standard' for the majority of cases. In some medically-compromised patients adrenaline-free solutions may be preferred. The effect of plain lignocaine is short lived

and does not give reliable pulpal anaesthesia.

Poor Technique

As far as conventional methods of local anaesthesia are concerned poor technique usually relates to mandibular anaesthesia, specifically failed inferior alveolar nerve block injections. The common causes of failure are touching bone too soon on the anterior ascending ramus (rectified by swinging the syringe across the mandibular teeth on the same side, advancing 1 cm and then returning to the original angle of approach) or injecting inferior to the mandibular foramen.

PATIENT DEPENDENT VARIABLES

Individual variations in the position of nerves and foramina

The foramina of importance in regional block anaesthesia in dentistry do not have a consistent location. Anatomic variations like Bifid inferior alveolar nerve in 0.4% cases, Retromolar foramen in 7.7% cases, Accessory mental foramen in 1.4%-6.6% of cases are reported (25). These variations play a significant role in block injections in comparison to infiltration anesthesia.

Accessory Innervation to the Teeth

Teeth may be innervated from more than one nerve trunk eg. upper molar teeth from the greater palatine nerve , maxillary anterior teeth from the naso-palatine nerve. The solution for both these cases is a palatal injection. Further accessory supplies which innervate mandibular teeth can be derived from the mylohyoid nerve, the auriculotemporal nerve and the upper cervical nerves. The mylohyoid branch leaves the main inferior alveolar trunk more than a centimeter superior to the mandibular foramen (26) so may not be anaesthetised by a conventional approach to the latter nerve. However, it may be anaesthetised using the techniques of Gow-Gates and Akinosi (24). The auriculotemporal nerve occasionally sends branches to the pulps of the lower teeth through foramina high on the ramus (27). This supply, like the mylohyoid branches, is countered by a 'high' block such as the Gow-Gates or Akinosi.

EFFECT OF INFLAMMATION ON LOCAL TISSUE PH

Inflammation with infection are also causes of anesthe-tic failure, particularly in situations of pulpitis or apical periodontitis (28). Vandermeulen recommends avoiding repeated anesthe-tic administration in cases of inflammation and infection, since tachyphylaxis (anesthetic reaction becoming increasingly weaker) may result (29). Inflammation- induced tissue acidosis may cause 'ion trapping' of local anesthetics.
Once injected, the local tissue pH and the drug's strength as an acid (measured as the pKa value) regulate the distribution of the local anesthetic between the acid and base forms according to the well-known Henderson-Hasselbalch equation (pH – Pka)½log (Base/Acid). The proportion of the drug that exists in the uncharged base form is available to diffuse across the cell membrane. Tissue pH does not equally ion trap all local anesthetics as they differ in their pKa properties. Local anesthetics with lower pKa values are likely to be more effective in endodontic pain patients. Mepivacaine with lower pKa value represents a logical local anesthetic for use in patients with irreversible pulpitis (30).

EFFECT OF INFLAMMATION ON NOCICEPTORS

Substances released from inflamed tissue have two major effects on nociceptive ('pain detecting') neurons (31). Firstly, they change the functional activity of these neurons. Secondly inflammation also changes the synthesis of several proteins in nociceptors, leading to an increase in neuropeptides, such as substance P and calcitonin generelated peptide. These neuropeptides play important roles in regulating pulpal inflammation (30).In addition, tissue injury may alter the composition, distribution or activity of sodium channels expressed on nociceptors (32-34). The effect of inflammation on these sodium channels may have profound implications in local anesthetic failures.

EFFECT OF INFLAMMATION ON CENTRAL SENSITIZATION

Activation and sensitization of nociceptors in pulpal and periradicular tissue results in a barrage of impulses sent to the trigeminal nucleus and brain. This barrage, in turn, produces central sensitization. Central sensitization is the increased excitability of central neurons and is thought to be a major central mechanism of hyperalgesia (35).

Under conditions of central sensitization, there is an exaggerated CNS response to even gentle peripheral stimuli. Reducing the afferent barrage reduces the central sensitization. This is done routinely by clinicians via cleaning and shaping techniques, but this is a conundrum, as the endodontic treatment is performed after local anesthesia (30).

PSYCHOLOGICAL FACTORS

Patient anxiety may also contribute to local anesthetic failure. First, the clinician should establish a positive and confident relationship and avoid exposing the patient to obvious fear-producing stimuli. Second, pharmacologic agents can be administered to control patient anxiety (30). Kaufman *et al.* (36) showed that oral triazolam 0.25mg was equally effective in comparison to intravenous diazepam in reducing anxiety in patients undergoing oral surgery.

SUMMARY

Supplementary injection techniques like intrapulpal, interligamentary or intraosseous injections along with nerve block help tremendously in achieving profound pulpal anaesthesia in patients diagnosed with acute irreversible pulpitis.

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