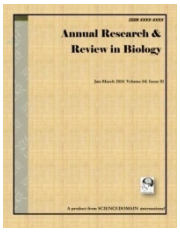

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Management of Local Anesthesia Failures in Endodontics with Different Anesthetic Techniques and Agents

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Authors' contributions

This work was carried out in collaboration between all authors. Author SS designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors AS, GB and MNH managed the analyses of the study and corrected the first Draft. All authors read and approved the final manuscript.

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ABSTRACT

Management of hot tooth in endodontic is often a challenge to the clinician. Adequate anesthesia after injection mainly depends on three major factors: (1) Dentist (2) Patient (3) Local anesthesia. Most of the times, hot tooth management requires different anesthetic techniques and combination of different anesthetic solutions. The purpose of this article is to focus on different techniques and different anesthetic solutions that can be used for the management of hot tooth.

Keywords: Anesthesia; hot tooth; supplemental injection techniques; irreversible pulpitis; Anesthetic solution.

1. INTRODUCTION

The term ''hot'' tooth generally describes to a condition in which a pulp that has been diagnosed with irreversible pulpitis, with spontaneous, moderate-to-severe pain. An example of this kind of condition is a patient who is sitting in the waiting room, sipping on a large glass

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of ice water to control the pain [1]. This condition is most commonly seen in mandibular molars. Clinician should be able to determine the condition which causing pain for the patient. Irreversible pulpitis is the inflammatory condition of the pulp usually caused by any noxious stimuli. Eg: Dental caries, Chemical, mechanical or thermal injuries to the pulp. Apical periodontitis is a condition in which there will be tenderness and pain when the patient bites. Radiographically, there will be thickening of the periodontal ligament and loss of lamina dura in this condition [2]. Allodynia is a condition in which pain occurs due to a stimulus. Temeperature or physical stimuli can provoke allodynia [3] whereas hyper algesia is an increased sensitivity to pain which can be caused due to damage of nociceptors or peripheral nerves [4].

Achieving adequate pulpal anesthesia for endodontic tooth diagnosed with irreversible pulpitis with moderate – severe pain is mandatory before starting the endodontic treatment. Acheiving anesthesia for that tooth is always necessary to commence the endodontic treatment. One must know the proper anatomy and the procedure thoroughly for achieving a proper anesthesia. Sometimes after giving a proper anesthesia also, patient shall respond negatively to the treatment because of pain. In Endodontics, this condition is often referred as “Hot Tooth”. Treating such condition shall always become a trouble to the clinician. This article describes some treatment strategies that the endodontists can use when treating patients with “hot” tooth.

When a carious lesion approximates the pulp, inflammatory changes within the pulp progressively worsen. In this stage, there will be an acute exacerbation of chronic inflammation takesplace with an influx of neutrophils and the release of inflammatory mediators (prostaglandins and interleukins) and proinflammatory neuropeptides(substance P, Bradykinin, and calcitoningene related peptide) [5] All these mediators can stimulate the peripheral nociceptors within the pulp of affected tooth, thereby increases the pain production and neuronal excitability [6]. All of this leads to moderate-severe pain even after giving adequate anesthesia with traditional techniques. So in this stage endodontist must achieve profound anesthesia for providing pain relief to the patient.

1.1 HOT TOOTH

The term ‘‘hot’’ tooth generally describes to a condition in which a pulp that has been diagnosed with irreversible pulpitis, with spontaneous, moderate-to-severe pain [1]. Pre-operative pain is a common finding for incomplete local anesthesia observed in patients with hot tooth. Although the exact mechanism of this clinical situation is unknown or incompletely understood several hypothesis been advocated.

1.1.1 Ion trapping

Low pH is responsible for ion trapping of local anesthetic. According to this hyphothesis, low tissue pH shall be responsible for a greater proportion of the local anesthetic being trapped in the charged acid form of the molecule and thus unable to cross cell membrane [8]. However ion trapping is for infiltration injections only, block injections are likely to involve acidotic tissues [7].

1.1.2 Altered Membrane excitability of peripheral nociceptors

Nerves from inflamed tissue shows decreased excitability threshold and altered resting potential. Studies shows that lower excitability thresholds are responsible for transmission of impulses even with action of local anesthetic [7,9].

1.1.3 Tetrodoxin resistant channels

It is confirmed that Tetrodoxin resistant channels (TTXr) class of sodium channels resist the action of local anesthesia. Increased expression of sodium channels in pulp are responsible for anesthetic failures in hot tooth.[10] TTX r channels are resistant to lidocaine , thereby causing incomplete anesthesia [7].

In dealing with a tooth diagnosed with irreversible pulpitis or condition suspicious for a “Hot” tooth, determining regardless of whether adequate local anesthesia has been achieved before treatment is important. Successive Inferior Alveolar Nerve block (IANB) can be traditionally confirmed by subjective and objective tests. Subjective test can be done by asking the patient if their lips feels numb, probing the gingiva around the tooth to be treated, etc. If patient respond positively to the subjective findings, then patient should not experience pain during treatment. However, these techniques are not confirmatory test in determining the pulpal anesthesia [7,11,12,13,14]. Objective tests includes by using ElectricPulp Tester or Cold test. If the patient responds negatively to the stimulus applied, then pulpal anesthesia has been achieved. However, condition diagnosed with a hot tooth, a failure to respond to the stimulus may not necessarily guarantee pulpal anesthesia [7,15,16,17].

Factors other than Hot tooth for pulpal Anesthetic failure after IANB.

1.1.4 The Central core theory

This theory states that the nerve that situated outside of the nerve bundle supply molar teeth while the nerve situated inside the nerve bundle supplies the anterior teeth [15]. The anesthetic solution may not diffuse into the nerve trunk to reach all the nerves to produce an adequate block even if deposited at the correct site. This theory may only applicable for the higher failure rates in the anterior teeth with IANB and not for the posterior teeth [11,12,13,14].

1.1.5 Central sensitization

Central sensitization may contribute to local anesthetic failures. Increased Sensitization may amplify incoming signals from sensory nerves. In central sensitization, there is an increased response to peripheral stimuli and because of this, the IANB may permit for sufficient enough signaling to occur thereby leading to the perception of pain [7].

1.1.6 Psychological factors

Patient anxiety is one of the factor for local anesthetic failure. It is understood that apprehensive patients have a reduced pain threshold and more likely to complain pain during the time of endodontic treatment [16].

2. MANAGEMENT OF HOT TOOTH

Even after giving a proper anesthesia, if the patient responds pain two treatment strategies could be considered:

I) Supplemental Injections

II) Change in the Anesthetic solution.

2.1 Supplemental Injections

Most of traditional injections might not work every time, so the clinician should go for alternative supplemental injection for managing pain. There are several alternative supplemental injection techniques available in the field of dentistry. Some of the most important and effective supplemental injections are reviewed in this article. This could be helpful for the clinician for managing pain.

Intraligamentary(periodontal ligament) Injection

Periodontal ligament (PDL) injection is still one of the supplemental injection for reducing pain in endodontics. It has been reported that supplemental PDL injection shows 50-96% of cases with successful anesthesia for endodontic procedures [17,18,19,20]. But, most of the times, a re-injection is advisable for good result [19,20].

2.2 Procedure

Prior to PDL injection, the area of injection is swabbed with an antiseptic solution. The needle is inserted at 30° to the long axis of the tooth until it is wedged between the tooth and the crestal bone and 0.2 ml of solution is deposited under back pressure [21]. The needle should be positioned for 5-10 seconds after injection to make sure that the solution is deposited over the site properly. The most important factor related to the success of this technique is that the injection should be performed against resistance [22]. Rapid onset of anesthesia is an advantage of intraligamentary anesthesia. Anesthesia is usually achieved within 30 s and will be there for entire debridement procedure [22,23,24].

Duration of Periodontal ligament Injection

Duration of anesthesia to be around 10-20 min [7,19,20,25,27].

3. FACTORS INFLUENCING EFFICIENCY

3.1 The Anesthetic Solution

The presence of vasoconstrictor like adrenaline shows increased efficacy of PDL injections. The combination of lidocaine with adrenaline shows 91.6% success rate for PDL injection whereas without the vasoconstrictor the success rate shows only 42% [26].

3.2 The Operative Procedure

The least success rate of PDL injection is for endodontic procedures and the greatest for Exodontias [27,28].

3.3 The Type of Tooth

It is reported that type of tooth also determines the efficiency of Intra ligamentary injection. Studies shows that the least success for pulpal anesthesia with mandibular lateral incisors [29,30].

3.4 Armamentarium for Intraligamentary injection

Traditionally, PDL injections are usually given by using either standard dental anesthetic syringe or a high pressure syringe. Recently, the development of computed controlled local anesthetic delivery system (Milestone Scientific, Livingston, NJ, USA) has been found to be able to deliver a PDL injection [17].

3.5 Intraosseous Injection

Due to the thickness of the cortical plate in posterior mandible, infiltration injection with lidocaine solutions are not effective for posterior mandible. In such situations intraosseous injection is an alternative. The use of intra- osseous anesthesia was described by Lilienthal [31].

3.6 Technique

Prior to Intraosseous injection, point of the perforation site should be selected. This point should be in the attached gingiva. The point of injection can be determined by imaginary two lines running at right angles to one another. The horizontal line runs along the buccal gingival margins of the tooth and the vertical line runs along the distal aspect of the interdental papilla of the tooth selected. The point of injection is 2mm apical to the intersection of these lines. The point of injection is infiltrated with 0.2 ml of local anesthetic in the gingiva and wait for 50-60 sec for achieving gingival anesthesia. [32]. After achieving adequate gingival anesthesia, by using specialized equipment, the perforator is advanced to the cancellous bone. At this stage perforator is removed and and by using short(8mm) 27 gauge needle, 1ml of solution is delivered slowly over a 2 min period. This technique anesthetize the tooth to be treated and will also anesthetize the tooth mesial and distal one in majority of cases [33].

3.7 Onset of Anesthesia

Onset of anesthesia is rapid [34,35,36,37,38]. There is no waiting time required for the onset of anesthesia.

3.8 Site of Injection

The injection is recommended to give on distal to the tooth to be anesthetized except for maxillary and mandibular second molars [34,35,39,40]. For maxillary and mandibular second molar, mesial side is preferred.

3.9 Devices for intra Osseous Anesthesia

Some of the commonly used systems available in the market includes:

1. Stabident
2. X-tip
3. Intra Flow
4. Comfort Control Syringe

3.9.1 Stabident

The Stabident system (Fairfax Dental Inc, Wimbledon, UK) consists of a 27-gauge bevelled wire which is used by a slow-speed handpiece, which perforates the cortical bone. After perforation, anesthetic solution is delivered into the cancellous bone with a 27-gaugeultrashort needle using a standard anesthetic syringe [17]. The insertion point should be on the attached gingiva, 2mm below the facial gingival margin, and midway between the tooth to be treated and an immediately adjacent tooth [7].

3.9.2 X- tip

X- tip system (Dentsply, York, PA, USA) consists of three parts: The driller, a 25-gauge sleeve that fits over the 27- gauge drill, and an ultra- short needle. The needle leads the guide sleeve into the cancellous bone. Using the guide sleeve, the needle 190 is directed into the cancellous bone to deposit the anesthetic solution [7].

3.9.3 Intra flow

The Intra Flow (Pro-DexInc, Santa Ana, CA,USA) anesthesia delivery system is designed as an all – in –one system that allows the clinician to perforate the bone and deposit anesthetic solution in a single step. The intra Flow device consists of a 24 gauge hollow perforator which is used to perforate the bone and infuse the local anesthetic solution [7,45].

3.9.4 Comfort control syringe

The Comfort Control Syringe (Dentsply, York, PA, USA) is an electronic system for delivering local anesthesia .It consists of 5 different injection rates that are preprogrammed into the system [41].

In mandibular molars with irreversible pulpitis, Supplimental IO injection has shown adequate pain relief [17,38,42,43,44].

3.9.5 Disadvantages

1. Transient increase in heart rate with Stabident and X-Tip systems when injecting with epinephrine- and levonordefrin-containing anesthetic solutions. [16,46,47].
2. Dentinal tooth damage [48].
3. osteonecrosis of bone [48].

Comparison between Intraligamentary and Intra Osseous injection (18,19,20,27,38,42,44)

	Intraligamentary Injection	Intraosseous Injection
Success of Injection	50-96%	79-91%
Amount of solution delivered	0.2 ml	1 ml
Onset of Anesthesia	Immediate	Immediate
Duration of action	10-20 min	Anesthesia for entire debridement.
Systemic effects	No change in heart rate, rhythm, amplitude, blood pressure.	Increased heart rate, tachycardia.

3.9.6 Intraseptal anesthesia

Intraseptal anesthesia can be considered as a supplemental anesthesia technique for reducing pain in endodontic treatment.

3.9.6.1 Procedure

A 27- gauge short needle is recommended for intraseptal ansthesia. Prior to injection, apply topical anesthesic for about 1 minute. Area of insertion of the injection will be center of the interdental papilla adjacent to the tooth to be treated. Slowly inject few drops of anesthetic solution as the needle enters soft tissue and advance the needle till it reaches the bone. Apply pressure to the syringe and push the needle into the interdental septum and deposit 0.2-0.4 ml of local anesthetic solution.

Factors indicating success of intrseptal injection

1. Resistance to the deposition of solution
2. Ischema of soft tissue adjacent to the injection area [49].

3.9.6.2 Intrapulpal Anesthesia

Even after injecting supplemental injections, 5-10% of tooth diagnosed with irreversible pulpitis shows pain during treatment. In this situation, intrapulpal anesthesia is an alternative.

This method on relies on the principle of back pressure. Once the tooth is opened till pulp chamber, solution is injected into the pulp under pressure. The amount of solution injected is around 0.2 ml.

3.9.6.3 Disadvantage

1. Short duration of action
2. Painful injection.

3.9.7 Change in anesthetic solution

A lot of different anesthetic solutions are available for aiming to achieve profound anesthesia to the patient. But all solutions are not advocating by the author for managing a 'Hot tooth' condition. For eg; studies shows that Hyaluronidase can be used for managing a Hot tooth condition. But because of adverse effects such as increased pain and trismus, author is not suggesting this solution for treating such situations [58]. So this article is focusing only on commonly used anesthetic solutions which aims to provide profound anesthesia to the patient.

3.9.7.1 1.4% Articaine

Anesthetic efficiency of 4% articaine with 1:100,000 epinephrine shows higher anesthetic efficiency than using 2% lidocaine with 1:100,000 epinephrine when used as buccal infiltration [50,51,52,55]. Mechanism of action is that articaine contains a thiophene group, which increases its lipid solubility. Lipid solubility determines the extent of molecules penetration into the nerve membranes. Therefore, articaine diffuses better through soft tissues than do other anesthetics, thereby causing better anesthesia [52,53,54].

3.9.7.2 Mandibular Buccal infiltration with articaine

Mandibular buccal infiltration with 4% articaine could be considered as a supplemental injection technique. Studies shows that buccal infiltration of 4% articaine shows higher anesthetic efficiency as compared to 2% lidocaine solution [59,60,61,62].

3.9.7.3 0.5 M Mannitol

Combination of 0.5 M mannitol and lidocaine with epinephrine in Inferior Alveolar Nerve Blocks shows higher anesthetic efficiency compared to lidocaine and epinephrine alone [56,57].

4. CONCLUSION

Management of hot tooth in endodontics always faces a challenge to the clinician. One should have thorough knowledge regarding the supplemental anesthesia techniques and the way to use it. Managing hot tooth with different anesthetic solution is also becoming a trend. Still studies are going on regarding this area. Due to the advancements of supplemental injection techniques and different anesthetic solutions, managing a hot tooth condition is now no longer a threat to the dentist.

COMPETING INTERESTS

Authors Have Declared that no competing interests exists.

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