**Review Article**

 **Eliminating pain : A Review on management of hot tooth**

**ABSTRACT**

Successful and efficient pain management techniques are necessary for management of orofacial pain. A routine technique used for intraoral pain management is local anaesthetic administration , but in some cases, it is difficult to achieve anaesthesia such as in hot teeth cases with symptomatic irreversible pulpitis(SIP). To achieve pulpal anaesthesia inferior alveolar nerve block (IANB) is considered the standard technique but it is not successful in 41-81% cases of irreversible pulpitis. Various techniques can be used to overcome this anaesthetic failure such as use of premedication, supplementary injections, alternative anaesthetics, anaesthetic solution volume adjustments, and cryotherapy etc. This review article is aimed to describe hot tooth, its identification, signs and symptoms and discuss different techniques for hot tooth management.

**Keywords**: Lidocaine ,Anaesthesia, Intraseptal, Intraligamentary, Premedication.

 **INTRODUCTION**

Orofacial pain management can be achieved by local anesthetic application in normal oral tissues but fail in inflamed tissues such as in hot teeth with irreversible pulpitis and present a challenge to endodontists1. Pain during endodontic treatment can lead to discomfort for both patients and dentists increasing apprehension and anxiety towards treatment 2. In normal cases inferior alveolar nerve block (IANB) has a failure rate of 15% 3, but in cases of irreversible pulpitis inflammation is present so inferior alveolar nerve block (IANB) can have a failure rate of 41-81% 4. A thorough knowledge of tooth anatomy, nerve supply, foramen location etc. is must to achieve anesthetic success. When conventional techniques of anesthesia fail in cases of inflammation in hot teeth different other strategies are applied for their management. This review aims to discuss different strategies for management of hot teeth.

Incidence

Highest incidence of hot teeth is in mandibular molars- 44-81% 5.

Reasons for anesthetic failure in hot tooth-

In endodontic practice successful orofacial pain management is considered to be a keystone. Hot teeth with irreversible pulpitis have inflamed tissues and have 8 times greater resistance than normal tissues 6. Several reasons are responsible for anesthetic failure-

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| 1 | Anatomical 7 | 1. Dense cortical mandibular bone can act as a barrier for diffusion of local anesthesia.
2. Accessory and cross innervations from contralateral inferior alveolar nerve7.
3. Foramen position7.

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| 2 | Inflammation and pH8 | 1. Lower pH at inflamed site leads to less penetration from nerve membrane.
2. Inflammation causes peripheral vasodilatation by release of inflammatory mediators which can affect the systemic absorption of local anaesthetics(LA) adversely and can lower the concentration of LA at its site of action8.
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| 3 | Tetrodotoxin-resistant Channels (TTXr)8 |  Inflamed pulp leads to more TTXr channels activation and causes local anaesthetic failure8. |
| 4 | Nociceptors8 | Inflammation causes release of inflammatory mediators which in turn lead to release of prostaglandins, thus causing increase in sensation of pain8. |

**Identification of hot tooth**

Mostly hot teeth are found at following locations 8-

1. Sites of faulty or recent restorations
2. Sites of traumas that occurred recently.
3. Mandibular molars due to dense cortical bone are difficult to anesthetize.
4. Patients apprehensive and anxious for dental treatment.

Signs8 **-**

1. Deep or faulty restorations.
2. Deep caries.
3. Fracture or craze lines coronally.
4. Mobility of tooth increases.
5. Periodontal ligament is thickened.

Symptoms 8-

1. Pain on biting .
2. Increased sensitivity to temperature extremes.
3. Earlier presentation: often intense, lingering pain in response to cold.

Later presentation: intense pain in response to heat; relieved by cold water.

1. Pain may be poorly localized and impulsive and for maxillary teeth it can often radiate from ear to temple.
2. Pain may radiate to opposite arch but not cross midline.

**Strategies for management of hot tooth –**

Different strategies can be applied to manage hot tooth with symptomatic irreversible pulpitis. These can be used either

1. Preoperative (before treatment) or
2. Perioperative (during treatment).
3. Preoperative management strategies9-

Use of premedications –

1. Nonsteroidal Anti-inflammatory drugs 3,10-16 (NSAIDs, Ibuprofen, combination of Ibuprofen and Acetaminophen, Selective Cox-2 Inhibitors like Rofecoxib etc.)- acts by lowering prostaglandin (PG) levels.
2. Corticosteroids17,18 -Prednisolone, Ibuprofen and Dexamethasone-combination of Ibuprofen and Dexamethasone improved the IANB success rate by 95.66%, while success rate of IANB was raised up to 85.72% by Dexamethasone alone.
3. Nitrous Oxide and Ketamine19- acts on opioid receptors and cause analgesia leading to anaesthetic success.
4. Benzodiazepines 20- acts by reducing anxiety and eliminating patient discomfort.
5. Perioperative management strategies9-
6. Alteration in anaesthetic solution27-36 – Addition of dexamethasone, or mannitol, or sodium bicarbonate to lidocaine, use of Clonidine as a vasoconstrictor and an alternative to epinephrine, Addition of magnesium sulphate, use of Amitriptyline local gel along with local anaesthesia , Prewarming the anaesthetic solution.
7. Cryotherapy 37.
8. Supplemental anaesthetic techniques38-52- Intraligamentary technique, Buccal infiltration, Submucosal technique for injection, Intraosseous injection technique, Intraseptal injection, Gow–Gates technique, Vazirani–Akinosi Technique.
9. Preoperative management strategies9-

Premedications-

1. Nonsteroidal Anti-inflammatory drugs (NSAIDs) 3,10-16-

Use of NSAIDs and pain relief: By NSAIDs prostaglandin production is inhibited, and it decreases the sensitization of nociceptor neurons and reduces the transmission of pain signals, providing relief from inflammation and pain. Commonly used NSAIDs are-

1. Use of Ibuprofen: Noguera-Gonzales et al. observed that in SIP, ibuprofen (600 mg) improved the IANB efficiency significantly10 .
2. Combination of Ibuprofen and Acetaminophen: This combination can be used as an alternative to NSAIDs sensitive patients with hypertension and gastro-intestinal ulcers11.
3. Other commonly used NSAIDs: Different combinations of NSAIDs (paracetamol+ etodolac , and paracetamol + acelofenac, ketorolac),12 Diclofenac, Ketorolac etc can be used. 20 mg. Piroxicam used I hour before IANB improve success rate compared with 550 mg naproxen sodium and 50 mg diclofenac potassium13 .
4. Specific COX-2 inhibitors14-16 : Meloxicam, Rofecoxib are COX-2 inhibitors that are more effective than ibuprofen in decreasing post-endodontic pain.
5. Corticosteroids17,18 -
6. Prednisolone- An anti-inflammatory steroidal drug acts by inhibiting phospholipase A2 synthesis reducing PGs levels and pro inflammatory cytokines. A study found 30 mg. Prednisolone given 30 minutes before the treatment reduces post treatment pain17.
7. Dexamethasone and Ibuprofen- By blocking COX pathway combination of Ibuprofen and Dexamethasone improved the IANB success rate by 95.66%, while success rate of IANB was raised up to 85.72% by Dexamethasone alone18.
8. Nitrous Oxide and Ketamine19 – A study found that 10 mg of ketamine is effective for improving the local anaesthetic success rate. It acts on N-methyl-D-aspartate (NMDA) and opiate receptors for analgesic effect19.
9. Benzodiazepines (BZDP)20- Acts by reducing anxiety and eliminating patient discomfort. A study found that 0.5 mg of preoperative dose of alprazolam orally reduced anxiety but didn’t improve IANB success20. A study demonstrated 0.5 mg alprazolam along with the Gow–Gates technique reduced acute pain in SIP21.
10. Perioperative Management Strategies9-
11. Alteration in anaesthetic solution22-30.
12. Cryotherapy31.
13. Supplemental anaesthetic techniques.

Alteration in anaesthetic solution22-30-

1. Adding dexamethasone to lidocaine22 : Also known as twin mix. Dexamethasone alone can efficiently relieve pain and its combination with lidocaine lead to improvement in sensory blockage , increase in pH and increased concentration of free base in LA solution. Lidocaine(2% ) with epinephrine(1:200,000) 1.8 mL and 4 mg. dexamethasone 1 mL increased anaesthetic duration and reduced latency for anaesthesia22.
2. Adding mannitol to lidocaine23 : This addition cause expansion of perineural membrane and improved penetration of lidocaine which is lipophilic in nature. 0.5 M mannitol when added to lidocaine with epinephrine(1:200,000) led to higher pulpal anaesthesia than lidocaine alone23.
3. Addition of Clonidine as an alternative vasoconstrictor to epinephrine24-26: Clonidine an alpha-2 adrenoceptor agonist , acts centrally and peripherally and increases threshold for pain by causing vasoconstriction of peripheral blood vessels. Clonidine inhibits A-delta and C-fibers and is a safe alternative for vasoconstrictor to epinephrin due to its fewer cardiotoxic adverse effects24,25. A study demonstrated that if clonidine(15 gm/mL) is added to lidocaine there is better IANB anaesthesia26 .
4. Magnesium sulfate27: Magnesium sulfate is a N-methyl-D-aspartate (NMDA) receptor antagonist. NMDA receptors overexpression can be a reason for anaesthetic failure by central sensitization. A study demonstrated magnesium sulfate (1 mL ) USP 50% can be used preoperatively to increase anaesthetic efficiency because of its action of blocking calcium channel that transports pain27.
5. Adding sodium bicarbonate to LA28: Alkalinization can reduce pain if added to LA solution. Buffered LA decreases pain on injection, improves onset of anaesthesia , and anaesthetic success. A study demonstrated that IANB efficacy is improved by buffered 2% lidocaine28.
6. Use of Amitriptyline as a local gel along with local anaesthetics29: App. 0.4 mg amitriptyline local gel can effectively complement LA effectiveness in reducing pain of irreversible pulpitis29.
7. Prewarming the LA solution30: Prewarming to 37–42°C of the LA solution has reduced discomfort and pain as compared to LA at normal room temperature30.

Cryotherapy31 –

By decreasing threshold for activation of nociceptors cryotherapy led to an improvement in local anaesthetic efficacy. A study demonstrated that root canals irrigation with a cold saline for 5 minutes (at 2.5°C) decreased postoperative pain and discomfort31.

Supplemental anaesthetic techniques32-39-

When IANB anaesthesia alone fails in cases of SIP , different supplemental techniques of anaesthesia are applied to achieve proper pulpal anaesthesia for patient comfort and cooperation for treatment. Different techniques that can be used as supplemental techniques are-

1. Buccal infiltration32
2. Intraligamentary injection33-35.
3. Intraseptal technique36,37.
4. Intraosseous technique38,39
5. Gow–Gates technique35.
6. Vazirani–Akinosi Technique35,38,39.
7. Intrapulpal anaesthetic technique7.

Buccal infiltration(BI)32: 4% articaine infiltration with epinephrine(1:100,000 ) raised the success in failed cases of IANB up to 58% .

Intraligamentary injection33-35: LA solution (0.2 mL ) was deposited into the periodontal ligament space ( between root of tooth and alveolar bone) at 30–40° angle with 27–30G needle, up to a depth of 2–3 mm sub-gingivally33-34. Success rate is achieved up to 84% after failed IANB35.

Intraseptal injection36,37: When LA solution is deposited into interdental septum for intraseptal injection along with BI and IANB success rate in raised to 80% than IANB + BI (66.6%) or IANB alone (30.3%) in SIP.

Intraosseous (IO) technique38,39: LA solution is deposited into porous cancellous bone around tooth using perforators38. Success rate is raised up to 90% when given along with IANB39.

Gow–gates /Wide open mouth technique35: Using extraoral landmarks entire mandibular nerve is anaesthetized. A study demonstrated that 4% articaine (2.2 mL) with adrenaline (1:100,000) by the Gow–Gates technique improved pulpal anaesthesia success rate by 53% in SIP cases as compared to IANB alone35.

Vazirani–akinosi / Limited mouth opening technique35,38,39 : Needle is inserted medial to the ramus of the mandible in a closed mouth position and LA solution is deposited into pterygomandibular space38. Success rate 41% is achieved but is insignificant. This technique is especially useful in limited mouth opening cases35.

Intrapulpal anaesthetic technique7: Mandibular posterior teeth (app. 5–10%) requires intrapulpal anaesthesia in cases of SIP and LA solution (0.2Ml) is deposited directed into pulpal chamber with high pressure7.

**CONCLUSION**

In endodontics, management of hot tooth is always an enigma to the clinician. So, a thorough and detailed knowledge of different management strategies is must. These days, different supplemental anaesthesia techniques and alteration in anaesthetic solution are becoming increasingly popular. Still further studies can be done to discover new management strategies.

**Clinical significance**

In endodontics, management of hot tooth always present challenges to the dentist as incidence of hot tooth is quite common in cases of irreversible pulpitis. Achieving effective pulpal anaesthesia in such cases can be very difficult. This review article was aimed to highlight the numerous reasons for anaesthetic failure and to discuss most efficient strategies for management of “hot” tooth.

DISCLAIMER (ARTIFICIAL INTELLIGENCE) Author(s) hereby declares that generative AI technologies such as ChatGPT (Free version, GPT 4o mini, downloaded from Google Chrome) was used to just frame the title only. No other addition was done using AI technology.

CONSENT AND ETHICAL APPROVAL It is not applicable.

DATA AVAILABILITY STATEMENT The data is available with the main author on request.

**REFERENCES**

1. Bigby J, Reader A, Nusstein J, Beck M, Weaver J. Articaine for supplemental intraosseous anesthesia in patients with irreversible pulpitis. J Endod 2006; 32(11): 1044-7
2. Karapinar-Kazandag M, Tanalp J, Ersev H. Effect of premedication on the success of inferior alveolar nerve block in patients with irreversible pulpitis: A systematic review of the literature. Biomed Res Int 2019;2019:6587429. DOI: 10.1155/2019/6587429
3. Ingle JI, Bakland LK. Preparation for Endodontic Treatment. In: Endodontics. 5th ed, Hamilton (ON): BC Decker; 2002: 385-8.
4. Matthews R, Drum M, Reader A, Nusstein J, Beck M. Articaine for supplemental buccal mandibular infiltration anesthesia in patients with irreversible pulpitis when the inferior alveolar nerve block fails. J Endod 2009; 35(3): 343-6.
5. Balivada A, Chandra V. The endodontic enigma: Hot tooth; Global J Res Anal 2023;12(3). DOI: 10.36106/gjra.
6. Meechan JG. Why does local anaesthesia not work everytime? Dent Update 2005;32(2):66–68, 70–72. DOI: 10.12968/denu.2005.32.2.66.
7. Boopathi T, Sebeena M, Sivakumar K, et al. Supplemental pulpal anesthesia for mandibular teeth. J Pharm Bioallied Sci 2013;5(Suppl 1): S103–S108. DOI: 10.4103/0975-7406.113307.
8. Sahu S, Kabra P, Choudhary E. Hot tooth – A challenge to endodontist. Int J Sci Res (IJSR) 2019;8(3):106–109. DOI: 10.21275/ART20195849.
9. Shoba J, Koshy M, Anirudhan S, Kalaichelvan T. Effective strategies to manage the clinically challenging hot tooth: A review. J Operat Dent Endod. 2024 Apr 30;8(1):17-22.
10. Noguera-Gonzalez D, Cerda-Cristerna BI, Chavarria-Bolaños D, et al. Efficacy of preoperative ibuprofen on the success of inferior alveolar nerve block in patients with symptomatic irreversible pulpitis: A randomized clinical trial. Int Endod J 2013;46(11):1056–1062. DOI: 10.1111/iej.12099.
11. Simpson M, Drum M, Nusstein J, et al. Effect of combination of preoperative ibuprofen/acetaminophen on the success of the inferior alveolar nerve block in patients with symptomatic irreversible pulpitis. J Endod 2011;37(5):593–597. DOI: 10.1016/j.joen.2011.02.015.
12. Jena A, Shashirekha G. Effect of preoperative medications on the efficacy of inferior alveolar nerve block in patients with irreversible pulpitis: A placebo-controlled clinical study. J Conserv Dent 2013;16(2):171–174. DOI: 10.4103/0972-0707.108209.
13. Wali A, Siddiqui TM, Qamar N, et al. Effectiveness of premedication with analgesics vs placebo for success of inferior alveolar nerve block in irreversible pulpitis. Int J Prosthodont Restor Dent 2012;2(1):5–9. DOI: 10.5005/jpjournals-10019-1038.
14. Malmstrom K, Daniels S, Kotey P, et al. Comparison of rofecoxib and celecoxib, two cyclooxygenase-2 inhibitors, in postoperative dental pain: A randomized, placebo- and active-comparator-controlled clinical trial. Clin Ther 1999;21(10):1653–1663. DOI: 10.1016/S0149- 2918(99)80045-9.
15. Gopikrishna V, Parameswaran A. Effectiveness of prophylactic use of rofecoxib in comparison with ibuprofen on postendodontic pain. J Endod 2003;29(1):62–64. DOI: 10.1097/00004770-200301000- 00017.
16. Shantiaee Y, Javaheri S, Movahhedian A, et al. Efficacy of preoperative ibuprofen and meloxicam on the success rate of inferior alveolar nerve
17. Jalalzadeh SM, Mamavi A, Shahriari S, et al. Effect of pretreatment prednisolone on postendodontic pain: A double-blind parallel randomized clinical trial. J Endod 2010;36(6):978–981. DOI: 10.1016/j. joen.2010.03.015.
18. Kumar M, Singla R, Gill GS, et al. Evaluating combined effect of oral premedication with ibuprofen and dexamethasone on success of inferior alveolar nerve block in mandibular molars with symptomatic irreversible pulpitis: A prospective, double-blind, randomized clinical trial. J Endod 2021;47(5):705–710. DOI: 10.1016/j.joen.2021.01.005.
19. Kaviani N, Khademi A, Ebtehaj I, et al. The effect of orally administered ketamine on requirement for anesthetics and postoperative pain in mandibular molar teeth with irreversible pulpitis. J Oral Sci 2011;53(4):461–465. DOI: 10.2334/josnusd.53.461.
20. Khademi AA, Saatchi M, Minaiyan M, et al. Effect of preoperative alprazolam on the success of inferior alveolar nerve block for teeth with irreversible pulpitis. J Endod 2012;38(10):1337–1339. DOI: 10.1016/j.joen.2012.06.007.
21. Shetkar P, Jadhav GR, Mittal P, et al. Comparative evaluation of effect of preoperative alprazolam and diclofenac potassium on the success of inferior alveolar, Vazirani-Akinosi, and Gow-Gates techniques for teeth with irreversible pulpitis: Randomized controlled trial. J Conserv Dent 2016;19(5):390–395. DOI: 10.4103/0972-0707.190013.
22. Bhargava D, Sreekumar K, Rastogi S, et al. A prospective randomized double-blind study to assess the latency and efficacy of twin-mix and 2% lignocaine with 1:200,000 epinephrine in surgical removal of impacted mandibular third molars: A pilot study. Oral Maxillofac Surg 2013;17(4):275–280. DOI: 10.1007/s10006-012-0372-3.
23. Kreimer T, Kiser R 2nd, Reader A, et al. Anesthetic efficacy of combinations of 0.5 mol/L mannitol and lidocaine with epinephrine for inferior alveolar nerve blocks in patients with symptomatic irreversible pulpitis. J Endod 2012;38(5):598–603. DOI: 10.1016/j.joen.2012. 02.016.
24. Wang C, Knowles MG, Chakrabarti MK, et al. Clonidine has comparable effects on spontaneous sympathetic activity and afferent A delta and C-fiber-mediated somatosympathetic reflexes in dogs. Anesthesiology 1994;81(3):710–717. DOI: 10.1097/00000542- 199409000-00025.
25. Patil PM, Patil SP. Is clonidine an adequate alternative to epinephrine as a vasoconstrictor in patients with hypertension? J Oral Maxillofac Surg 2012;70(2):257–262. DOI: 10.1016/j.joms.2011.07.011.
26. Shadmehr E, Aminozarbian MG, Akhavan A, et al. Anaesthetic efficacy of lidocaine/clonidine for inferior alveolar nerve block in patients with irreversible pulpitis. Int Endod J 2017;50(6):531–539. DOI: 10.1111/ iej.12659.
27. Shetty KP, Satish SV, Kilaru KR, et al. Comparison of anesthetic efficacy between lidocaine with and without magnesium sulfate USP 50% for inferior alveolar nerve blocks in patients with symptomatic irreversible pulpitis. J Endod 2015;41(4):431–433. DOI: 10.1016/j. joen.2015.01.003.
28. Shurtz R, Nusstein J, Reader A, et al. Buffered 4% Articaine as a primary buccal infiltration of  the  mandibular first molar: A prospective, randomized, double-blind study. J Endod 2015;41(9):1403–1407. DOI: 10.1016/j.joen.2015.05.005.
29. Moghadamnia AA, Partovi M, Mohammadianfar I, et al. Evaluation of the effect of locally administered amitriptyline gel as adjunct to local anesthetics in irreversible pulpitis pain. Indian J Dent Res 2009;20(1):3–6. DOI: 10.4103/0970-9290.49047.
30. Kurien RS, Goswami M, Singh S. Comparative evaluation of anesthetic efficacy of warm, buffered and conventional 2% lignocaine for the success of inferior alveolar nerve block (IANB) in mandibular primary molars: A randomized controlled clinical trial. J Dent Res Dent Clin Dent Prospects 2018;12(2):102–109. DOI: 10.15171/joddd.2018.016.
31. Keskin C, Özdemir Ö, Uzun İ, et al. Effect of intracanal cryotherapy on pain after single-visit root canal treatment. Aust Endod J 2017;43(2):83–88. DOI: 10.1111/aej.12175.
32. Kanaa MD, Whitworth JM, Corbett IP, et al. Articaine and lidocaine mandibular buccal infiltration anesthesia: A prospective randomized double-blind cross-over study. J Endod 2006;32(4):296–298. DOI: 10.1016/j.joen.2005.09.016.
33. Burtscher D, Dalla Torre D. Intraligamentary anesthesia – A brief review of an underestimated anesthetic technique. Oral Heal Care 2019;4(4). DOI: 10.15761/OHC.1000177.
34. Dreyer WP, van Heerden JD, de V Joubert JJ. The route of periodontal ligament injection of local anesthetic solution. J Endod 1983;9(11):471–474. DOI: 10.1016/S0099-2399(83)80161-7.
35. Aggarwal V, Singla M, Miglani S, et al. Efficacy of articaine versus lidocaine administered as supplementary intraligamentary injection after a failed inferior alveolar nerve block: a randomized double-blind study. J Endod 2019;45(1):1–5. DOI: 10.1016/j.joen.2018. 09.012.
36. Webster S Jr, Drum M, Reader A, et al. How effective is supplemental intraseptal anesthesia in patients with symptomatic irreversible pulpitis? J Endod 2016;42(10):1453–1457. DOI: 10.1016/j.joen.2016. 07.002.
37. Dianat O, Mozayeni MA, Layeghnejad MK, et al. The efficacy of supplemental intraseptal and buccal infiltration anesthesia in mandibular molars of patients with symptomatic irreversible pulpitis. Clin Oral Investig 2020;24(3):1281–1286. DOI: 10.1007/s00784-019- 03006-8.
38. Gallatin J, Reader A, Nusstein J, et al. A comparison of two intraosseous anesthetic techniques in mandibular posterior teeth. J Am Dent Assoc 2003;134(11):1476–1484. DOI: 10.14219/jada.archive.2003.0077.
39. Akinosi JO. A new approach to the mandibular nerve block. Br J Oral Surg 1977;15(1):83–87. DOI: 10.1016/0007-117x(77)90011-7.