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OPEN ACCESS CASE REPORT

Management of Hot Tooth in Endodontics: An Updated Review

Pujari Bhargav[1*], Vamsee Krishna Nallagatla[1], M. Chandra Sheaker[1], C. Sunil Kumar[1], S. Sunil Kumar[1], R. Bharathisuma[1]

[1] *Conservative Dentistry & Endodontics, CKS Teja Institute of Dental Sciences & Research, Tirupathi, India.*

ABSTRACT

Endodontic treatments are performed in pulpal inflammation conditions where local anesthesia is the most important pain control measure. But achieving local anesthesia in inflamed tissues is still a difficult process. Anatomical variations, inflammation & anxiety are the main factors responsible for anesthetic failure. The strategies for the management of the patient include; patient education, anxiety management, & pharmacological management to increase the success rate of local anesthesia. Other techniques include intraligamentary, intraosseous, intraseptal and intrapulpal injections to improve anesthesia, especially where conventional methods have failed. Each method has different efficacy and discomfort, and among them, intraosseous and intraligamentary injections have been found to be effective in enhancing the success of local anesthesia. This review explains the causes of local anesthetic failure and outlines the management to maximize patient's comfort in endodontic treatment.

Keywords: Irreversible pulpitis, anesthetic failure, Hot Tooth, Pain management, Supplemental anesthetic techniques.

**** Corresponding author address:*** luckybhargav212@gmail.com

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INTRODUCTION

Endodontic procedures rely on effective pain management to ensure patient comfort. One of the most common and safe methods for achieving this is the administration of local anesthesia within the oral cavity. This approach effectively numbs the targeted area, enabling the dentist to perform the treatment without causing undue discomfort. Local anesthetic techniques used during endodontics are generally regarded as reliable and carry a low risk of complications, making them an essential component of the treatment process [1]. In patients with pulpal inflammation, achieving local anesthesia can be difficult, leading to a condition known as a "hot tooth," where traditional local anesthetic techniques may be less effective [2]. Somya Sahu et al. stated that a patient drinking cold water to relieve intense dental pain is a common scenario involving a "hot tooth. In endodontic terms, a "hot tooth" does not refer to a tooth that is physically hot or attractive. Instead, it describes a tooth with irreversible pulpitis (symptomatic irreversible pulpitis), characterized by spontaneous, moderate-to-severe pain [3]. Anesthetic failure can be attributed to several factors, including accessory innervation, patient anxiety and fear, the concentration and quantity of the anesthetic administered, the technique used by the operator, abnormal physiological responses due to inflammation, and anatomical variations [4].
"Electronic databases such as PubMed, Scopus, and ResearchGate were searched using keywords 'Hot Tooth,' 'Anesthetic Failure,' 'Irreversible Pulpitis,' 'Pain Management,' and 'Supplemental Anesthetic Techniques' to gather relevant data.

Clinical Signs and Symptoms of Hot Tooth

Signs of irreversible pulpitis include

- deep restorations or caries,
- coronal fractures,
- increased tooth mobility, and
- thickening of the periodontal ligament.

Symptoms typically include

- pain when biting or during percussion testing,
- heightened sensitivity to temperature extremes, and
- intense, lingering pain in response to cold in the early stages.

As the condition progresses, pain becomes more intense with heat and is relieved by cold water. The pain may also be impulsive, poorly localized, and radiate from the ear to the temple for maxillary teeth. Additionally, pain may shift to the opposite arch but not cross the midline [3].

Causes for Anesthetic Failure in Patients with a Hot Tooth

Irreversible pulpitis is characterized by intense, piercing pain that may persist for several minutes to hours at a time. Severe inflammation of the pulp frequently results in inadequate anesthesia during [5]. When tissue is inflamed, the pH drops, reducing the amount of anesthetic in its base form that can penetrate nerves [6]. Consequently, some of the active ionized form accumulates inside the nerve, reducing the anesthetic's effectiveness. Moreover, nerves in inflamed tissue show changes in their resting potentials & become easier [7].

Multiple elements play a role in the unsuccessful outcome of local anesthesia, including

- Improper injection techniques [8],
- Significant variations in neuroanatomy [9], and
- The activation of nociceptors [10].

In mandibular molars, dense cortical bone acts as a barrier to the penetration of anesthetic, whereas the thinner bone in the maxilla allows for easier diffusion. Insufficient anesthesia can also result from additional nerve branches or cross innervation by the contralateral inferior alveolar nerve (IAN). Additionally, the position of foramina and the tooth's alignment also have a role in the effectiveness of the local anesthetics [11].
The acidic environment of inflamed tissue lowers the pH, limiting the penetration of the anesthetic's base form through the nerve sheath & membrane. Due to this, less of the ionized form reaches the nerve, leading to reduced anesthetic effectiveness. Ion trapping is more commonly associated with infiltration injections, whereas block injections are generally less affected by the acidic conditions of inflamed tissues [12].

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Management of Hot Tooth

Patient education

Educating patients is an essential aspect of dental care. Generally, dentists are responsible for explaining treatment procedures, whereas dental hygienists and prevention assistants usually provide guidance on oral hygiene and preventive measures [13]. Patients should be well-informed about their treatment to ensure they are mentally prepared for the procedures, helping to eliminate the fear of the unknown and reduce anxiety.

Management of anxiety

Fear & anxiety trigger physical, emotional, cognitive, & behavioral reactions in individuals, making it a common issue in dental practices. Anxiety is usually associated with painful stimuli & heightened perception of pain, causing patients to experience more intense and prolonged pain, and they may also have an exaggerated memory of the pain [14].

1. Preoperative Anxiety Assessment

The initial step in managing dental anxiety is to identify anxious patients, often achieved through self-reported questionnaires like the Dental Anxiety Scale. Studies show that recognizing and addressing the patient's anxiety is vital for building trust and fostering a calmer, more comfortable environment [15].

2. Pharmacological Management

The administration of oral benzodiazepines is a common practice for managing anxiety or inducing sedation, but prolonged use, especially beyond a few weeks, can lead to physical & psychological dependence and an increased tolerance. In the Dental Practitioners Formulary, diazepam and temazepam are the oral benzodiazepines approved for use and may be prescribed as premedication before dental procedures [16]. In general, benzodiazepines may be contraindicated in patients with hepatic impairment [17].

3. Behavioral Techniques

Cognitive behavioral therapy & behavioral management effectively reduce patient anxiety. However, studies revealed that individuals with increased anxiety levels were less receptive to these approaches [18].

Role of premedication

Various approaches are developed for managing a "hot tooth," with a significant focus on reducing inflammation before administering local anesthesia. The nociceptive fibers, even at low activation thresholds, are stimulated by inflammatory mediators. Premedication strategies have been employed to enhance anesthetic efficacy by reducing inflammation through the inhibition of prostaglandins & other mediators, which causes pain [19]. It can be difficult to obtain adequate anesthesia in symptomatic irreversible pulpitis conditions. These cases can be managed effectively by administering premedication one hour before local anesthesia [20]. Premedication is recommended with anti-inflammatory drugs.

Modaresi et al. studied the effect of premedication before anesthesia with ibuprofen & acetaminophen in irreversible pulpitis condition [21]. Taking oral non-steroidal anti-inflammatory drugs (NSAIDs), particularly 600 mg ibuprofen, one hour before inferior alveolar nerve block can improve pain relief [22]. NSAIDs like aspirin & ibuprofen are the most commonly used drugs for relieving pain because of their anti-inflammatory & analgesic properties. Paracetamol provides strong pain relief but has minimal anti-inflammatory effects. Opioids, while potent analgesics, have common side effects and should be used in severe pain cases. Codeine (60 milligrams), typically combined with paracetamol (1000 milligrams), is the most commonly used opioid [23]. NSAIDs such as aspirin reduce the antiplatelet effect and have a thrombogenic effect on platelet function. NSAIDs raise systolic blood pressure by about 5 mmHg and contribute to fluid retention, making them contraindicated for long-term use [24].

Role of Electric Pulp Test (EPT) in checking Local Anaesthesia

EPT is recognized as an effective tool in evaluating pulp status in primary teeth. It has demonstrated high accuracy when compared to other pulp sensibility testing techniques [25]. A-delta fibers present in the dentin-pulp complex are stimulated when an electric current is applied to the tooth. A positive response occurs when the nerves are not fully anesthetized. The EPT is well-established as an indicator of local anesthesia in permanent teeth [26]. Following the injection of local anesthetic, traditional dental

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anesthesia indicators, such as lip numbness and mucosal sensitivity, were assessed [27]. EPT should be used cautiously in patients with cardiac pacemakers [28].

Test Cavity Preparation

Before beginning access preparation, a small test cavity can be created to verify the effectiveness of the anaesthesia [29].

Additional anesthetic/supplemental injections

Intraligamentary injection

Research on the anesthetic efficacy of intraligamentary supplemental injection in hot tooth condition has shown a success rate of 85%. A promising approach to enhance endodontic anesthesia involves placing the anesthetic solution near the root apex. Due to the obstruction caused by a thick buccal cortical plate, intraligamentary injections offer a less invasive solution. A conventional syringe or a pressure syringe is used for this approach, applying high pressure to deliver the anesthetic solution into the periodontal space (Figure 1) [30-32].

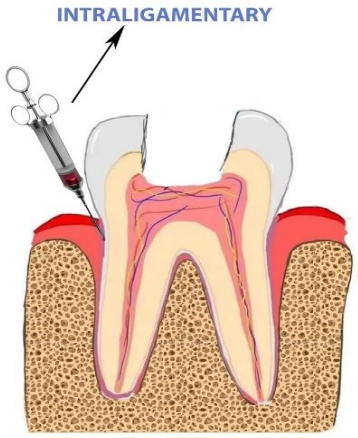

Figure 1: Intraligamentary injection

Aggarwal et al. reported that 2% lidocaine with epinephrine (1.2 ml), when administered as a supplementary intraligamentary injection, produced higher rates of anesthetic success [33]. Whereas Nusstein et al. found an increase in success rate when 2% lidocaine with epinephrine (1.4 ml) was administered via a computer-controlled local anesthetic system [34].

Pulpal anesthesia is typically achieved 30 seconds after an intraligamentary injection. Key factors for success with this technique include proper needle positioning and administering the anesthetic under pressure. The clinician should feel resistance during the injection, and applying significant pressure is advised to ensure the best results [35]. Temporary undesirable side effects after intraligamentary injection are postoperative pain due to high pressure during injection [36].

Intraosseous (IO) injection

IO injection can be a valuable addition to a dentist's local anesthetic techniques, particularly when supplemental anesthesia is needed [37]. IO anesthesia delivers the anesthetic solution into the cancellous bone directly, enabling rapid access to the periapical area and the nerve's axonal region (Figure 2).

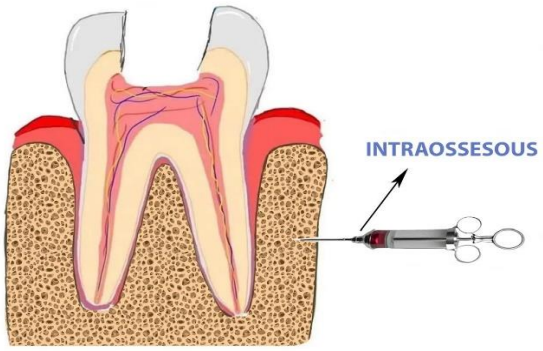

Figure 2: Intraosseous injection

The transcortical injection avoids nerve injuries caused by intraoral nerve blocks in symptomatic pulpitis cases, decreasing the likelihood of unintentional vessel injection or damage to the lingual nerve [38]. Studies done by Martinez et al. in comparison of IO injection with IAN block for managing hot teeth in the posterior mandibular region required no supplementary anesthesia [39]. Manfred Niliu et al. reported that when IO anesthesia was used alongside IAN block, it outperformed the combination of intraligamentary & IAN block [40].
Razavian et al. reported risk of root injury and temporary tachycardia with IO injection. The authors

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also noted that the equipment is expensive for IO injection. For these reasons, they are not preferring IO as the primary technique [41].

Intraseptal anesthesia

Intraseptal anesthesia is particularly beneficial when used in combination with regional blocks for both maxillary and mandibular teeth [42]. Anesthesia is delivered directly into the interdental septum, which spreads via porous alveolar bone into the surrounding cancellous bone [43].

In Woodmansey's injection method, the needle is advanced until it reaches the bone, penetrating the osseous crest, and pressing it firmly into the interdental septum for administering the anesthetic. Woodmansey also suggested performing the intraseptal injection at the proximal sides of the tooth to ensure complete pulpal anaesthesia [44].

The intraseptal technique delivers local anesthesia to a single tooth and its surrounding soft tissues. It works by anesthetizing the nerve endings in the tissues associated with the specific tooth [45]. Bonar T et al. found that the intraseptal injection increased the success rate for anesthesia in the mandibular first molar [46]. Dianat et al. proved that supplementing an IAN block with an intraseptal injection in symptomatic irreversible pulpitis of mandibular molars increased the success rate of anesthesia [47]. Brkovic et al. has reported that intraseptal injection is more effective in managing postoperative pain than intraosseous and intraligamentary injections [48].

Intrapulpal anesthesia

Achieving profound anesthesia during an endodontic procedure can be challenging for various reasons. When the pulp is exposed, anesthetic can be directly injected into the pulp (Figure 3). However, intrapulpal anesthesia is typically a painful technique and needs pulpal exposure before administering the anesthetic. Because of this, it is rarely the first choice for dentists as a supplementary anesthetic method [49]. The intrapulpal injection technique (IPI) is often chosen when patients experience pain during pulp extirpation, particularly in cases of a hot tooth. A key factor in the success of IPI is the need to administer the anesthetic under pressure [50].

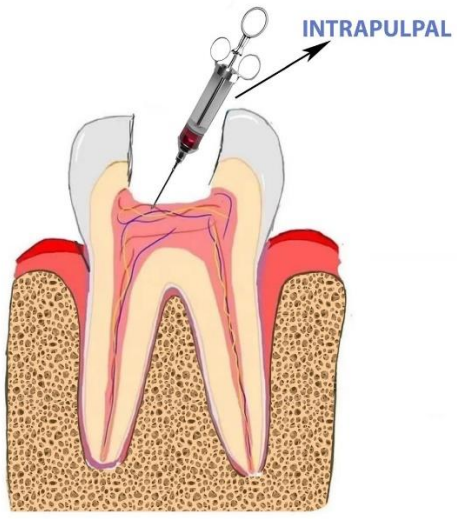

Figure 3: Intrapulpal injection

Monheim et al. suggested that sustained pressure can cause degeneration of nerve fibers, resulting in profound anesthesia [51]. 0.2 to 0.3 ml of local anesthesia is deposited into the pulp with a 27-gauge short needle after inserting it into the pulp chamber. Although this technique can be uncomfortable for the patient, it is generally effective in providing pain relief. In most cases, the anesthesia lasts long enough to allow for the removal of pulpal tissues [52].

Sujatha Gopal Sooraparaju et al. reported that before giving the intrapulpal injection, a mixture of benzocaine gel and hyaluronidase is applied to the exposed pulp to reduce the associated discomfort [53]. Hargreaves et al. suggest that intrapulpal injection should be considered as a last resort, to be used only when all other options have failed [54].

CONCLUSION

Effective pain management during endodontic procedures, particularly for "hot tooth" cases with irreversible pulpitis, requires a comprehensive approach. Local anesthesia can be challenging due to inflammation and anatomical variations, so supplementary techniques like intraligamentary, intraosseous, and intrapulpal injections, along with premedication using NSAIDs like ibuprofen, can improve anesthetic success. These methods target specific areas to overcome barriers like dense bone and accessory innervation. Success depends not only on the clinician's skill but also on patient cooperation

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and anxiety management, making patient education and preoperative assessment crucial for optimal outcomes. Further research or clinical trials are necessary to optimize techniques and patient discomfort for successful management of hot tooth.

Conflict of interest

The authors declare that no conflict of interest.

REFERENCES

1.Abbott PV, Parirokh.M. Strategies for managing pain during endodontic treatment. Aust Endod J. 2018;44(2):99-113. doi: 10.1111/aej.12249

2.Ramachandran A, Khan SIR, Siddeeqh S, Gopinathan PA, Bijai LK, Iyer K. Management Protocols of the Hot Tooth-A KAP Survey among General Dentists and Endodontists. J Pharm Bioallied Sci. 2023;15(Suppl 1):383-390. doi: 10.4103/jpbs.jpbs_99_23

3. Somya Sahu, Pooja Kabra, Ekta Choudhary. Hot Tooth -A Challenge to Endodontists. Int J Sci Res. 2019; 8:106-109. doi:10.21275/ART20195849

4.Rairam S, Belam A, Ratnakar P, Patil V, Kulkarni S, Patil S. Influence of needle gauge on pain perception and use of obturators in achieving profound pulpal anesthesia - A double-blinded in vivo study. J Conserv Dent Endod. 2024;27(8):849-852. doi: 10.4103/JCDE.JCDE_357_24.

5.Wallace JA, Michanowicz AE, Mundell RD, Wilson EG. A pilot study of the clinical problem of regionally anaesthetizing the pulp of an acutely inflamed mandibular molar. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1985;59(5):517–521. doi: 10.1016/0030-4220(85)90095-7.

6.Byers MR, Taylor PE, Khayat BG, Kimberly CL. Effects of injury and inflammation on pulpal and periapical nerves. J Endod. 1990;16(2):78–84. doi:10.1016/S0099-2399(06)81568-2

7.Modaresi J, Dianat O, Soluti A. Effect of pulp inflammation on nerve impulse quality with or without anaesthesia. J Endod. 2008;34(4):438–441. doi: 10.1016/j.joen.2008.01.014.

8.Steinkruger G, Nusstein J, Reader A, Beck M, Weaver J. The significance of needle bevel orientation in achieving a successful inferior alveolar nerve block. J Am Dent Assoc. 2006;137(12):1685–1691. doi: 10.14219/jada.archive.2006.0114

9.Yonchak T, Reader A, Beck M, Meyers WJ. Anesthetic efficacy of unilateral and bilateral inferior alveolar nerve blocks to determine cross innervation in anterior teeth. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2001;92(2):132–135. doi: 10.14219/jada.archive.2006.0114.

10.Henry MA, Hargreaves KM. Peripheral mechanisms of odontogenic pain. Dent Clin North Am. 2007;51(1):19–44. doi: 10.14219/jada.archive.2006.0114.

11. Boopathi T, Sebeena M, Sivakumar K, Harikaran J, Karthick K, Raj A . Supplemental pulpal anesthesia for mandibular teeth. J Pharm Bioallied Sci. 2013;5(Suppl 1):103-108. doi: 10.4103/0975-7406.113307.

12. Shoba J, Koshy M, Anirudhan S, Kalaichelvan T. Effective Strategies to Manage the Clinically Challenging Hot Tooth: A Review. J Oper Dent Endod. 2023; 8:17–22. doi:10.5005/jp-journals-10047-0128

13.Bruers JJ, van Dam BA, den Boer JC. Voorlichting in tandartspraktijken [Patient education in a dental practice]. Ned Tijdschr Tandheelkd. 2008;115(10):519-525.

14.Appukuttan D. Strategies to manage patients with dental anxiety and dental phobia: literature review. Clin CosmetInvestig Dent. 2016; 8:35-50. doi: 10.2147/CCIDE.S63626.

15.Klingberg G, Broberg AG. Dental fear/anxiety and dental behaviour management problems in children and adolescents: a review of prevalence and concomitant psychological factors. Int J Paediatr Dent. 2007;17(6):391-406. doi: 10.1111/j.1365-263X.2007.00872. x.

16.Finn K, Moore D, Dailey Y, Thompson W. The use of oral benzodiazepines for the management of dental anxiety: a web-based survey of UK dentists. Br Dent J. 2023; 24:1–5. doi: 10.1038/s41415-023-5850-5.

17.Ruijia Yang, Rusin Zhao, Fatima Chaudry, Tao Wang, Paul Brunton, Zohaib Khurshid, Jithendra Ratnayake. Modern sedative agents and techniques used in dentistry for patients with special needs: A review. J Taibah Univ Med Sci. 2023;19(1):153-163. doi: 10.1016/j.jtumed.2023.10.004.

18. Harding A, Vernazza C R, Wilson K, Harding J, Girdler N M. What are dental non-attenders preferences for anxiety management techniques? A cross-sectional study based at a dental access centre. Br Dent J. 2015; 218(7):415-421. doi: 10.1038/sj.bdj.2015.249.

19.Appukuttan D. Strategies to manage patients with dental anxiety and dental phobia: literature

https://doi.org/10.20428/yjms.v19i6.2979
https://journals.ust.edu/index.php/yjms

review. Clin Cosmet Investig Dent. 2016; 8:35-50. doi: 10.2147/CCIDE.S63626.
20. Sharma A, Sharma R, Sharma M, Panadan JJ, Ansari MA, Dalai S.Comparative evaluation of effect of different premedication agents on efficacy of Articaine: A randomized control trial. J Oral Biol Craniofac Res. 2023;13(2):218-223. doi: 10.1016/j.jobcr.2023.01.007.
21. Modaresi J, Dianat O, Mozayeni MA. The efficacy comparison of ibuprofen, acetaminophen-codeine, and placebo premedication therapy on the depth of anesthesia during treatment of inflamed teeth. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2006;102(3):399–403. doi: 10.1016/j.tripleo.2005.10.053.
22.Lapidus D, Goldberg J, Hobbs EH, Ram S, Clark GT, Enciso R. Effect of premedication to provide analgesia as a supplement to inferior alveolar nerve block in patients with irreversible pulpitis. J Am Dent Assoc. 2016;147(6):427-437. doi: 10.1016/j.adaj.2016.01.006.
23. Hargreaves K, Abbott PV. Drugs for pain management in dentistry. Aust Dent J. 2005;50(4 Suppl 2):14-22. doi: 10.1111/j.1834-7819. 2005.tb00378.x.
24.Davis A, Robson J. The dangers of NSAIDs: look both ways. Br J Gen Pract. 2016;66(645):172-3. doi: 10.3399/bjgp16X684433.
25.Hori A, Poureslami HR, Parirokh M, Mirzazadeh A, Abbott P. The ability of pulp sensibility tests to evaluate the pulp status in primary teeth. Int J Paediatr Dent. 2011;21(6):441-445. doi: 10.1111/j.1365-263X.2011.01147. x.
26.Renuka MS, Rao AP, Natarajan S, Karuna YM, Nayak PA, Rao S. Reliability of the electric pulp tester as an indicator of pulpal anesthesia in primary maxillary posterior teeth to assess the need for supplemental injections: An observational clinical study. J Indian Soc Pedod Prev Dent. 2023;41(3):228-233. doi: 10.4103/jisppd.jisppd_294_23.
27.Certosimo AJ, Archer RD. A clinical evaluation of the electric pulp tester as an indicator of local anesthesia. Oper Dent. 1996;21(1):25-30.
28.Sriman N, Prabhakar V, Bhuvaneswaran JS, Subha N. Interference of apex locator, pulp tester and diathermy on pacemaker function. J Conserv Dent. 2015;18(1):15-19. doi: 10.4103/0972-0707.148868.
29.Pradnya V.Bansode, Seema D.Pathak, M. B. Wavdhane, Anjali Pandey. The Hot Tooth. Journal of Dental and Medical Sciences. 2017; 16:19-22. doi:10.9790/0853-1612031921
30. Chen LS, Nusstein J, Drum M, Fowler S, Reader A, Guo X. Effect of a combination of nitrous oxide and intraligamentary injection on the success of the inferior alveolar nerve block in patients with symptomatic irreversible pulpitis. J Endod. 2021;47(12):1890–1895. doi: 10.1016/j.joen.2021.08.013.
31.*Aggarwal V, Singla M, Saatchi M, Hasija M. Anaesthetic efficacy of 2% lidocaine with different concentrations of epinephrine (1:80,000 and 1:200,000) in intraligamentary injection after a failed primary inferior alveolar nerve block: a randomized double-blind study. Acta Odontol Scan. 2020;78(4):275–280.* doi: 10.1080/00016357.2019.1700302.
32.Aggarwal V, Singla M, Saatchi M, Gupta A, Hasija M, Meena B. Effect of Cooling of Lidocaine with Epinephrine on the Anesthetic Success of Supplementary Intraligamentary Injection after a Failed Primary Inferior Alveolar Nerve Block: A Randomized Controlled Trial. EurEndod J. 2023;8(4):239-245. doi: 10.14744/eej.2023.41275.
33. Aggarwal V, Singla M, Miglani S, Kohli S, Sharma V, Bhasin SS. Does the volume of supplemental intraligamentary injections affect the anaesthetic success rate after a failed primary inferior alveolar nerve block? A randomized-double blind clinical trial. Int Endod J. 2018;51(1):5–11. doi: 10.1111/iej.12773.
34.*Nusstein J, Claffey E, Reader A, Beck M, Weaver J. Anesthetic effectiveness of the supplemental intraligamentary injection, administered with a computer-controlled local anesthetic delivery system, in patients with irreversible pulpitis. J Endod. 2005;31(5):354–358.*doi: 10.1097/01.don.0000140565.88940.60.
35.Kamali M, Parirokh M, Manochehrifar H, Nakhaei N. Assessing the Impact of Mandibular Molar Root Length on Success in Supplemental Intraligamentary Injection for Irreversible Pulpitis. Iran Endod J. 2024;19(1):28-34. doi: 10.22037/iej.v19i1.42660.
36.Burtscher D. Intraligamentary anesthesia – A brief review of an underestimated anesthetic technique. Oral Health Care. 2019:4:2-3. doi: 10.15761/OHC.1000177
37.Idris M, Sakkir N, Naik KG, Jayaram NK. Intraosseous injection as an adjunct to conventional

https://doi.org/10.20428/yjms.v19i6.2979
https://journals.ust.edu/index.php/yjms

local anesthetic techniques: A clinical study. J Conserv Dent. 2014;17(5):432-435. doi: 10.4103/0972-0707.139828.
38. Probster L. Intraosseous anesthesia as an alternative to conventional infiltration and conduction anesthesia. Quintessence. 2012;63(1):71–76. doi: 10.4103/0972-0707.139828.
39.Martínez A, Lujan Pardo MD, Harris Ricardo J. Perception of discomfort during injection and the need for supplemental anesthesia in the intraosseous technique using 4% articaine. Acta Odontol Latinoam. 2016;29(3):214- 218.
40.Nilius M, Mueller C, Nilius MH, Haim D, Leonhardt H, Lauer G. Intraosseous anesthesia in symptomatic irreversible pulpitis: Impact of bone thickness on perception and duration of pain. J Dent Anesth Pain Med. 2020;20(6):367-375. doi: 10.17245/jdapm.2020.20.6.367.
41.Razavian H, Kazemi S, Khazaei S, Jahromi MZ. X-tip intraosseous injection system as a primary anesthesia for irreversible pulpitis of posterior mandibular teeth: A randomized clinical trail. Dent Res J. 2013;10(2):210-213. doi: 10.4103/1735-3327.113346
42.Gazal G, Fareed WM, Zafar MS. Role of intraseptal anesthesia for pain-free dental treatment. Saudi J Anaesth. 2016;10(1):81-86. doi: 10.4103/1658-354X.169482.
43.Webster S Jr, Drum M, Reader A, Fowler S, Nusstein J, Beck M. 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.
44. Woodmansey K. Intraseptal anesthesia: a review of a relevant injection technique. Gen Dent. 2005;53(6):418–420.
45. Malamed SF, Trieger N. Intraoral maxillary nerve block: An anatomical and clinical study. Anesth Prog. 1983;30(2):44–48.
46.Bonar T, Nusstein J, Reader A, Drum M, Fowler S, Beck M. Anesthetic Efficacy of Articaine and Lidocaine in a Primary Intraseptal Injection: A Prospective, Randomized Double-Blind Study. Anesth Prog. 2017;64(4):203-211. doi: 10.2344/anpr-64-04-10.
47. Dianat O, Mozayeni MA, Layeghnejad MK, Shojaeian S. 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.
48. Brkovic BM, Savic M, Andric M, Jurisic M, Todorovic L. Intraseptal vs. periodontal ligament Anesthesia for maxillary tooth extraction: Quality of local Anesthesia and haemodynamic response. Clin Oral Investig. 2010;14(6):675–681. doi: 10.1007/s00784-009-0352-7.
49. Parirokh M, Sadr S, Nakhaee N, Abbott PV, Askarifard S. Efficacy of supplementary buccal infiltrations and intraligamentary injections to inferior alveolar nerve blocks in mandibular first molars with asymptomatic irreversible pulpitis: a randomized controlled trial. Int Endod J. 2014;47(10):926-933. doi: 10.1111/iej.12236.
50. Balasubramanian SK, Natanasabapathy V. Safe intrapulpal anaesthesia. Br Dent J. 2017;222(1):4. doi: 10.1038/sj.bdj.2017.8.
51.Kronish AD. Monheim's Local Anesthesia and Pain Control in Dental Practice. Anesth Prog 1974;21(4):112.
52.Reed KL, Malamed SF, Fonner AM. Local anesthesia part 2: technical considerations. Anesth Prog. 2012;59(3):127-136.
53.Sooraparaju SG, Abarajithan M, Sathish ES, Suryakumari NB, Ealla KK, Gade W. Anaesthetic Efficacy of Topical Benzocaine Gel Combined with Hyaluronidase for Supplemental Intrapulpal Injection in Teeth with Irreversible Pulpitis- A Double Blinded Clinical Trial. J Clin Diagn Res. 2015;9(8): ZC95-ZC97. doi: 10.7860/JCDR/2015/12575.6401.
54.Hargreaves KM, Keiser K. Local anesthetic failure in endodontics: Mechanisms and management. Endod Top. 2002; 1:26–39. doi:10.1034/j.1601-1546.2002. 10103.x