Review Article

Failure of molar anesthesia in endodontics : A systematic review

Vidhi Kiran Bhalla, Sonali Taneja, Sherin Jose Chockattu[1]

Department of Conservative Dentistry and Endodontics, ITS Centre for Dental Studies and Research, Ghaziabad, Uttar Pradesh, [1]Department of Conservative Dentistry and Endodontics, Bapuji Dental College and Hospital, Davangere, Karnataka, India

Abstract

Introduction: Failure of molar anesthesia is commonly encountered in our clinical practice ranging around 15% in normal pulps and 44%–81% in inflamed pulps. Effective pain management is challenging in such situations. The aim of the present systematic review was to enlist the reasons for local anesthesia failure in mandibular molars during root canal treatment and to assess the effectiveness of supplementary methods along with the conventional inferior alveolar nerve block (IANB) in achieving profound anesthesia.

Materials and Methods: A literature search on Pubmed and Google scholar database from the year 1990–2020 was conducted using the keywords: "Molar anesthesia," "Local anesthesia failure," "Hot tooth," "irreversible pulpitis." The articles pertaining to the failure of IANB during endodontic treatment of mandibular molars and the techniques for the improved success of molar anesthesia were reviewed. The data were analyzed in terms of author, year, type of study design, study population and type of intervention, method of assessment of outcome, outcome assessed, result and clinical recommendations.

Results: The search yielded 9090 articles, from which the specific articles relevant to the topic were reviewed. The articles were reviewed independently by two authors. Finally, a total of 7 randomized controlled trials fulfilling the eligibility criteria were analyzed and subjected to qualitative assessment.

Conclusion: The failure of IANB could be attributed to several reasons such as anatomical variations, Operator Technique, Presence of inflammation, and Psychological reasons. In addition, there is a positive association in using adjuncts for achieving effective anesthesia in mandibular molars.

Keywords: Hot tooth, inferior alveolar nerve block, irreversible pulpitis, local anesthesia failure, molar anesthesia

Address for correspondence: Dr. Vidhi Kiran Bhalla, Department of Conservative Dentistry and Endodontics, ITS Centre for Dental Studies and Research, Ghaziabad, Uttar Pradesh, India.
E-mail: vidhibhalla@gmail.com
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INTRODUCTION

Profound analgesia is essential for the successful completion of endodontic procedures.[1] In clinical practice, the administration of inferior alveolar nerve block (IANB) remains the most frequent and widely accepted method for achieving anesthesia of mandibular molars.[2] However, there are difficulties encountered in obtaining successful analgesia after IANB. A recent survey estimated that 85%

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of dental students and interns have experienced inferior nerve block failures in their clinical practice.[3]

Studies have reported that in teeth with healthy pulp, the failure rate of IANB is 15%, while this rate may increase to 44%–81% in patients with inflamed pulp.[4] Failure of local anesthesia occurs commonly in patients with inflamed pulps, a condition referred to as "Hot tooth." Effective pain management in such patients is challenging.[5]

The present systematic review focuses on published research for the failure of IANB, analyze research on the effectiveness of supplementary methods for the improved success of IANB and further provides evidence-based treatment strategies for effective pain management.

MATERIALS AND METHODS

Search strategy

A literature search was conducted on the PubMed database from the year 1990–2020. Furthermore, a manual search was conducted on the cross-references of relevant articles to identify potential studies for the review.

For the Electronic search, the following keywords used along with the Boolean Operators: ("Molar anesthesia" [MeSh] OR "Inferior Alveolar nerve block" [MeSh]" OR "Hot tooth" [MeSh] OR "irreversible pulpitis" AND "Success" [MeSh])

PICO analysis

- Participant: Mandibular molars indicated for Endodontic Treatment
- Intervention: IANB with/without Supplementary methods
- Comparison: IANB alone
- Outcome: Failure/Success of Local Anesthesia.

Eligibility criteria

The inclusion criteria included the following:

- *In vivo* clinical trials pertaining to the reasons of failure of IANB
- Randomized controlled trials assessing techniques for improved success in molar anesthesia during endodontic treatment
- Articles published in English Language and available in full text from the year 1990–2020.

The exclusion criteria included:

- Case reports/series were excluded
- Articles analyzing local anesthetic failure during extractions
- Randomized controlled trials already assessed in the systematic reviews and meta-analysis were excluded (pertaining to improving anesthesia success).

Data collection and analysis

Two reviewers independently evaluated the article records identified by the database search. First, the title of the searched articles was screened, which was followed by the abstract and those studies found relevant to the study design were further assessed according to the eligibility criteria. A consensus was reached among the two reviewers for the articles selected. Studies fulfilling the inclusion and exclusion criteria were then subjected to qualitative assessment. The data were analyzed in terms of Author, Year, Type of study design, Study population, and type of intervention, Method of assessment of outcome, Outcome assessed, Result, and Clinical Recommendations. The risk of bias of the selected articles was performed using the modified Cochrane Collaboration Tool.[6]

RESULTS

The search yielded 9090 articles, from which the specific articles relevant to the topic were reviewed after evaluating the title, abstract, and full-text article for their eligibility for inclusion in the review. Finally, a total of 7 randomized controlled trials were included, which assessed the effect of "supplementary methods" to conventional IANB. Figure 1 depicts the search methodology. Table 1 shows the characteristics of the included studies. The risk of bias assessment of the included studies is depicted in Table 2.

DISCUSSION

The present systematic review included seven randomized controlled trials that studied an "adjunctive treatment" (Laser, cryotherapy, Acupuncture) before conventional IANB or reported the addition of an "agent" to the local anesthetic agent (clonidine, magnesium sulfate, tramadol, mannitol). Among them, in six studies, the success rate of IANB improved in the intervention groups. In the literature, the reasons for the failure of the local anesthesia can be summarized as:

Accessory innervations

One of the main reasons for inadequate analgesia could be attributed to the presence of accessory innervations to the mandibular teeth. The nerve to the mylohyoid contributes to additional innervations in about 10%–20% of the cases.[7,8] A study by Wilson *et al.* on 37 cadavers reported that this mylohyoid nerve branched from the inferior alveolar nerve at an average distance of 14.7 mm above the mandibular foramen and may provide accessory innervations when part of its course is intraosseous.[8]

Table 1: List of randomized controlled trials included in the systematic review

S.No	Author (reference#)	Study design	Study groups and intervention	Method of assessment of outcome	Outcome assessed	Result	Clinical recommendation
1	Shadmehr *et al*., 2017[31]	Randomized controlled trial	Mandibular molars Group A: 1.8 mL of 2% lidocaine with clonidine (15 µg mL-1) Group B: 1.8 mL of 2% lidocaine with epinephrine	Visual analog scale	Success rate of IANB	The success rates for IANB using lidocaine with epinephrine and lidocaine with clonidine solutions were 29% and 59%, respectively.	For mandibular molars with irreversible pulpitis, addition of clonidine to lidocaine improved the success rate of IANB compared to a standard lidocaine/epinephrine solution.
2	Shetty KP *et al*., 2015[32]	Randomized Controlled Trial	Mandibular molars Group A : Lidocaine alone Group B : Lidocaine with magnesium sulphate 50 %	Heft-Parker VAS	Success of IANB	The success rate for the IAN block was 58% for magnesium sulfate group and 32% for the placebo group, with statistically significant difference between the 2 groups	In mandibular posterior teeth diagnosed with symptomatic irreversible pulpitis, preoperative administration of 1 mL magnesium sulfate USP 50% resulted in statistically significant increase in success of IAN block compared with placebo.
3	Cohen *et al*., 2013[34]	Randomized Controlled Trial	Mandibular molars Group A: 1.72-mL formulation of 68.8 mg lidocaine with 50 µg epinephrine Group B: 5-mL formulation of 68.8 mg lidocaine with 50 µg epinephrine (1.72 mL) plus 0.9 M mannitol (3.28 mL)	Pulp Tester	Success rate of IANB	5 mL-formulation of 68.8 mg lidocaine with 50 µg epinephrine plus 0.9 M mannitol was significantly better than the 1.72-mL formulation of 68.8 mg lidocaine with 50 µg epinephrine	Addition of 0.9 M mannitol to a lidocaine with epinephrine formulation was significantly more effective in achieving a greater percentage of total pulpal than a lidocaine formulation without mannitol
4	Topçuoğlu HS *et al*., 2019[51]	Randomized controlled Trial	Mandibular molar Group A : Standard IANB Group B : Cryotherapy + IANB	Heft parker VAS	Success of IANB	In cryotherapy group, the success rate of the IANBs was 55.8%, whereas in the control group it was 30.8%	Intraoral cryotherapy application increased the success rate of IANBs in mandibular molar teeth with SIP.
5	Jalali S *et al*., 2015[53]	Randomized controlled Trial	Mandibular molar Group A : Standard IANB Group B : Acupuncture+	Visual Analogue Scale	Success of IANB	Success rates of IANB for the acupuncture and control groups were 60% and 20%, respectively	The application of acupuncture before the endodontic treatment increased the effectiveness of IANBs for mandibular molars with symptomatic irreversible pulpitis.
6	Ghabraei S *et al*., 2018[54]	Randomized controlled Trial	Mandibular molars Group A : Control group Group B: Laser therapy	Heft-Parker VAS	Success of IANB	The results of this study showed that the necessity for supplemental injection was lower in the group receiving laser than in the group without laser	Application of Photobiomodulation therapy (PBM) before anesthesia is effective on increasing depth of anesthesia.
7	Rodríguez-Wong L *et al*., 2015[58]	Randomized controlled Trial	Mandibular molar Group A (Experimental group) : 1.3 mL of 2% mepivacaine with epinephrine 1 : 100 000 plus 0.5 mL of tramadol 50 mg mL Group B (Control group) : 1.8 mL of 2% mepivacaine with epinephrine 1 : 100 000	Heft-Parker VAS	Success of IANB	The success rates of anaesthesia with the IANB for the experimental and control groups were 57.1 and 46.4%, respectively	The combination of mepivacaine-tramadol achieved similar success rates for IANB when compared to mepivacaine 2% epinephrine 1 : 100 000.

Hence, blockade of the mylohyoid nerve is not possible with the classic IANB technique. Apart from the mylohyoid nerve, the long buccal and great auricular nerve may also provide alternate innervations to molar teeth.[9,10]

To overcome this problem, the Gow-Gates technique may be employed in which the local anesthetic agent is deposited within the pterygomandibular space at a higher level than the conventional approach. This injection technique is

Table 2: Assessment of randomized controlled trials using the modified Cochrane assessment tool risk of bias among the studies

Author	Random Sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel's (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data addressed (attrition bias)	Selective reporting (reporting bias)	Other bias
Shadmehr *et al*., 2017	+	+	+	+	+	+	+
Cohen *et al*., 2013	+	+	+	-	+	+	+
Shetty KP *et al*., 2015	+	+	+	?	+	+	+
Topçuoğlu HS *et al*., 2019	+	+	+	?	?	+	?
Jalali S *et al*., 2015	+	+	+	+	-	-	?
Ghabraei S *et al*., 2018	+	+	+	?	+	+	+
Rodríguez-Wong L *et al*., 2015	+	+	+	?	+	+	+

+: Low risk of bias, ?: Unclear risk of bias, -: High risk of bias

known to anesthetize all the nerves which branch from the inferior alveolar nerve after its exit from the foramen ovale, which are supposedly not anesthetized by the conventional IANB technique.[11] Furthermore, the use of intraligamentary and intraosseous injection techniques blocks all other sources of accessory innervations from the lingual, long buccal, and transverse cervical nerve.[12,13]

Anatomical variations

Adequate knowledge of the pterygomandibular space and the associated structures is essential for effective and safe mandibular anesthesia. Anatomical variations in the mandible and mandibular foramen contribute to such failures.[14]

Variation in mandibular anatomy

A common factor reported for the failure of local anesthesia is the variation in the anatomy of the mandible. The changes in ramal width and height, as well as the position of mandibular foramen with age, may account for the wrong insertion of the needle and hence failure to achieve anesthesia.[15] In such cases, the use of 4% articaine buccal infiltration can be used as an alternative when the IANB fails; however, this technique may only be effective when the thickness of the buccal cortical plate is <3 mm.[16]

Bifid mandibular canals

Certain anatomical variations like the presence of bifid mandibular canals, could lead to inadequate analgesia. They arise as a result of the anatomical variations of the inferior alveolar nerve during intramembranous ossification of the mandible.[17] Nortjé *et al.* retrospectively analyzed panoramic radiographs of 3612 patients for detection of bifid canals and reported bifurcation of the nerve with dual ipsilateral canals in thirty-three (0.9%) of the subjects The nerve bifurcation occurs before entering the mandibular canal, hence the standard IANB will be ineffective in blocking stimulus from both nerves.[18]

In such cases, a high IANB, such as the Gow-Gates technique, may be effective in anesthetizing the nerve trunk before the bifurcation begins.[11]

Presence of retromolar foramen

The presence of retromolar foramina containing neurovascular bundles represents another anatomic variation and may provide alternate innervation.[18] A study by Sawyer and Kelly studied 234 adult human mandibles and reported the incidence of retromolar foramina in 7.7% of the cases. However, the authors concluded that the correlation of the occurrence of retromolar foramen to the failure of local anesthesia was questionable and required further investigation.[19-21]

The study by von Arx *et al.* demonstrated the presence of retromolar foramen in 25% of the cases using cone-beam computed tomography analysis and furthermore stressed the clinical importance of its presence to mandibular block failure.[22] The foramen may provide accessory innervation to the posterior mandible and even contain an aberrant buccal nerve.[22-24]

A possible solution could be to inject small amount of solution directly into the retromolar region to provide a reduction of "escape pain" in some patients. The administration of the Gow-Gates technique or other high pterygoid entry injection may also be recommended.[25]

Position of mandible

The success of IANB is also influenced by the skeletal positioning of the mandible.[17,21] The study by You *et al.* reported that the failure rates of IANB were significantly greater in the retrognathic mandible (14.5%) and prognathic mandible (9.5%) in comparison to the normal mandible (7.3%).[21] In the case of the retrognathic mandible, the mandibular foramen is superiorly placed, from its normal position. As a result, using the conventional IANB technique of placing the needle above the occlusal plane, the solution is deposited inferior to the mandibular canal leading to failure to achieve anesthesia. Moreover, another possible reason for high failure rates could be attributed to the limited mouth opening due to short condyle length in the retrognathic group. In such situations, alternative use of Gow-Gates and Akinosi techniques that are not influenced by the location of the mandibular foramen can also be considered.[17,26]

In forwardly placed mandibles, the mandibular foramen is placed at a lower level than the normal mandible due to the long condylar length. Hence, it is likely that the local anesthetic solution may get deposited at a higher level with the conventional technique.[14]

Operator technique

The pulps of mandibular molar teeth are anesthetized by the administration of an IANB. The aim is to deliver the local anesthetic solution into the pterygomandibular space, as close to the mandibular foramen as possible. The technique involves the insertion of the needle tip into the pterygomandibular depression. The level of injection is gauged after palpating the coronoid notch, keeping the needle parallel and 1 cm above the level of the occlusal plane.[8] The needle should be inserted above the tip of the lingula to avoid the pressure exerted by the sphenomandibular ligament to prevent the diffusion of the local anesthetic solution. However, anesthetic failures occur even after the needle placement has been done optimally. One reason for this, could be the needle deflection upon entering the loose tissues of the pterygomandibular space. Hence, apart from the conventional technique, rotation of the needle while insertion may be suggested to reduce needle deflection.[14]

Repeated administration of local anesthetic often leads to reduced responsiveness, an effect called as tachyphylaxis. It has been proposed that repeated or continuous injection may reduce the efficacy of the local anesthetic.[27]

Inflammation related conditions

The ineffectiveness of anesthetic injections administered into inflamed tissues is attributed to the acidic tissue pH that interferes with the dissociation of anesthetic drug. However, some authors believe that inflammation modifies the activity of peripheral sensory nerves through a complicated neuronal process involving sprouting of nerve fibers with increased expression of neuropeptides like substance *P* and Calcitonin gene-related peptide and the release of inflammatory mediators like PGE_2, $PGF_{2\alpha}$, interleukin-1 (IL-1), IL-6.[28] The high failure rates in "Hot Tooth" is mainly related to the sensitization and activation of the peripheral nerves. In addition, with increasing tissue acidosis, the expression of acid-sensing ion channels, transient receptor potential vanilloid receptor type 1 channels and Tetrodotoxin-resistant sodium channels, namely Nav 1.8 and Nav 1.9 is increased, leading to sustained depolarization and further resistance to the action of local anesthetics.[28] In endodontic literature, the activation of nociceptors by the release of inflammatory mediators remains the major cause for the decrease in success rate of IAN block in patients with irreversible pulpitis.[14, 29]

Some of the measures to overcome such failures could be:

Change in the local anesthetic agent

Lidocaine is considered as the gold standard anesthetic drug and is usually combined with a vasoconstrictor and administered in dentistry. Other anesthetic agents commonly preferred are mepivacaine, articaine, and bupivacaine.[30]

The administration of lidocaine along with clonidine,[31] magnesium sulfate,[32,33] mannitol,[34] buffered sodium bicarbonate[35] has been reported in recent studies to improve the success rate of molar anesthesia with symptomatic irreversible pulpitis. Further studies may be recommended in this area to further come to conclusive evidence.

Mepivacaine, in comparison to lidocaine, has more favorable chemical properties like lower pKa and reduced vasodilatation. In addition, mepivacaine is indicated in patients with systemic disorders, as it remains effective even without vasoconstrictors.[30] A recent systematic review comparing the efficacy of lidocaine and mepivacaine in patients with symptomatic irreversible pulpitis concluded that both of them were similarly effective for pain control after IANB for endodontic treatment.[36]

Bupivacaine is another local anesthetic agent that has a longer duration of action than lidocaine due to its low lipid solubility and higher binding ability to proteins. A recent meta-analysis by Su *et al*. concluded that bupivacaine is better than lidocaine for longer procedures and when there is a need for postoperative pain management.[37]

Articaine is the second most common anesthetic agent used in dentistry. A plethora of evidence recommends the use of articaine over lidocaine, specifically for infiltration procedures. This is mainly attributed to the chemical composition of articaine consisting of a theophene ring and an additional ester linkage.[38-41]

Volume of anesthetic agent

For adequate analgesia, the local anesthetic agent must block at least three subsequent nodes of Ranvier. The longest internodal span of the inferior alveolar nerve has been found to be approximately 1.8 mm. Hence, to accomplish absolute blockade, approximately 6 mm of the nerve needs to be exposed to the local anesthetic agent.[42]

The systematic review by Milani *et al.* concluded that for patients with irreversible pulpitis, increasing the volume of anesthetic solution from 1.8 ml to 3.6 ml significantly improved the success rate of IANB. It has been theorized that 3.6 ml of anesthetic solution completely filled the pterygomandibular space, thus providing a higher concentration around the nerve trunk and improved analgesia.[43]

Various other approaches and techniques reported for providing successful anesthesia are supplemental anesthesia,[44,45] Premedication with nonsteroidal anti-inflammatory drugs (NSAIDs),[46-49] opioid analgesics,[50] intraoral cryotherapy,[51] acupuncture[52,53] and photobiomodulation therapy[54] and the evidence-based studies are listed in Table 1. A list of 11 systematic reviews and meta-analysis reviewed is provided in Table 3.

Psychological reasons

Apart from the above-listed factors, fear and anxiety may also contribute to the reduced local anesthetic activity. The "Fight

Table 3: Evidence of systematic reviews and meta-analysis on improving the success of molar anesthesia

S.No	Author (Year)	Anesthetic agent/ adjunct evaluated	Type of article &Number of articles reviewed	Conclusion/clinical recommendations
1	Guo J *et al.*, 2018[35]	Sodium bicarbonate buffered lidocaine	Meta-analysis, 11 studies reviewed	Buffered lidocaine significantly decreased onset time and injection pain (VAS) compared with non-buffered lidocaine in IANB. However, the level of evidence was low to moderate, hence additional studies are warranteed.
2	Kung J *et al.*, 2015[40]	Articaine Vs Lidocaine	Systematic review and meta-analysis, 10 Randomized controlled trials	Significant advantage to using articaine over lidocaine for supplementary infiltration after mandibular block anesthesia but no advantage when used for mandibular block anesthesia alone or for maxillary infiltration.
3	Tupyota P *et al.*, 2018[45]	Effect of supplemental techniques (supplemental injection, Premedication with NSAIDS,anesthetic volume)	Systematic review and meta-analysis, 17 studies	Changing the injection techniques or supplemental injection had no significant effect on pulp anaesthesia. Increased anaesthetic volumes and premedication with NSAIDs provide predictable anaesthesia and more pain control during endodontic treatment of lower molars with irreversible pulpitis.
4	Nagendraprabhu *et al.*, 2018[46]	NSAIDS as oral predication	Systematic review and metanalysis, 13 Randomized controlled Trials	Oral premedication with NSAIDs and ibuprofen (>400 mg/d) increased the anesthetic success of IANBs in patients with irreversible pulpitis
5	Nagendrababu V *et al.*, 2020[46]	Articaine Vs Lidocaine	Umbrella review	Articaine is more effective than lidocaine for local anaesthesia of teeth with irreversible pulpitis undergoing root canal treatment. There is limited evidence that injection of articaine is less painful, has more rapid onset and has fewer adverse events compared with lidocaine.
6	Shirvani A *et al.*, 2017[47]	Preoperative oral analgesics	Systematic review and metaanalysis	Administration of preemptive oral analgesics are superior in achieving anesthetic success in inflamed pulp.
7	Karapinar-Kazandag M *et al.*, 2019[49]	Oral premedication	Systematic review and metanalysis, 35 studies	Moderate evidence suggest that some premedications were partially effective for the enhancement of mandibular anesthetic effect in irreversible pulpitis.
8	Zanjir M *et al.*, 2019[59]	Pulpal anesthetic strategies	Systematic review and metanalysis, 47 intervention studies	Very low- to moderate-quality evidence suggests intraosseous injection using 2% lidocaine with 1:100,000 epinephrine or 4% articaine with 1:100,000 epinephrine or buccal and lingual infiltrations of 4% articaine with 1:100,000 epinephrine are superior strategies to achieve pulpal anesthesia during endodontic treatment of mandibular molars with symptomatic irreversible pulpitis.
9	Pulikkotil SJ *et al.*, 2018[60]	Oral premedication	Systematic review and metaanalysis,	Oral premedication with dexamethasone, NSAIDs or Tramadol significantly increased anaesthetic success.However, more clinical trials are warranted.
10	Corbella S *et al.*, 2017[61]	Premedication, anesthetic agent and supplemental infiltration	Systematic review and metanalysis, 19 studies	The use of premedication with anti-inflammatory drugs before IANB can increase the efficacy of the IANB. The type of anesthetic agent, the volume of anesthetic, and the use of a supplemental buccal infiltration do not seem to affect the efficacy of anesthesia.
11	Dou L *et al.*, 2013[62]	Additional lingual infiltration	Systematic review	An additional lingual infiltration following buccal infiltration can enhance the anesthetic efficacy compared with buccal infiltration alone in the mandibular incisor area. However, for all the other teeth it requires more investigation.

VAS: Visual analog scale, IANB: Inferior alveolar nerve block, NSAIDs: Nonsteroidal anti-inflammatory drugs, SIP: Symptomatic irreversible pulpitis

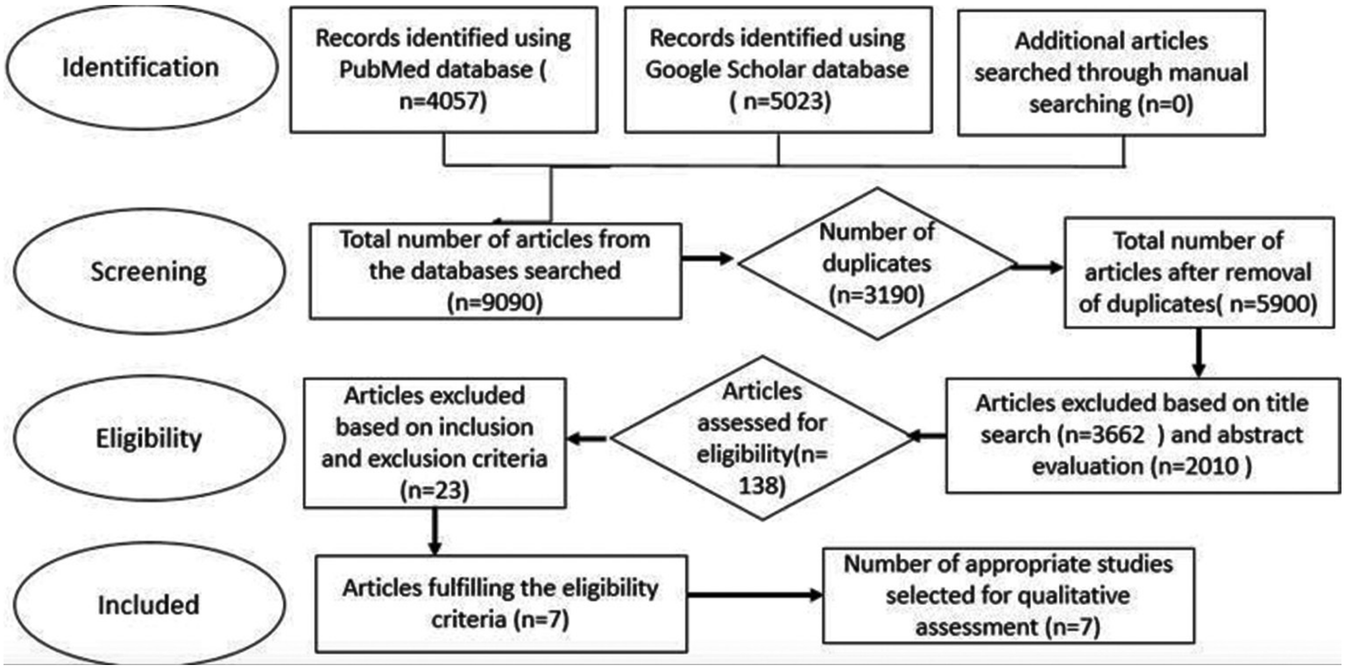

Figure 1: Flowchart for the search methodology

or flight" response is typical in anxious patients as a result of the activation of the sympathetic nervous system, which further exacerbates patient's pain perception. Hence, in such patients use of anti-anxiety medications and sedation may be useful in making the patient more relaxed and comfortable.[55]

Oral administration of ketamine may produce analgesia by interacting with N-methyl D aspartate (NMDA) receptors, opioid receptors, monoaminergic receptors, muscarinic receptors, and calcium and sodium ion channels. The study by Kaviani *et al.* reported that preoperative administration of ketamine can be used to reduce the volume of anesthetic solution for IANB in patients with irreversible pulpitis and can significantly reduce the postoperative pain as well.[56]

Nitrous oxide is the commonly used anesthetic agent, acts on the opiate and NMDA receptors to provide analgesia. Administration of 30%–-50% Nitrous Oxide resulted in the improved success of IANB compared to room air/oxygen and may be preferred in severely apprehensive patients.[57]

Evidence based recommendations for achieving successful molar anesthesia

1. The significant advantage of choosing articaine as a supplemental anesthetic of choice has been emphasized in two systematic reviews and metanalysis and an umbrella review[38-41]
2. Increasing the volume of anesthetic solution to 3.6 ml significantly increased the success rate of IANB[43]
3. The results of two systematic reviews concluded that supplemental infiltration improved the success of IAN block in patients with symptomatic irreversible pulpitis[44,45]
4. Premedication with NSAID 1 h before the treatment procedure, especially in the cases of symptomatic irreversible pulpitis for achieving successful molar anesthesia. However, in patients with a known contraindication to its administration, alternative medication should be employed.[46-49]

Based on the systematic review, it may be concluded that additive approaches or the addition of certain agents may improve the clinical efficacy of molar anesthesia and the key findings may be summarized as shown in Table 1. The result of six randomized controlled trials included showed a statistically significant improvement in molar anesthesia with the addition of supplementary methods or additives within the local anesthetic agent. Hence, within the limitations, it can be concluded that there is a positive association in using adjuncts for achieving effective anesthesia in mandibular molars. However, the articles were scarce, and hence, further research is needed to reach to a conclusive evidence However, the level of evidence is 1 B[63] since the number of individual studies on each of the separate interventions is less to come to conclusive evidence. The literature search included only two databases (Google Scholar and PubMed). Hence, studies published in other databases may be overlooked.

CONCLUSION

The failure of IANB could be attributed to several reasons such as the presence of accessory innervations, anatomical variations (mandibular anatomy, retromolar foramen, skeletal positioning of mandible), operator technique, presence of inflammation, and psychological reasons. Adequate knowledge of these factors is crucial for successful management.

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Conflicts of interest

There are no conflicts of interest.

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