Original Article

Comparison of Analgesic Effect of Inferior Alveolar Nerve Block and Lidocaine Infiltration in Posterior Mandibular Implant Placement: A Split-Mouth Randomized Clinical Trial

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ABSTRACT

Background: Implantology is a widely accepted treatment, as it restores aesthetics and function, and is the preferred option for replacing missing teeth. In mandibular implant surgery, the Inferior Alveolar Nerve Block (IANB) is the most common anesthetic technique, as it eliminates sensation on one side of the jaw, floor of the mouth, teeth, tongue, and gums. However, its high failure rate is due to the technical difficulty of the injection procedure. Additionally, deep anesthesia from IANB carries risks such as damage to the mandibular canal. In contrast, infiltration anesthesia desensitizes the inferior alveolar nerve locally, allowing patients to perceive pain and alert the dentist if the implant approaches the nerve. We aimed to compare the effects of IANB and local infiltration anesthesia for posterior mandibular implant surgery.

Methods: This prospective, randomized, double-blind clinical trial followed a split-mouth design, involving 29 patients undergoing bilateral implant surgery in the posterior mandible within a single session. On one side, IANB anesthesia was used, and on the other, infiltration was administered. Pain was assessed using the Visual Analog Scale (VAS).

Results: All 58 implants were analyzed. The VAS scores during surgery were significantly higher for the infiltration technique ($P = 0.03$). However, no significant difference in pain was observed 24 hours post-surgery ($P = 0.223$).

Conclusion: Both IANB and infiltration anesthesia are effective for mandibular implant surgery, but IANB offers more reliable pain control, making it preferable for complex cases, while infiltration is suitable for less invasive procedures.

KEYWORDS
Local Anesthesia; Infiltration; Nerve Block; Dental Implants; Mandible

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INTRODUCTION

The Inferior Alveolar Nerve Block (IANB) is the most common technique for achieving anesthesia in the posterior mandible during implant surgery [1]. However, it presents several challenges, including technical complexity, high failure rates (20-25%)[2], prolonged soft tissue anesthesia, risk of permanent nerve injury predominantly to the lingual nerve (0.01% – 0.04%) [3], accidental intravascular injection and increased patient discomfort [4, 5]. Additionally, in bilateral surgeries, IANB can lead to extensive soft tissue anesthesia, causing patient discomfort. However, recent advancements in research challenge this traditional perspective, suggesting that local infiltration anesthesia may offer an alternative for posterior mandibular procedures. Unlike IANB, infiltration anesthesia is technically simpler and associated with fewer complications, while potentially providing comparable efficacy. These findings have prompted growing interest in exploring infiltration anesthesia as an alternative to IANB in implant surgeries [6].

Several studies have compared IANB and infiltration anesthesia for implant surgery in the posterior mandible. A 2021 study found no significant difference in pain levels between the two techniques when measured using the Visual Analog Scale (VAS) [7]. Long-term data from Heller et al. [8], involving 8,000 implants using infiltration anesthesia, confirmed its effectiveness, with only three cases of permanent paresthesia. Soydan et al. [9] and Sanchez-Siles et al. [10] also found no significant differences in pain perception between the two methods. Furthermore, infiltration anesthesia was a simpler and safer alternative for posterior mandibular extractions [11].

Despite these findings, only one study has directly compared IANB and infiltration anesthesia for implant placement in the posterior mandible in the same session under identical conditions [7]. Additionally, most prior studies have predominantly utilized 4% articaine as the anesthetic agent. In contrast, this study standardizes the anesthetic by using 2% lidocaine for both techniques, ensuring that the comparison isolates the effects of the anesthesia method itself, independent of the pharmacological properties of the agent. In addition to appropriate anesthesia techniques, the clinical success of implant procedures also strongly depends on achieving and maintaining implant stability [12].

We aimed to compare the effectiveness and patient pain perception of IANB versus infiltration anesthesia in posterior mandibular implant surgery. Given the limited research on direct comparisons and the potential benefits of infiltration anesthesia, further evaluation is needed to determine if it can serve as a safer and more effective alternative to IANB.

MATERIALS AND METHODS

This study was a randomized controlled trial (RCT) with a double-blinded design. The goal was to compare the effectiveness of two local anesthesia techniques — Inferior Alveolar Nerve Block (IANB) and local infiltration — in managing pain during mandibular posterior implant surgery. Ethical approval was obtained from the Ethics Committee at TUMS (code: 1400.102REC. DENTISTRY.TUMS.IR). Prior to any procedures, all patients were informed about the potential for experiencing discomfort during the surgery and provided written informed consent to participate in the study.

This clinical trial was registered in the Iranian Registry of Clinical Trials (IRCT) with the registration code: IRCT20250429065518N.

The study population included patients who required dental implant placement in the posterior mandibular region. Eligible patients were aged 18 yr or older, systemically healthy, and candidates for bilateral implant surgery in the first or second molar region. It was essential that the alveolar ridge in the surgical site had fully healed and reconstructed adequately. A power analysis was conducted to determine the appropriate sample size needed to achieve sufficient statistical power for detecting meaningful differences or associations in this study. However, certain individuals were excluded from the study. Patients with systemic conditions contraindicating surgery or an allergy to local anesthetics were excluded, as were pregnant individuals, heavy smokers, and those suffering from untreated periodontal conditions. Patients who had taken medications affecting pain perception (such as analgesics, antidepressants, or sedatives) within 48 hours prior to surgery were also excluded. Additionally, individuals with active pathological conditions at the injection site and cases requiring

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immediate implant placement were not permitted to participate. Other exclusion criteria included cases needing bone grafting, extreme dental anxiety or phobia, neurological disorders, or individuals who were familiar with the distinct injection techniques (e.g., dental professionals).

In this study, bilateral mandibular implant surgeries were performed in a single session. For each patient, one side was anesthetized using the IANB technique, while the other side was anesthetized using local infiltration anesthesia. This design aimed to minimize variability and allowed for comparison of the two methods under consistent conditions.

For surgical implant placement, on one side, infiltration anesthesia was administered using 2% lidocaine containing 1:100,000 epinephrine manufactured by Exir (Exir Pharmaceutical Company, Boroujerd, Lorestan Province, Iran (. On the other side, inferior alveolar nerve block (IANB) was performed using the same anesthetic. In the infiltration technique, a 27-gauge short needle (25 mm) manufactured by Ava Medical Corporation (Iran), was utilized. A total of 1.8 mL of lidocaine was injected into the buccal vestibule, followed by 0.9 mL of lidocaine into the lingual vestibule. In the IANB technique, performed directly, a 27-gauge long needle (35 mm) manufactured by Ava Medical was utilized, and after the needle contacted the ramus bone, 1.8 mL of lidocaine was injected. Subsequently, 0.9 mL of lidocaine was injected into the buccal vestibule for soft tissue anesthesia of the buccal area.

Upon administering the anesthetic, efficacy was assessed 2–5 minutes post-injection, verifying numbness of the lips and tongue alongside reduced soft tissue sensitivity when probed. If anesthesia failed, additional attempts were made, and these subjects were excluded from the study to maintain consistency in data collection.

Implant surgeries were performed under strict anatomical guidelines, with minimum safety distances maintained between implant margins and critical structures such as the inferior alveolar nerve canal. Implants were placed at least 2 millimeters short of the canal, with at least 1 millimeter of bone remaining on the buccal and lingual walls. The spacing between implants and adjacent teeth was at least 1.5 millimeters. The cylindrical implants utilized were of standard specifications from the Dentis brand (South Korea).

Pain levels were measured using the Visual Analogue Scale (VAS), where patients marked their sensation on a 170mm scale. The scale ranged from 0 (no pain) to 170 (maximum imaginable pain). Pain levels were categorized as:

- No pain: 0 mm
- Mild pain: 1–54 mm
- Moderate pain: 55–114 mm
- Severe pain: ≥115 mm [7]

This measurement was repeated 24 hours post-surgery to assess residual pain once the anesthesia had worn off.

To ensure the accuracy and validity of the Visual Analogue Scale (VAS) questionnaire, it underwent a process of forward-backward translation. Initially, the questionnaire was translated from English to Persian by one translator. Subsequently, a second translator independently translated the Persian version back into English. The original English version and the back-translated English version were then compared to verify semantic equivalence and ensure accurate comprehension.

Twenty nine patients were enrolled in the study, with randomization conducted using block randomization (blocks of 4), generated by Excel software. This study followed a double-blind, split-mouth design involving 29 patients. Randomization was performed using block randomization (blocks of 4) via Excel by the study's statistical consultant. For each patient, a sealed envelope labeled with a study ID contained the randomized assignment of anesthetic type (IANB or infiltration) and the side (right or left) to receive it first. These envelopes were prepared before the clinical phase and only opened at the time of surgery. Participants were enrolled by the clinical research team, and the operating surgeon implemented the interventions based on the envelope contents without prior knowledge of the allocation. While the surgeon and the statistician were necessarily unblinded, both the patients and the outcome assessor collecting VAS scores remained blinded to group allocation. Identical injection protocols were used to prevent recognition, and data were coded prior to analysis. These procedures ensured proper allocation concealment and minimized bias throughout the study.

Statistical analysis was performed using SPSS 22 software (IBM Corp., Armonk, NY, USA); with pain measurements analyzed using paired *t*-tests for parametric data and the Wilcoxon signed-rank

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test for non-parametric data. Adjustments were made for potential carryover effects in the crossover design. Statistical significance was defined as **$P < 0.05$**.

RESULTS

We enrolled 29 patients who were preparing for implant surgery and had visited the treatment center. Among them, 15 were women (51.7%), and 14 were men (48.3%). The participants' average age was 47 years, with a standard deviation of 11.47 years. The youngest patient was 28 years old, while the oldest was 69 years old. In this study, 58 implants were placed. Among them, 22 implants were positioned at the site of the seventh tooth (17 on the left side and 10 on the right side). Additionally, 36 implants were placed at the site of the sixth tooth (17 on the left side and 19 on the right side). The average bone height on the left side was 13.37 mm, while on the right side; it was 13.21 mm. The average bone width was 7 mm on the left side and 6.75 mm on the right side.

The average implant length and diameter on the left side were 10.5 mm and 4.65 mm, respectively. On the right side, the average implant length and diameter were 10.6 mm and 4.6 mm, respectively.

The average surgery duration was 8.96 minutes on the left side and 9.13 minutes on the right side. Statistically, there was no significant difference in bone height and width, implant length and diameter, or surgery duration between the left and right sides.

The average VAS pain score for the block injection was 16.72, while for the infiltration injection was 35.37. The lowest pain score reported for both techniques was 0, whereas the highest was 54 for the block injection and 85 for the infiltration injection. The reported pain levels in both groups were below 54, categorizing them as mild pain. However, pain during surgery was higher on the side where the infiltration injection was administered.

24 hours after surgery, the average VAS score on the side where the block injection was performed was 35.27; while on the infiltration side was 40.79. The lowest VAS score 24 hours post-surgery for both techniques was 0, and the highest was 85. The mean pain level within 24 hours post-surgery remained below 54, keeping it in the mild pain category. However, pain levels on the infiltration side were slightly higher.

Statistical analysis showed that pain during surgery was significantly higher on the side where the infiltration injection was used (P-value = 0.03). On the other hand, there was no significant difference in pain levels 24 hours post-surgery between the block and infiltration injection sides ($P = 0.223$). Effect sizes were calculated using Cohen's d to assess the magnitude of treatment effects. For intraoperative pain, the effect size was 0.70, indicating a moderate-to-large clinical impact in favor of the IANB technique. In contrast, the 24-hour postoperative pain showed a small effect size of 0.32, suggesting that the difference between the two anesthetic methods at that time point was modest despite being numerically higher in the infiltration group (Table 1).

DISCUSSION

Local anesthesia techniques in implant surgery play an essential role in patient comfort and determining the clinical success of the procedure. The present study illustrated that the inferior alveolar nerve block (IANB) technique was significantly more effective

Table 1: Comparison of Visual Analogue Scale (VAS) Pain Scores Between IANB and Infiltration Techniques

Pain Assessment Time	Group	Mean ± SD	Mean Difference (Infiltration – IANB)	*P*-value	Effect Size (Cohen's d)	Interpretation
During surgery (Intraoperative)	IANB	16.72 ± 19.94				
	Infiltration	35.37 ± 32.01	18.66 ± 30.79 (Infiltration – IANB)	0.03*	0.70	Moderate to large effect
24h after surgery	IANB	13.27 ± 14.89				
	Infiltration	18.44 ± 17.55	5.17 ± 23.85 (Infiltration – IANB)	0.223	0.32	Small effect

Note: Data are presented as mean ± standard deviation.
*Statistically significant difference ($P < 0.05$).
Effect size was calculated using Cohen's d. A value of 0.70 indicates a clinically meaningful difference in intraoperative pain, while 0.32 indicates a small effect for 24h postoperative pain.

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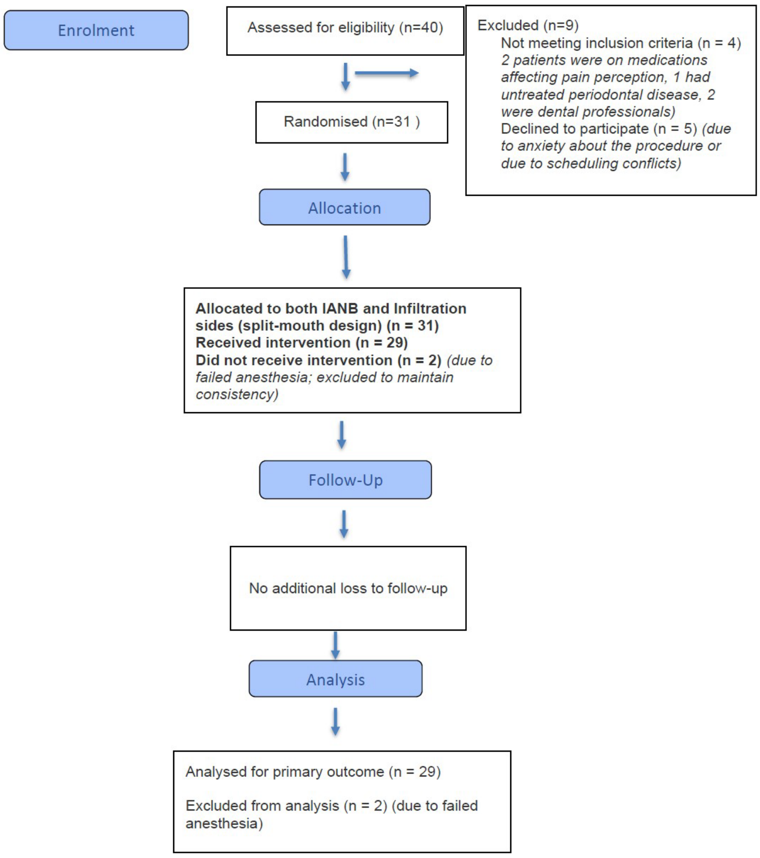

Figure 1: CONSORT 2025 Flow Diagram of Participant Progress Through the Phases of the Trial

in reducing intraoperative pain compared to infiltration anesthesia during mandibular posterior implant surgery. In this trial, the mean VAS pain score for the IANB group was 16.72 as opposed to 35.37 in the infiltration anesthesia group, reflecting a significant difference (P=0.03). Even though both results are within the "mild pain" range, the comparison highlights the superior efficacy of the IANB method. The calculated effect size (Cohen's d = 0.70) indicates a moderate to large treatment effect. This reinforces the clinical significance of the difference in intraoperative pain levels between the two anesthetic techniques, supporting the preference for IANB in more complex or invasive mandibular procedures. While the study findings align with several previous reports, discrepancies exist with some other studies.

Numerous studies, including the work of Blanco-Garcia et al.[6], demonstrate that the inferior alveolar nerve block technique is associated with lower intraoperative pain compared to infiltration anesthesia during implant procedures. Blanco-Garcia's study particularly emphasized that the VAS scores for infiltration anesthesia during mandibular implant surgery were consistently higher than those observed with IANB. Similarly, Etoz et al. [13] showed that while infiltration anesthesia proved effective in areas like the first and second molars, it failed to anesthetize adequately in certain regions such as the second premolar. The current study corroborates these findings, indicating comparable results for posterior mandibular regions where infiltration techniques resulted in mild pain but did not obstruct surgery.

Additional investigations by AlGhamdi [1] and Heller et al. [8] similarly reported that infiltration anesthesia could provide adequate numbness during mandibular posterior implant placements. Heller's longitudinal study spanning over 30 years, with more than 8,000 implants placed in posterior mandibular regions, established that infiltration anesthesia was commonly effective without the need for auxiliary techniques or procedure stoppage.

On the other hand, studies such as Omar in 2020 [14] and Soydan et al. [9] yielded differing outcomes regarding the efficacy of IANB versus infiltration anesthesia. Omar's [14] study presented a unique protocol in which implant surgeries on different

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sides of the mandible were performed three weeks apart. This prolonged interval introduced variables—such as fluctuations in pain perception or psychological adaptation—that could confound the reliability of patient-reported pain scores. By contrast, the current research minimized such effects by performing procedures on both sides of the mandible in a single session under controlled conditions. Soydan et al. [9] involved distinct methodological challenges, including varying exposure to anesthesia techniques among groups. Some patients received only one injection (either infiltration or (IANB), whereas others underwent both, complicating intra-group comparisons. Moreover, this study failed to randomize participants effectively, leaving uncertainty regarding random allocation bias. Additionally, patients represented varying overall systemic health levels (ASA classifications), introducing potential heterogeneity in pain tolerance.

While infiltration anesthesia may be attractive due to its reduced risk of complications—such as nerve injury or prolonged soft tissue numbness—its effectiveness is influenced by site-specific factors such as bone density and patient tolerance. For example, infiltration performed in high-density cortical bone regions like the mandibular molars may lead to suboptimal results. In these scenarios, anesthesia selection becomes crucial to procedural success. On the other hand, in a study the reduced risk of complications with infiltration anesthesia compared to IANB was emphasized. The authors noted issues such as nerve trauma and extended numbness with IANB, issues that could be avoided with careful infiltration technique. Moreover, infiltration anesthesia provided adequate pain control for straightforward anterior mandibular procedures, though IANB remained preferred for complex posterior surgeries. [6, 15, 16]

Studies such as Awad et al. [11] advocate infiltration anesthesia as a simpler, safer option for minor surgical interventions such as posterior tooth extractions. However, these studies highlight that more invasive surgeries—namely implant placements—necessitate methods like IANB for enhanced intraoperative pain control. The findings of this study strengthen this assessment, particularly regarding the comprehensive numbness provided by the IANB technique in preventing pain during drilling and implant fixation.

IANB achieves effective anesthesia by targeting the inferior alveolar nerve comprehensively, resulting in numbness across the lower lip and adjacent tissues. While this provides wide coverage and improved patient comfort, it carries risks of potential nerve damage and aspiration [14]. Conversely, infiltration anesthesia targets specific areas without inducing deep numbness, thereby reducing complications like impaired sensory feedback. This latter approach may be particularly beneficial in patients with heightened sensitivity or in anatomically challenging cases requiring conservative nerve management.

Reducing anesthetic dosages—particularly with vasoconstrictor-enriched formulas like lidocaine—could mitigate risks related to overspread anesthesia [10]. These findings lend credibility to the selective use of infiltration in posterior mandibular procedures alongside recommendations for further technique optimization (e.g., epinephrine enhancement).

Furthermore, inconsistencies in employed anesthetic agents—such as variable concentrations of lidocaine or the use of articaine—have distorted comparative analyses. The advantage of the present study is in its tightly controlled methodology: both anesthesia techniques were administered within the same session by the same clinician, and lidocaine with a consistent formula (2%, with 1:100,000 epinephrine) was employed throughout. However, limitations remain, especially given the study's single-center approach and limited patient population. Therefore, there is a need for a simpler and safer anesthesia technique for mandibular block procedures. This study aimed to compare patients' pain perception during implant surgery using inferior alveolar nerve block (IANB) versus infiltration anesthesia.

It seems that infiltration anesthesia could effectively numb the periosteum and soft tissue. In fact, in the absence of teeth, two main sources of pain receptors, namely pulp tissue and periodontal ligament (PDL) fibers, typically difficult to anesthetize with infiltration injections; are eliminated. However, the receptors in the bone and soft tissues are successfully anesthetized by infiltration. In addition, when the anesthetic is injected locally into the surgical site, the vasoconstriction effect of the epinephrine in the anesthetic helps control bleeding in the surgical area to a certain extent.

Furthermore, localized infiltration anesthesia prevents the numbing of soft and hard tissues that are not involved in the surgical field, reducing

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complications for both the dentist and the patient. Additionally, infiltration injection is technically simpler and has a high success rate, reportedly up to 95% [17]. In contrast, the high failure rate of the inferior alveolar nerve block (IANB), which is attributed to technical challenges and the lack of reliable anatomical landmarks, is reported to be as high as 81% [18]. Moreover, during bilateral mandibular surgeries, bilateral IANB injections result in extensive numbing of tissue, causing significant discomfort for the patient.

CONCLUSION

The findings affirm that both IANB and infiltration anesthesia are viable options for mandibular posterior implant surgeries. However, IANB more reliably reduces intraoperative pain and provides adequate anesthesia for complex procedures. Infiltration may serve as a safe alternative for less invasive surgeries, particularly in patients prone to complications or anxieties associated with nerve blocks. Nonetheless, IANB remains the preferred technique for extensive mandibular implant placements, effectively balancing comfort and surgical precision.

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CONFLICT OF INTERESTS

The authors report there are no competing interests to declare.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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