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Original Article

Efficacy of Buccal Infiltration Combined with Inferior Alveolar Nerve Block versus Inferior Alveolar Nerve Block Alone in Mandibular Molars with Irreversible Pulpitis: A Randomized Clinical Trial.

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Abstract

Background:
To evaluate the comparative efficacy of the inferior alveolar nerve block (IANB) alone and in combination with buccal infiltration for achieving effective pulpal anesthesia and postoperative pain reduction in mandibular molars diagnosed with irreversible pulpitis.

Methodology:
A randomized, parallel-group, open-label clinical trial was conducted in the Endodontics Department of Fatima Jinnah Dental College Hospital, Karachi, from October 2023 to May 2024. A total of 150 patients diagnosed with irreversible pulpitis in mandibular molars were randomly assigned into two groups. Group I received 1.8 mL of 2% lidocaine with 1:100,000 epinephrine via IANB, while Group II received 1.5 mL via IANB supplemented with 0.3 mL buccal infiltration. Pain was evaluated using a Visual Analog Scale (VAS) before anesthesia, 15 minutes post-injection, during access cavity preparation, immediately after treatment, and after 12 hours. Data were analyzed using repeated-measures ANOVA with a significance level of $p \leq 0.05$.

Results:
Both groups demonstrated similar pre-operative VAS scores ($p > 0.05$). However, Group II showed significantly lower pain scores after 15 minutes and during cavity preparation compared to Group I ($p < 0.001$). Postoperative and 12-hour follow-up pain scores were comparable between groups ($p > 0.05$). No adverse effects were observed.

Conclusion:
Supplemental buccal infiltration combined with IANB provides significantly better intraoperative pulpal anesthesia compared to IANB alone in mandibular molars with irreversible pulpitis. However, its effect on prolonged postoperative pain relief remains minimal.

Keywords:
Irreversible Pulpitis, Inferior Alveolar Nerve Block, Buccal Infiltration, Endodontic Anesthesia, Pain Control.

Introduction

Dental pain remains one of the most common reasons for patients seeking endodontic treatment, and irreversible pulpitis is among the leading causes of such visits [1]. This condition is characterized by persistent, spontaneous, and often nocturnal pain resulting from inflammation of the dental pulp that cannot recover [2]. Achieving profound anesthesia in these patients is essential for pain-free and successful endodontic procedures.

In upper teeth, anesthesia is effectively achieved by local infiltration, whereas in mandibular posterior teeth, clinicians predominantly rely on the inferior alveolar nerve block (IANB) technique [3]. Several local anesthetic formulations are available, including 3% mepivacaine, 4% prilocaine, 4% articaine with 1:100,000 or 1:200,000 epinephrine, 0.5% bupivacaine with 1:200,000 epinephrine, and 0.75% ropivacaine without vasoconstrictor [4]. Buffered lidocaine solutions have also been introduced to enhance onset and patient comfort.

Despite being the most commonly used approach, IANB alone often fails to provide complete pulpal anesthesia in cases of irreversible pulpitis, even when soft-tissue numbness is achieved [5]. This failure has been attributed to anatomical variations, accessory innervation, altered tissue pH, and tachyphylaxis. To address these limitations, several supplemental techniques have been introduced, including intraligamentary, intraosseous, intrapulpal, and buccal infiltrations in conjunction with the standard IANB [6].

Previous investigations have explored the success rate of IANB combined with buccal infiltration, showing improved anesthetic efficacy compared to IANB alone [7]. However, variations in sample size, anesthetic agents, and outcome measures have limited the generalizability of findings. This study, therefore, aimed to evaluate the comparative efficacy of IANB alone versus IANB with supplemental buccal infiltration in achieving adequate pulpal anesthesia and postoperative pain reduction in mandibular molars with irreversible pulpitis. The results of this trial are expected to contribute valuable clinical evidence toward optimizing anesthetic protocols in endodontic practice.

Methodology

Trial Design

This study was designed as a parallel-group, open-label, randomized clinical trial with a 1:1 allocation ratio to compare the anesthetic efficacy of the inferior alveolar nerve block (IANB) alone versus the combined use of IANB with buccal infiltration in mandibular molars diagnosed with irreversible pulpitis. Due to the procedural nature of the intervention, double-blinding was not feasible. However, randomization ensured unbiased allocation, and an independent statistician blinded to group assignment performed data analysis. The trial was retrospectively registered in the Thai Clinical Trials Registry (TCTR20250923005).

Participants

A total of 150 adult patients (aged 18–60 years) presenting to the Endodontics Department of Fatima Jinnah Dental College and Hospital, Karachi, from October 2023 to May 2024, were enrolled. All participants had a confirmed diagnosis of irreversible pulpitis in a mandibular molar, verified through detailed pain history, cold test, and electric pulp testing (EPT), followed by periapical radiography [8,9]. Patients with systemic diseases, allergies to lidocaine or epinephrine, radiographic evidence of periapical pathology, or pregnancy were excluded to minimize confounding variables. Written informed consent was obtained from all participants after a full explanation of the study protocol.

Interventions

Participants were randomly assigned to two equal groups using a computer-generated randomization list. Group I received a standard inferior alveolar nerve block with 1.8 mL of 2% lidocaine containing 1:100,000 epinephrine (Medicaine, Huons, Korea). Group II received 1.5 mL of the same anesthetic solution as an IAN block supplemented with 0.3 mL buccal infiltration adjacent to the affected molar [10]. A standardized 27-gauge aspirating syringe was used for all injections, administered over 60 seconds to minimize injection discomfort. After 15 minutes, anesthesia of soft tissues (lip, tongue, and buccal mucosa) was assessed, followed by pulp vitality tests using cold and EPT stimuli to confirm pulpal anesthesia [11]. All procedures, including anesthesia and access cavity preparation, were performed by the same experienced clinician to maintain procedural consistency.

Outcomes

The primary outcome measure was pain intensity during endodontic access cavity preparation, assessed using the Visual Analog Scale (VAS) at multiple time points: before injection, 15 minutes after anesthesia, during cavity preparation, immediately post-operatively, and at 12-hour follow-up. A secondary outcome was the success rate of pulpal anesthesia, determined by the absence of pain response during EPT or cold testing before cavity preparation. Additionally, demographic variables such as age and gender were recorded to assess their potential influence on anesthesia effectiveness.

Sample Size

The total sample size of 150 participants (75 per group) was determined to achieve adequate statistical power based on prior studies showing moderate effect sizes in pain reduction when supplemental anesthesia is used for irreversible pulpitis. The sample size was also sufficient to detect clinically meaningful differences in VAS scores with a confidence level of 95% and a power of 80%.

Randomization

Random allocation was performed using a computer-generated sequence prepared by an independent researcher not involved in the clinical procedures. Sequentially numbered, opaque, sealed envelopes were used to ensure allocation concealment until the point of intervention. Participants were assigned to either the control (IANB only) or experimental (IANB + Buccal Infiltrate) group accordingly.

Blinding

Given the obvious procedural differences between the two techniques, operator and patient blinding was not feasible. However, outcome assessment and data analysis were carried out by an independent statistician blinded to the group assignment to minimize assessment bias.

Ethics

Ethical approval for the study was obtained from the Ethical Review Committee of Fatima Jinnah Dental College Hospital, Karachi, and the College of Physicians and Surgeons Pakistan (ERC No. SEP-2022-OPR06). All participants signed informed consent forms, and the study adhered to the ethical principles outlined in the Declaration of Helsinki.

Statistical Methods

Data were analyzed using SPSS version 26. Descriptive statistics (mean ± standard deviation) were calculated for quantitative

variables. Repeated-measures ANOVA was applied to compare mean VAS scores across multiple time points between groups, with a p-value ≤ 0.05 considered statistically significant. Independent t-tests were used to compare mean pain scores between the two groups at each time point, while Chi-square tests evaluated categorical variables such as anesthetic success and demographic factors. Effect sizes were computed using Cohen's d to assess the magnitude of intergroup differences.

Results

Recruitment

Participant recruitment was carried out from October 2023 to May 2024 at the Endodontics Department of Fatima Jinnah Dental College Hospital, Karachi. A total of 180 patients were initially assessed for eligibility based on the inclusion and exclusion criteria. Of these, 150 participants met the eligibility criteria and were enrolled in the study. Thirty individuals were excluded due to systemic illness, radiographic evidence of periapical pathology, allergy to local anesthetic, or refusal to participate. All 150 enrolled participants were randomized equally into two groups—Group I (IANB only, n = 75) and Group II (IANB + Buccal Infiltrate, n = 75). There were no dropouts or protocol deviations during the study period. A CONSORT flow diagram was constructed to illustrate the recruitment, allocation, follow-up, and analysis process (Figure 1).

Baseline Data

Both groups were comparable at baseline in terms of demographic and clinical characteristics. The mean age of participants was 36.5 ± 10.8 years in Group I and 35.9 ± 9.7 years in Group II, with an overall range between 18 and 60 years. There was a nearly equal distribution of males and females across the groups (p = 0.648). Pre-procedural pain intensity, as measured by the Visual Analog Scale (VAS), was also similar in both groups, indicating no significant baseline difference in pain perception (p > 0.05). Clinical and radiographic findings confirmed that all included cases were diagnosed with irreversible pulpitis without signs of periapical pathology, ensuring homogeneity between the two groups at baseline.

Numbers Analysed

All 150 participants completed the trial and were included in the final analysis, corresponding to a 100% follow-up rate. No participants were lost to follow-up or excluded from analysis. Statistical analysis was performed on an intention-to-treat basis to preserve the benefits of randomization. Data were complete for all measured outcomes, including pre-anesthesia, intra-procedure, and post-operative pain assessments.

Outcomes and Estimation

The primary outcome was pain intensity, assessed using the VAS at multiple time intervals. Both groups reported comparable pre-operative pain scores (p = 0.732). Fifteen minutes after the administration of anesthesia, Group II (IANB + Buccal Infiltrate) demonstrated a significantly greater reduction in mean VAS score compared to Group I (p < 0.001). During access cavity preparation, patients in Group II reported minimal to no pain, while several participants in Group I experienced moderate to severe pain despite evident soft tissue anesthesia. The difference between the two groups during the procedure was highly significant (p < 0.001), confirming superior intraoperative pain control with the addition of buccal infiltration.

Immediately post-operatively and at the 12-hour follow-up, both groups demonstrated similar pain reduction trends, with no statistically significant differences observed (p = 0.264 and p = 0.308, respectively). Although Group II showed slightly lower mean VAS scores, the difference was not clinically meaningful beyond the operative period. The effect size (Cohen's d) indicated a large effect favoring the combined anesthesia technique during the operative phase, emphasizing its clinical relevance in achieving profound pulpal anesthesia.

Ancillary Analyses

Additional subgroup analyses were performed to assess the influence of age and gender on pain perception and anesthetic success. Neither age nor gender showed a statistically significant correlation with pain scores at any time point (p = 0.968 and p = 0.648, respectively). These findings suggest that the effectiveness of supplemental buccal infiltration was independent of demographic factors. Furthermore, analysis of EPT and cold test responses after 15 minutes demonstrated a higher frequency of non-response in Group II, confirming more profound pulpal anesthesia compared to Group I.

Harms

No adverse effects, allergic reactions, or complications were reported in either group throughout the study period. All patients tolerated the anesthetic techniques well, and no cases of prolonged numbness, swelling, hematoma, or tissue injury were observed. This indicates that the addition of a buccal infiltrate to the conventional IAN block is a safe and well-tolerated procedure in routine endodontic practice.

Table 1: Comparison of Mean VAS Pain scores between Group I and II at different time intervals.

Time Interval	Group I (n = 75) Mean ± SD	Group II (n = 75) Mean ± SD	p-value
Pre-operative (baseline)	7.6 ± 1.2	7.5 ± 1.3	0.732
15 min post-injection	3.9 ± 1.5	2.1 ± 1.1	<0.01*
During cavity preparation	4.2 ± 1.7	1.8 ± 1.0	<0.01*
Post-operative (immediate)	2.5 ± 1.4	2.2 ± 1.3	0.264
12 hours post-treatment	1.9 ± 1.3	1.7 ± 1.1	0.308

*p < 0.05, p < 0.01 indicate statistically significant differences.
Group I (IANB only); Group II (IANB + Buccal Infiltrate)

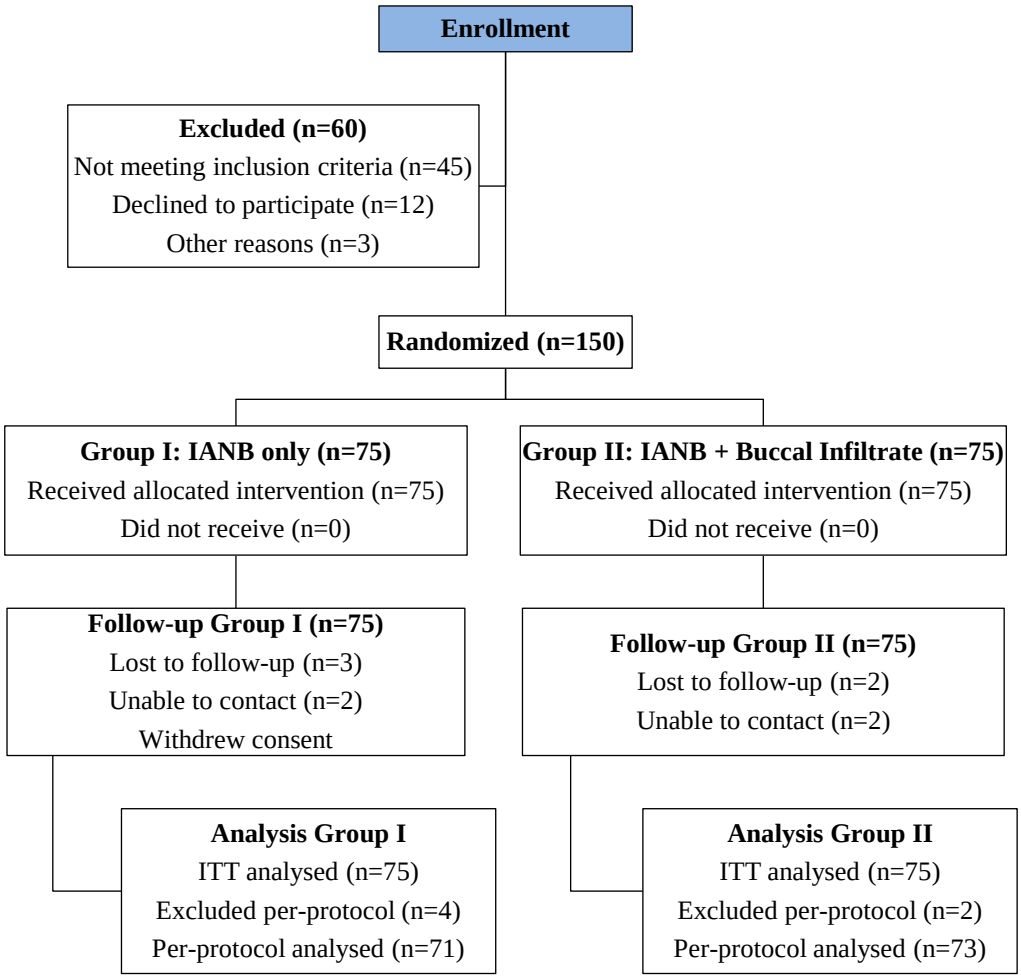

Figure 1. CONSORT Flow Diagram.

Table 2. Effect Size (Cohen's d) and 95% Confidence Intervals for differences in VAS pain scores between groups.

Time Interval	Mean Difference (G1–G2)	95% CI for Mean Diff	Cohen's d [95% CI]	Partial η^2	Significance
Pre-operative (baseline)	0.1	-0.28, 0.48	0.08 [-0.23, 0.39]	0.001	Non-significant
15 min post-injection	1.8	1.35, 2.25	1.32 [0.98, 1.66]	0.308	Significant
During cavity preparation	2.4	1.92, 2.88	1.70 [1.34, 2.06]	0.431	Significant
Post-operative (immediate)	0.3	-0.12, 0.72	0.21 [-0.10, 0.52]	0.007	Non-significant
12 hours post-treatment	0.2	-0.18, 0.58	0.16 [-0.15, 0.47]	0.004	Non-significant

Table 3. Demographic Distribution and Relationship of Gender and Age with Pain Scores.

Variable	Comparison / Correlation	p-value	Result	Interpretation
Gender	Male vs. Female VAS scores	0.648	Not significant	No difference in pain perception between males and females
Age	Age vs. VAS scores correlation	0.968	Not significant	No association between age and pain perception

Table 4. Response to Electric Pulp Test (EPT) and Cold test after 15 minutes of anesthesia.

Test Outcome	Group I: IANB only (n = 75)	Group II: IANB + Buccal Infiltration (n = 75)	p-value
Cold Test			
– No response	28 (37.3%)	56 (74.7%)	<0.001*
– Positive response	47 (62.7%)	19 (25.3%)	
EPT			
– No response	30 (40.0%)	58 (77.3%)	<0.001*
– Positive response	45 (60.0%)	17 (22.7%)	

*p < 0.05, p < 0.01 indicate statistically significant differences.

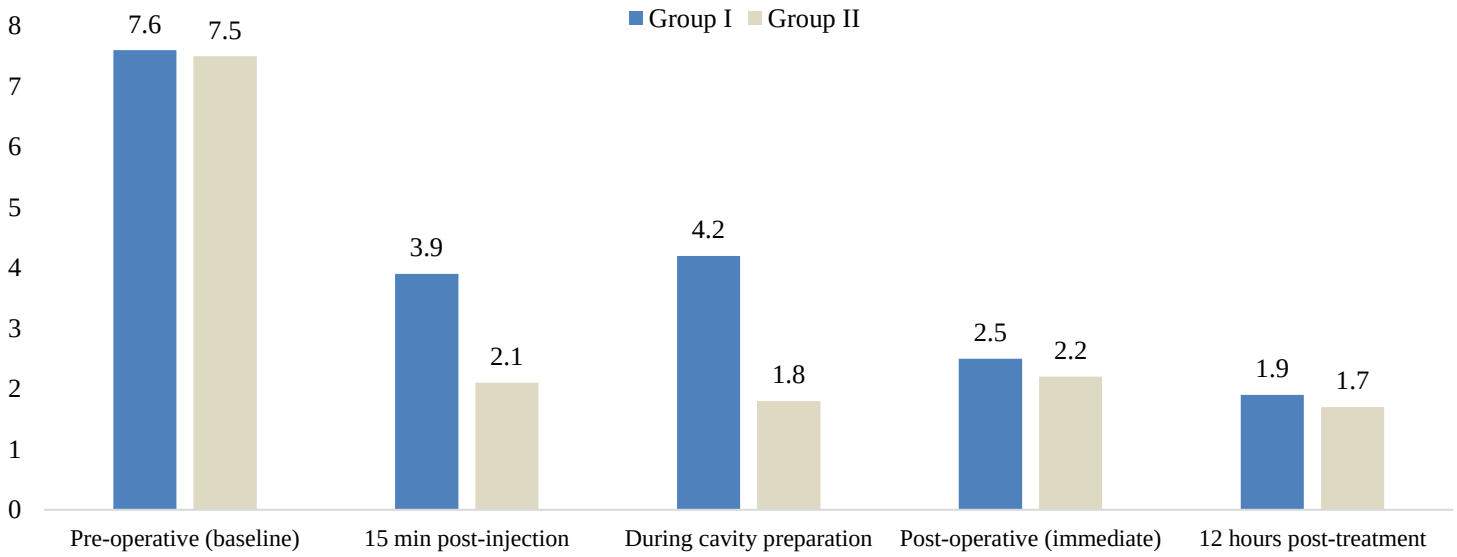

Figure 2. Comparison of Mean VAS Pain scores between groups over time.

Discussion

The findings of this randomized clinical trial demonstrate that the addition of a buccal infiltrate to the conventional inferior alveolar nerve block (IANB) significantly improves intraoperative pulpal anesthesia in mandibular molars with irreversible pulpitis. Although both groups achieved adequate soft tissue anesthesia, patients who received supplemental buccal infiltration (Group II) reported markedly lower pain scores during cavity preparation compared with those who received IANB alone (Group I). These results highlight that combining buccal infiltration with IANB provides more profound and predictable anesthesia for endodontic procedures in cases of irreversible pulpitis.

The results are consistent with previous research showing that IANB alone often fails to produce complete pulpal anesthesia in inflamed mandibular molars [12,13]. Several studies have reported that supplemental injections such as buccal, intraligamentary, or intraosseous infiltrations enhance anesthetic success by targeting accessory innervation and improving anesthetic diffusion through cortical bone [6, 7]. In the present trial, patients in Group I frequently experienced pain or pressure sensations during access cavity preparation despite evident lip numbness, confirming that soft tissue anesthesia does not necessarily indicate pulpal anesthesia.

Comparable outcomes were observed by Webster et al., who found that IANB alone was insufficient to control pain during endodontic access and that additional intraseptal anesthesia was required for effective analgesia [12]. Similarly, Gao et al. demonstrated that buccal infiltration of articaine significantly reduced intraoperative pain compared with lidocaine and mepivacaine [14]. The present findings also align with those of Paul et al., who showed that adding a buccal infiltrate whether containing piroxicam or saline—enhanced anesthesia success and patient comfort during access cavity preparation [15].

Other studies have investigated adjunctive agents to prolong and potentiate anesthesia. Aksoy et al. reported improved anesthetic success with pre-operative submucosal administration of articaine, dexamethasone, or tramadol, with dexamethasone extending the duration of IANB anesthesia [16,17]. Likewise, Dianat et al. and Afkhami et al. found that combining IANB with buccal or intraseptal infiltration yielded significantly higher success rates than IANB alone [17,18]. Collectively, these studies corroborate the current findings that supplemental infiltration provides a clinically meaningful advantage in achieving pain-free operative conditions for mandibular molars with irreversible pulpitis.

The possible mechanism underlying this improvement lies in the dual action of anesthetic diffusion through both the cancellous bone and buccal cortical plate, ensuring complete coverage of nerve terminals supplying the pulp and periapical tissues. Additionally, the buccal infiltration may compensate for variable nerve anatomy and accessory innervation that often compromise IANB effectiveness. Importantly, no gender- or age-related differences were found in pain response or anesthetic efficacy, indicating that the technique's success is independent of demographic variation.

Limitations

This study has certain limitations that should be acknowledged. Pain perception is inherently subjective and can vary according to individual thresholds, anxiety levels, and previous dental experiences. Anatomical variations, differences in bone density, and accessory nerve pathways might also influence anesthetic success. Because this was an open-label trial, blinding of both operator and participants was not feasible, which could introduce performance bias. Moreover, the study was conducted in a single clinical setting with a limited sample size; therefore, multicenter trials with larger populations are recommended for broader generalization. Future studies should also explore other anesthetic agents such as articaine or buffered lidocaine, compare various supplemental routes, and assess long-term postoperative pain and patient satisfaction.

Conclusion

The addition of a buccal infiltrate to the inferior alveolar nerve block significantly enhances pulpal anesthesia during endodontic procedures in mandibular molars with irreversible pulpitis. While the combination technique provides superior intraoperative pain control compared to IANB alone, it does not yield a statistically significant difference in postoperative or 12-hour pain reduction. The approach is simple, safe, and well tolerated, offering a practical solution for clinicians to achieve effective anesthesia and improve patient comfort during root canal therapy. Further randomized controlled studies are warranted to evaluate its effectiveness across different anesthetic formulations and patient populations.

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References

1. Islam S, Ali M, Shaikh A, Rashid S, Hosein T, Baloch J. Effects of three oral analgesics on postoperative pain following root canal preparation: a controlled clinical trial. Pak Armed Forces Med J. 2021;71(2):526–9.
2. Berman LH, Hargreaves KM, editors. Cohen's Pathways of the Pulp. 12th ed. St. Louis: Elsevier; 2020.
3. Mathison M, Pepper T. Local anesthesia techniques in dentistry and oral surgery. Dent Clin North Am. [Year not provided].
4. Badr N, Aps J. Efficacy of dental local anesthetics: a review. J Dent Anesth Pain Med. 2018;18(6):319–32. doi:10.17245/jdapm.2018.18.6.319
5. Parirokh M, Satvati SA, Sharifi R, Rekabi AR, Gorjestani H, Nakhaee N, Abbott PV. Efficacy of combining a buccal infiltration with an inferior alveolar nerve block for mandibular molars with irreversible pulpitis. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2010;109(3):468–73. doi:10.1016/j.tripleo.2009.10.009
6. Kanaa MD, Whitworth JM, Meechan JG. A prospective randomized trial of different supplementary local anesthetic techniques after failure of inferior alveolar nerve block in patients with irreversible pulpitis in mandibular teeth. J Endod. 2012;38(4):421–5. doi:10.1016/j.joen.2011.12.009
7. Fowler S, Drum M, Reader A, Beck M. Anesthetic success of an inferior alveolar nerve block and supplemental articaine buccal infiltration for molars and premolars in patients with symptomatic irreversible pulpitis. J Endod. 2016;42(3):390–2. doi:10.1016/j.joen.2015.12.005
8. Yadav S. Anesthetic success of supplemental infiltration in mandibular molars with irreversible pulpitis: a systematic review. J Conserv Dent Endod. 2015;18(3):182–6. doi:10.4103/0972-0707.158941
9. Torabinejad M, Walton RE. Endodontics: Principles and Practice. 5th ed. St. Louis: Elsevier Health Sciences; 2009.
10. Khalil H. A basic review on the inferior alveolar nerve block techniques. Anesth Essays Res. 2014;8(1):3–8. doi:10.4103/0259-1162.128892
11. Thangavelu K, Kannan R, Kumar NS. Inferior alveolar nerve block: alternative technique. Anesth Essays Res. 2012;6(1):53–7. doi:10.4103/0259-1162.103375
12. 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):1453–7. doi:10.1016/j.joen.2016.07.001
13. Schellenberg J, Drum M, Reader A, Nusstein J, Fowler S, Beck M. Effect of buffered 4% lidocaine on the success of the inferior alveolar nerve block in patients with symptomatic irreversible pulpitis: a prospective, randomized, double-blind study. J Endod. 2015;41(6):791–6. doi:10.1016/j.joen.2015.02.018
14. Gao X, Meng K. Comparison of articaine, lidocaine and mepivacaine for buccal infiltration after inferior alveolar nerve block in mandibular posterior teeth with irreversible pulpitis. Br Dent J. 2020;228(8):605–8. doi:10.1038/s41415-020-1448-3
15. Paul S, Nandamuri S, Raina A, Bansal M. Efficacy of buccal piroxicam infiltration and inferior alveolar nerve block in patients with irreversible pulpitis: a prospective, double-blind, randomized clinical trial. Restor Dent Endod. 2021;46(1):e6. doi:10.5395/rde.2021.46.e6
16. Aksoy F, Ege B, Tosun S. The effect of pre-operative submucosal administration of dexamethasone, tramadol, and articaine on the success rate of inferior alveolar nerve block on mandibular molars with symptomatic irreversible pulpitis: a randomized, double-blind placebo-controlled clinical trial. Int Endod J. 2021;54(11):1982–92. doi:10.1111/iej.13578
17. 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;24:1281–6. doi:10.1007/s00784-019-02985-5
18. Afkhami F, Pirmoazen S, Ardestani A, Fard MJ. Comparative evaluation of anesthetic efficacy of inferior alveolar nerve block and inferior alveolar nerve block plus buccal or lingual infiltration using articaine in mandibular molars with irreversible pulpitis: a preliminary prospective randomized single-blind clinical trial. Quintessence Int. 2021;52(9):780–8. doi:10.3290/j.qi.b1843817
19. Monteiro MR, Groppo FC, Haiter-Neto F, Volpato MC, Almeida JF. 4% articaine buccal infiltration versus 2% lidocaine inferior alveolar nerve block for emergency root canal treatment in mandibular molars with irreversible pulpitis: a randomized clinical study. Int Endod J. 2015;48(2):145–52. doi:10.1111/iej.12389