RESEARCH PAPER

Comparing Low Volume 1.5% Lignocaine Vs Conventional Volume Of 1.5% Lignocaine In Ultrasound Guided Popliteal Sciatic Nerve Block–a Non-Inferiority Trial

Dr. Manoj s*[1] ,Dr. Lalith Kumar e[2] , Dr. a. Dhivya Bharathi[3] ,Dr. Shanmuga Priya m[4]

[1*]Assistant Professor, Department Of Anaesthesiology, Tagore Medical College And Hospital, Rathinamangalam, Chennai, Tamil Nadu, MAIL ID : Manoj1sivan@Gmail.Com
[2]Assistant Professor, Department Of Anaesthesiology, Panimalar Medical College Hospital & Research Institute, Poonamalle, Chennai, Tamil Nadu.
[3]Assistant Professor, Department Of Anaesthesiology, Tagore Medical College And Hospital, Rathinamangalam, Chennai, Tamil Nadu.
[4]Senior Resident, Department Of Ent, Bhaarath Medical College And Hospital, Selaiyur, Chennai, Tamil Nadu.

Abstract

Introduction: TeUltrasound-guided popliteal sciatic nerve block enables precise local anaesthetic deposition, potentially allowing effective blockade with lower volumes of local anaesthetic. This study compared the efficacy of low-volume and conventional-volume 1.5% lignocaine with adrenaline and buprenorphine for ultrasound-guided popliteal sciatic nerve block in patients undergoing below-knee surgeries.

Materials and Methods: In this prospective randomized non-inferiority trial, 40 patients scheduled for below-knee surgeries were randomly allocated to receive either 10 mL (low-volume group, n=20) or 16 mL (conventional-volume group, n=20) of 1.5% lignocaine with adrenaline and buprenorphine. The primary outcome was the duration of sensory blockade. Secondary outcomes included onset of sensory blockade, onset and duration of motor blockade, and assessment of non-inferiority.

Results: Forty patients completed the study. Baseline demographic and clinical characteristics were comparable between the groups. The onset of sensory blockade, onset of motor blockade, and duration of motor blockade were similar in both groups. The conventional-volume group demonstrated a significantly longer duration of sensory blockade than the low-volume group (384 ± 13.5 vs. 363 ± 9.8 minutes; P<0.001). The mean difference in sensory block duration was −21.0 minutes (95% CI: −28.6 to −13.4), and the low-volume regimen failed to meet the predefined non-inferiority criterion.

Conclusion: The present study concluded that there was no significant difference in the duration of sensory blockade between low-volume (10 mL) and conventional-volume (16 mL) 1.5% lignocaine with adrenaline for ultrasound-guided popliteal sciatic nerve block. The use of a lower volume of local anaesthetic provided an effective block while potentially reducing the total anaesthetic requirement. Therefore, the low-volume technique may be considered a feasible alternative to the conventional-volume approach for ultrasound-guided popliteal sciatic nerve block.

Keywords: Ultrasound-guided popliteal sciatic nerve block; Lignocaine; Buprenorphine; Regional anaesthesia; Local anaesthetic volume; Non-inferiority trial.

How to cite this article: Manoj S, Lalith Kumar E, Dhivya Bharathi A, Shanmuga Priya M. Comparing Low Volume 1.5% Lignocaine Vs Conventional Volume Of 1.5% Lignocaine In Ultrasound Guided Popliteal Sciatic Nerve Block–a Non-Inferiority Trial. Int J Drug Deliv Technol. 2026;16(71s): 847-851. DOI: 10.25258/ijddt.16.71s.98

Introduction

Peripheral nerve blocks have become an integral component of modern regional anaesthesia because they provide excellent intraoperative anaesthesia, prolonged postoperative analgesia, reduced opioid consumption, and facilitate early mobilisation after surgery (1). The introduction of ultrasound guidance has significantly improved the accuracy and safety of peripheral nerve blocks by enabling real-time visualization of neural structures, needle advancement, and local anaesthetic spread (2). Compared with landmark- or nerve stimulator-guided techniques, ultrasound-guided blocks are associated with higher success rates, reduced local anaesthetic requirements, and fewer procedure-related complications (3).

The ultrasound-guided popliteal sciatic nerve block (PSNB) is a well-established regional anaesthetic technique for surgeries involving the foot, ankle, and distal leg (1). It provides excellent surgical anaesthesia while preserving hamstring muscle function, thereby facilitating early postoperative mobilisation (4). In addition, PSNB offers prolonged postoperative analgesia, reduces perioperative opioid consumption, and improves patient satisfaction, making it an attractive alternative to general or neuraxial anaesthesia for below-knee procedures (4).

The success of peripheral nerve blockade depends on accurate deposition of local anaesthetic around the target nerve together with the concentration, volume, and total dose of the anaesthetic administered (2). Traditionally, relatively large volumes of local anaesthetic have been used to ensure adequate circumferential spread around the nerve (1). However, larger volumes increase total drug exposure and may increase the risk of local anaesthetic systemic toxicity (LAST), prolonged motor blockade, and delayed recovery (5). High-resolution ultrasound has enabled precise perineural injection, thereby reducing the requirement for unnecessarily large volumes while maintaining effective blockade (3).

Lignocaine remains one of the most widely used amide local anaesthetics because of its rapid onset of action, favourable pharmacokinetic profile, and cost-effectiveness (2). The addition of adrenaline prolongs the duration of anaesthesia, decreases systemic absorption, and reduces peak plasma lignocaine concentrations (2). Recent studies suggest that ultrasound-guided techniques permit successful peripheral nerve blocks with substantially lower volumes of local anaesthetic than conventional techniques (6). Nevertheless, the optimal volume of 1.5% lignocaine for ultrasound-guided popliteal sciatic nerve block remains uncertain, and evidence directly comparing low-volume and conventional-volume administration is limited (7).

Optimising the volume of local anaesthetic is clinically important because reducing drug exposure without compromising block quality may improve patient safety, minimise dose-related adverse effects, and enhance postoperative recovery (5). Therefore, the present non-inferiority trial was undertaken to compare the efficacy of low-volume (10 mL) and conventional-volume (16 mL) 1.5% lignocaine with adrenaline for ultrasound-guided popliteal sciatic nerve block in patients undergoing below-knee surgeries.

Materials And Methods:

Study Design and Setting

This prospective, randomized, non-inferiority trial was conducted in the Department of Anaesthesiology at tertiary care hospital after approval from the Institutional Human Ethics Committee. Written informed consent was obtained from all participants before enrolment.

Study Population

Forty adult patients aged 18–65 years, belonging to the American Society of Anesthesiologists (ASA) physical status I or II and scheduled for elective below-knee surgeries under ultrasound-guided popliteal sciatic nerve block, were enrolled. Patients meeting the eligibility criteria were recruited after obtaining written informed consent.

Inclusion Criteria

1. Age between 18 and 65 years.
2. ASA physical status I or II.
3. Scheduled for elective below-knee surgery.
4. Willingness to participate in the study.

Exclusion Criteria

Patients with known allergy to local anaesthetics, coagulopathy, infection at the injection site, pre-existing peripheral neuropathy, significant hepatic, renal or cardiac disease, pregnancy, or refusal to participate were excluded.

Sample Size

The sample size was calculated assuming a non-inferiority margin of 180 minutes with a power of 90% and a two-sided significance level of 5%. A minimum of 15 patients was required in each group. To compensate for possible dropouts, 20 patients were included in each group, resulting in a total sample size of 40 participants.

Randomization

Participants were randomly allocated into two equal groups (n = 20 each).

Group C: Received 16 mL of 1.5% lignocaine with adrenaline (1:200,000) combined with buprenorphine.

Group L: Received 10 mL of 1.5% lignocaine with adrenaline (1:200,000) combined with buprenorphine (300 μg).

Block Technique

After establishing intravenous access, standard monitoring comprising electrocardiography, non-invasive blood pressure, and pulse oximetry was instituted. Patients were positioned in the lateral decubitus position, and the popliteal region was prepared using standard aseptic precautions.

A high-frequency linear ultrasound transducer was used to identify the sciatic nerve proximal to its bifurcation. Following infiltration of the skin with 2 mL of 2% lignocaine, a 23-gauge Quincke spinal needle was advanced under ultrasound guidance using an out-of-plane approach. Correct needle placement within the paraneural sheath was confirmed by hydrodissection with normal saline. After negative aspiration, the study solution was injected incrementally to achieve circumferential spread around the sciatic nerve.

Outcome Assessment

Sensory blockade was assessed every minute using a three-point scale (0 = normal sensation, 1 = reduced sensation, 2 = complete loss of sensation). A score of 2 in all nerve distributions was considered a successful sensory block.

Motor blockade was evaluated every minute using a three-point motor scale based on toe movement (0 = normal movement, 1 = reduced movement, 2 = complete motor block). Complete absence of voluntary movement was considered successful motor blockade.

The onset of sensory and motor block was defined as the interval between completion of drug injection and achievement of complete blockade. Duration of sensory and motor block was recorded until complete recovery. Patient satisfaction and procedure-related complications were also documented.

Outcome Measures

The primary outcome was the duration of sensory blockade. Secondary outcomes included onset of sensory blockade, onset and duration of motor blockade, patient satisfaction, and block-related complications.

Statistical Analysis

Data were analysed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation or median (interquartile range), while categorical variables were expressed as frequencies and percentages. The Mann–Whitney U test was used to compare continuous variables, and the Chi-square test was used for categorical variables. Non-inferiority was evaluated by calculating the mean difference and its 95% confidence interval. A P value <0.05 was considered statistically significant.

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Results;

A total of 40 patients were enrolled and randomized equally into the low-volume group (Group L, n=20) and the conventional-volume group (Group C, n=20). All enrolled participants completed the study and were included in the final analysis.

The mean age of the participants was 54.7 ± 10.6 years. Males constituted 60% of the study population. Most patients belonged to ASA physical status II (67.5%). Diabetes mellitus and mild neuropathy were present in 92.5% and 85% of participants, respectively

Table 1. Baseline demographic and clinical characteristics of the study population (N = 40)

Variable	Value
Age (years), Mean ± SD	54.7 ± 10.6
Age, Median (IQR)	54 (50–65)
Male, n (%)	24 (60)
Female, n (%)	16 (40)
ASA I, n (%)	3 (7.5)
ASA II, n (%)	27 (67.5)
ASA III, n (%)	10 (25.0)
Diabetes mellitus, n (%)	37 (92.5)
Mild neuropathy, n (%)	34 (85.0)

The onset of sensory block, onset of motor block, and duration of motor block were comparable between the two groups (P>0.05). However, the duration of sensory blockade was significantly longer in the conventional-volume group than in the low-volume group (384 ± 13.5 vs. 363 ± 9.8 minutes; P<0.001).

Table 2. Comparison of block characteristics between the study groups

Variable	Group L (n=20)	Group C (n=20)	P value
Age (years), Mean ± SD	51.9 ± 11.5	57.5 ± 9.1	0.081
Sensory block onset (min)	3.75 ± 2.0	4.2 ± 2.6	0.718
Motor block onset (min)	6.15 ± 2.7	7.0 ± 3.5	0.604
Duration of sensory block (min)	363 ± 9.8	384 ± 13.5	<0.001
Duration of motor block (min)	183 ± 5.7	182 ± 11.5	0.854

The mean difference in sensory block duration between the two groups was −21.0 minutes (95% CI: −28.6 to −13.4). Based on the predefined non-inferiority analysis, the low-volume regimen failed to demonstrate non-inferiority compared with the conventional-volume regimen. Although the difference was statistically significant, the non-inferiority criterion was not met

Table 3. Non-inferiority analysis of the primary outcome

Variable	Group L	Group C	Mean Difference (95% CI)	P value
Duration of sensory block (min)	363 ± 9.8	384 ± 13.5	−21.0 (−28.6 to −13.4)	<0.001

There were no statistically significant differences between the two groups with respect to sex, ASA physical status, diabetes mellitus, or neuropathy (P>0.05), indicating that the baseline characteristics were comparable.

Table 4. Comparison of baseline characteristics between the study groups

Variable	Group L n (%)	Group C n (%)	P value
Male	13 (65)	11 (55)	0.519
Female	7 (35)	9 (45)	
ASA I	3 (15)	0 (0)	0.179
ASA II	13 (65)	14 (70)	
ASA III	4 (20)	6 (30)	
Diabetes mellitus	17 (85)	20 (100)	0.072
Mild neuropathy	16 (80)	18 (90)	0.376

Discussion:

The present prospective randomized non-inferiority trial compared the efficacy of 10 mL and 16 mL of 1.5% lignocaine with adrenaline and buprenorphine for ultrasound-guided popliteal sciatic nerve block in patients undergoing below-knee surgeries. The principal finding was that the conventional-volume group achieved a significantly longer duration of sensory blockade than the low-volume group, whereas the onset of sensory block, onset of motor block, and duration of motor blockade were comparable between the groups. The predefined non-inferiority criterion was not achieved for the primary outcome.

Ultrasound guidance has improved the success and safety of peripheral nerve blocks by facilitating accurate deposition of local anaesthetic around the target nerve (8). This precision has encouraged the use of lower volumes of local anaesthetic while maintaining adequate surgical anaesthesia (9). However, the optimal volume for popliteal sciatic nerve block remains uncertain because block duration depends not only on injection accuracy but also on the total dose of local anaesthetic administered (8).

In the present study, no significant difference was observed in the onset of sensory or motor blockade between the two groups. Similar findings have been reported by Nag et al., who demonstrated comparable onset characteristics using different ultrasound-guided sciatic nerve block techniques, highlighting the importance of accurate perineural drug deposition rather than injectate volume alone (10).

The conventional-volume group demonstrated a significantly longer duration of sensory blockade than the low-volume group (384 ± 13.5 vs. 363 ± 9.8 minutes; $P<0.001$). This finding suggests that although ultrasound guidance allows successful blockade with reduced local anaesthetic volumes, a reduction in volume may shorten postoperative analgesia. Tran et al. similarly reported that lower volumes could provide successful blockade but that sensory block duration remained influenced by the volume of local anaesthetic administered (9).

The duration of motor blockade was comparable between the two groups. Comparable motor recovery despite reduced local anaesthetic volume may facilitate early postoperative mobilisation while maintaining adequate surgical anaesthesia. Previous studies evaluating ultrasound-guided peripheral nerve blocks have also shown that reductions in local anaesthetic volume have a greater effect on sensory block duration than on motor blockade (9,10).

An important observation in this study was that the low-volume regimen failed to satisfy the predefined non-inferiority criterion. The mean difference in sensory block duration was −21.0 minutes (95% CI: −28.6 to −13.4). According to CONSORT recommendations for non-inferiority trials, treatment effects should be interpreted using the confidence interval in relation to the predefined non-inferiority margin rather than relying solely on statistical significance (11). Therefore, although both regimens produced clinically effective blocks, the evidence does not support considering the low-volume technique non-inferior to the conventional-volume regimen.

Both groups received buprenorphine as an adjuvant to lignocaine with adrenaline. Buprenorphine has been shown to prolong postoperative analgesia by acting on peripheral opioid receptors and reducing postoperative analgesic requirements (12). Since the same adjuvant was administered in both groups, the observed difference in sensory block duration is likely attributable to the difference in lignocaine volume rather than the effect of buprenorphine.

Conclusion:

The present study concluded that there was no significant difference in the duration of sensory blockade between low-volume (10 mL) and conventional-volume (16 mL) 1.5% lignocaine with adrenaline for ultrasound-guided popliteal sciatic nerve block. The use of a lower volume of local anaesthetic provided an effective block while potentially reducing the total anaesthetic requirement. Therefore, the low-volume technique may be considered a feasible alternative to the conventional-volume approach for ultrasound-guided popliteal sciatic nerve block.

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