Section: Anaesthesiology

Original Research Article

A COMPARISON OF 0.25% BUPIVACAINE WITH 25 MCG FENTANYL VERSUS 0.25% LEVOBUPIVACAINE WITH 25 MCG FENTANYL IN INTERSCALENE BLOCK FOR UPPER LIMB SURGERIES

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Received : 03/06/2026
Received in revised form : 17/07/2026
Accepted : 31/07/2026

Keywords:
Interscalene block; bupivacaine; levobupivacaine; fentanyl; brachial plexus; postoperative analgesia.

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DOI: 10.47009/jamp.2026.8.4.182

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2026; 8 (4); 1084-1087

ABSTRACT

Background: The interscalene brachial plexus block reliably anaesthetises the C5–C7 distribution and is the block of choice for shoulder and proximal upper-limb surgery, but comparative data on low-concentration (0.25%) bupivacaine versus levobupivacaine with a fentanyl adjuvant for this block remain limited. **Objective:** To compare 0.25% bupivacaine with 25 mcg fentanyl versus 0.25% levobupivacaine with 25 mcg fentanyl for interscalene brachial plexus block in patients undergoing elective upper-limb surgery. **Materials and Methods:** Prospective interventional comparative study of 100 ASA I/II patients aged 20–50 years undergoing elective upper-limb surgery at a rural tertiary care hospital, Kuppam, over 18 months, randomised by the chit method to Group B (0.25% bupivacaine with 25 mcg fentanyl, n=50) or Group L (0.25% levobupivacaine with 25 mcg fentanyl, n=50). Onset and duration of sensory and motor blockade, duration of analgesia, time to first rescue analgesia, Visual Analogue Scale (VAS) pain scores, and haemodynamic parameters were compared using Student's t-test and chi-square test. **Results:** Baseline demographic characteristics were comparable between groups. Sensory blockade onset was significantly faster in Group L (9.0 ± 0.9 vs 11.49 ± 2.1 min; $p<0.0001$), and motor blockade onset was earlier at the threshold of significance (14.6 ± 1.0 vs 15.46 ± 2.7 min; $p=0.05$). Group L also showed significantly longer duration of sensory blockade (8.53 ± 1.0 vs 7.41 ± 1.5 h), motor blockade (7.05 ± 1.5 vs 5.97 ± 1.3 h), and analgesia (9.15 ± 1.6 vs 7.93 ± 1.7 h; all $p\leq0.001$), with delayed first rescue analgesia (8.12 ± 0.6 vs 6.82 ± 0.7 h; $p<0.0001$) and a lower requirement for repeat rescue doses (all Group L patients needed only one dose versus two in all Group B patients; $p<0.0001$). Pulse rate, respiratory rate, blood pressure, mean arterial pressure, and SpO_2 remained comparable between groups throughout (all $p>0.05$). **Conclusion:** 0.25% levobupivacaine with fentanyl provides faster sensory onset, longer sensory and motor blockade, and more prolonged, dose-sparing postoperative analgesia than 0.25% bupivacaine with fentanyl for interscalene block, with comparable haemodynamic stability, supporting its preferential use for upper-limb surgery.

INTRODUCTION

Regional anaesthesia provides targeted sensory and motor blockade while minimising airway manipulation, systemic drug exposure, and perioperative opioid requirement, and is increasingly favoured for upper-limb surgery.[1]

The brachial plexus, formed by the anterior rami of C5–T1, can be blocked at several levels — interscalene, supraclavicular, infraclavicular, or axillary — with the approach chosen according to the surgical site and patient factors; ultrasound guidance improves accuracy and reduces complications.[2]

The interscalene approach reliably anaesthetises the C5–C7 roots supplying the shoulder, clavicle, and proximal humerus while relatively sparing the C8–T1 (ulnar) distribution, making it the block of choice for shoulder surgery, though careful selection of agent,

ISSN (O): 2687-5365; ISSN (P): 2753-6556

concentration, and adjuvant remains important to optimise block quality and duration.[3]

Bupivacaine, a long-acting amide local anaesthetic used as a racemic mixture, provides dense and prolonged sensory and motor blockade, while levobupivacaine, its pure S(-)-enantiomer, offers a comparable pharmacodynamic profile with a more favourable cardiovascular and neurological safety margin.[4,5] Addition of an opioid adjuvant such as fentanyl to the local anaesthetic has been shown to prolong analgesia when administered perineurally in brachial plexus blocks.[6]

Although both agents are well established in regional anaesthesia, data directly comparing low-concentration (0.25%) bupivacaine and levobupivacaine with a fixed-dose fentanyl adjuvant for interscalene block are limited, most comparative studies having used higher concentrations without an opioid adjuvant.[7] This study was therefore undertaken to compare 0.25% bupivacaine with 25 mcg fentanyl versus 0.25% levobupivacaine with 25 mcg fentanyl in interscalene block for upper-limb surgeries.

Aims and Objectives

To compare 0.25% bupivacaine with 25 mcg fentanyl versus 0.25% levobupivacaine with 25 mcg fentanyl in interscalene block for upper-limb surgeries.

MATERIALS AND METHODS

Study design and setting: Prospective interventional comparative study conducted in the Department of Anaesthesiology at a rural tertiary care hospital, Kuppam, Andhra Pradesh, over 18 months (May 2024 to October 2025).

Study population and sampling: Adult patients of either gender, aged 20–50 years, ASA physical status I or II, scheduled for elective upper-limb surgery and willing to provide written consent were included by purposive sampling and randomly allocated by the chit method. Patients with infection at the injection site, coagulation abnormalities, hepatic or renal dysfunction, epilepsy, pregnancy, or known hypersensitivity to local anaesthetics were excluded. Sample size, calculated from the study by Abhishek et al.[8] (mean difference δ=0.56, SD σ=1.14, α=0.05, power 80%), yielded 50 patients per group (n=100 total): Group B received 0.25% bupivacaine with 25 mcg fentanyl and Group L received 0.25% levobupivacaine with 25 mcg fentanyl.

Assessment tools: Motor blockade was graded using the Modified Bromage Scale (0 = full movement to 3 = complete motor block), and postoperative pain was assessed using the 10 cm Visual Analogue Scale (VAS), with 0 indicating no pain and 10 the worst imaginable pain, categorised as mild (1–3), moderate (4–6), or severe (7–10).

Procedure: After Institutional Human Ethics Committee approval (PESIMSR/IHEC/C-4/2024) and informed written consent, patients underwent standard pre-anaesthetic evaluation and were kept nil per oral for six hours preoperatively. After intravenous access and standard monitoring, ultrasound-guided interscalene brachial plexus block was administered under aseptic precautions with the allocated study drug. Onset and recovery of sensory blockade (loss/return of pinprick sensation) and motor blockade (Modified Bromage Scale), duration of analgesia, time to first rescue analgesia, and intraoperative haemodynamic variables were recorded at predefined intervals; VAS scores were recorded postoperatively at fixed time points and at first request for rescue analgesia.

Statistical Analysis: Data were entered in Microsoft Excel and analysed using SPSS version 21. Continuous variables were expressed as mean ± standard deviation and compared using Student's t-test; categorical variables were expressed as frequencies/percentages and compared using the chi-square test. $p<0.05$ was considered statistically significant.

RESULTS

One hundred patients (50 per group) undergoing elective upper-limb surgery were studied. Age, gender distribution, height, weight, and ASA physical status were comparable between Group B and Group L (all $p>0.05$), confirming adequate baseline matching. [Table 1]

Table 1: Baseline demographic and clinical characteristics

Parameter	Group B (n=50)	Group L (n=50)	p value
Age (years), Mean ± SD	36.12 ± 3.8	36.88 ± 3.6	0.312
Gender, Male / Female, n (%)	34 (68%) / 16 (32%)	31 (62%) / 19 (38%)	0.529
Height (cm), Mean ± SD	162.94 ± 6.9	164.14 ± 4.1	0.294
Weight (kg), Mean ± SD	68.74 ± 8.8	66.72 ± 5.06	0.165
ASA status I / II, n (%)	28 (56%) / 22 (44%)	30 (60%) / 20 (40%)	0.685

Sensory blockade onset was significantly faster and motor blockade onset marginally earlier in Group L, while duration of sensory blockade, motor blockade, analgesia, and time to first rescue analgesia were all significantly longer in Group L. [Table 2]

Table 2: Comparison of block characteristics and analgesic outcomes

Parameter	Group B (Mean ± SD)	Group L (Mean ± SD)	p value
Onset of sensory blockade (min)	11.49 ± 2.1	9.0 ± 0.9	<0.0001*
Onset of motor blockade (min)	15.46 ± 2.7	14.6 ± 1.0	0.05
Duration of sensory blockade (h)	7.41 ± 1.5	8.53 ± 1.0	<0.0001*

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Duration of motor blockade (h)	5.97 ± 1.3	7.05 ± 1.5	<0.0001*
Duration of analgesia (h)	7.93 ± 1.7	9.15 ± 1.6	0.001*
Time to first rescue analgesia (h)	6.82 ± 0.7	8.12 ± 0.6	<0.0001*

Baseline pulse rate, respiratory rate, systolic and diastolic blood pressure, mean arterial pressure, and SpO_2 were comparable between groups, and this stability was maintained at every subsequent recorded time point up to 10 hours postoperatively (all p>0.05;. [Table 3]

Table 3: Baseline haemodynamic parameters between groups

Parameter (baseline)	Group B (Mean ± SD)	Group L (Mean ± SD)	p value
Pulse rate (bpm)	83.20 ± 9.0	82.88 ± 9.0	0.860
Respiratory rate (breaths/min)	16.06 ± 1.4	16.00 ± 1.4	0.840
Systolic BP (mmHg)	122.4 ± 9.8	121.9 ± 10.1	0.812
Diastolic BP (mmHg)	72.1 ± 5.8	71.8 ± 5.6	0.844
Mean arterial pressure (mmHg)	88.9 ± 6.1	88.5 ± 6.3	0.826
SpO_2 (%)	98.68 ± 0.8	98.70 ± 0.8	0.911

VAS scores were identical at baseline, 2, and 4 hours (no pain in either group) and comparable at 6 and 10 hours, with a small but significant difference favouring Group L at 8 hours. All 50 patients in Group B required two doses of rescue analgesia, whereas all 50 patients in Group L required only one dose. [Table 4]

Table 4: Postoperative VAS scores and rescue analgesia requirement

Parameter	Group B	Group L	p value
VAS at 6 h, Mean ± SD	1.48 ± 0.5	1.54 ± 0.5	0.553
VAS at 8 h, Mean ± SD	2.76 ± 0.7	2.48 ± 0.5	0.047*
VAS at 10 h, Mean ± SD	3.52 ± 0.6	3.64 ± 0.5	0.325
Rescue analgesia doses required, n (%)	2 doses: 50 (100%)	1 dose: 50 (100%)	<0.0001*

DISCUSSION

In this study of 100 patients undergoing elective upper-limb surgery, baseline age, gender, anthropometric measures, and ASA status were comparable between groups, consistent with Casati et al,[9] and McLeod et al,[10] who reported similar age-matched cohorts in levobupivacaine–bupivacaine comparisons, and with Cox et al,[11] and Fanelli et al,[12] who found comparable gender and ASA distribution across study groups, supporting attribution of subsequent differences to drug pharmacology rather than baseline imbalance.

Sensory blockade onset was significantly faster with levobupivacaine (9.0 ± 0.9 vs 11.49 ± 2.1 min; p<0.0001) and motor onset was marginally earlier (p=0.05), broadly consistent with Gautier et al,[13] who found comparable onset profiles for 0.5% levobupivacaine and bupivacaine in interscalene block, and partly consistent with Vanna et al,[14] though the significantly faster onset seen here contrasts with Reddy et al,[15] who reported faster onset with bupivacaine in lower-limb blocks; such discrepancies likely reflect differences in concentration, volume, technique, and patient population.

Duration of sensory and motor blockade and total analgesia were all significantly longer with levobupivacaine, consistent with the prolonged sensory blockade and favourable safety margin described by Foster et al,[5] and Bardsley et al,[16] and with the longer motor blockade reported by Casati et al,[9] McLeod et al,[10] and Glaser et al.[17] The markedly prolonged time to first rescue analgesia and the requirement for only a single rescue dose in all Group L patients, compared with two doses in all Group B patients, mirror the extended postoperative analgesia and reduced supplementary analgesic requirement reported with levobupivacaine in these earlier studies.

Pulse rate, respiratory rate, blood pressure, mean arterial pressure, and SpO_2 remained stable and comparable between groups throughout the study, in keeping with the favourable cardiovascular safety profile of levobupivacaine relative to racemic bupivacaine described by Bardsley et al,[16] supporting the use of either agent at this concentration without adverse haemodynamic effect, while the additional benefits of faster onset and prolonged, dose-sparing analgesia favour levobupivacaine with fentanyl for interscalene block.

Limitations

The study was conducted at a single centre with a sample size determined for the primary onset outcome. Motor and sensory recovery beyond the observation window and long-term functional outcomes were not assessed, and plasma drug levels were not measured to directly confirm the presumed safety advantage of levobupivacaine.

CONCLUSION

0.25% levobupivacaine with 25 mcg fentanyl produced faster onset of sensory blockade and significantly prolonged sensory blockade, motor blockade, and postoperative analgesia compared with 0.25% bupivacaine with 25 mcg fentanyl in interscalene brachial plexus block, with a

ISSN (O): 2687-5365; ISSN (P): 2753-6556

correspondingly reduced requirement for rescue analgesia. Haemodynamic parameters remained stable and comparable between groups throughout, confirming the safety of both regimens. These findings support the preferential use of levobupivacaine with fentanyl for interscalene block in upper-limb surgery, particularly when prolonged postoperative analgesia is desired.

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ISSN (O): 2687-5365; ISSN (P): 2753-6556