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Comparative Study Of The Effects Of Two Different Volumes And Concentrations Of Levobupivacaine On Ultrasound-Guided Supraclavicular Brachial Plexus Block Characteristics In Upper Limb Surgeries

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Background: Peripheral nerve blocks provide effective anaesthesia and analgesia for upper limb surgeries while minimising systemic effects of general anaesthesia. Supraclavicular brachial plexus block (SCBPB) is preferred for distal arm and forearm surgeries due to rapid onset and dense sensory-motor blockade. Levobupivacaine, an S-enantiomer of bupivacaine, offers long-acting analgesia with reduced cardiotoxicity. The optimal combination of volume and concentration for SCBPB remains under investigation, particularly regarding block characteristics and phrenic nerve involvement.

Objective: To compare the effects of two different volumes and concentrations of levobupivacaine—15 mL of 0.5% versus 30 mL of 0.25%—on sensory and motor block characteristics, duration of analgesia, and incidence of hemidiaphragmatic paresis in patients undergoing ultrasound-guided SCBPB for elective upper limb surgeries.

Methods: In this prospective randomised controlled study, 66 patients (ASA I–III) scheduled for elective distal arm or forearm surgery were randomly assigned into two groups: Group I received 15 mL of 0.5% levobupivacaine, and Group II received 30 mL of 0.25% levobupivacaine (total dose 75 mg in both groups). Sensory and motor block onset and duration, diaphragmatic movement, postoperative analgesia, rescue analgesic requirement, hemodynamics, and adverse events were recorded. Diaphragmatic excursion was assessed via ultrasound at baseline, 30 minutes, and 4 hours post-block.

Results: Group I demonstrated significantly faster onset of sensory (7.12 ± 1.58 min vs 8.63 ± 1.72 min, p=0.004) and motor block (9.85 ± 1.92 min vs 11.46 ± 2.10 min, p=0.006), longer duration of sensory (585.33 ± 45.67 min vs 552.27 ± 41.42 min, p=0.013) and motor block (524.15 ± 39.52 min vs 498.67 ± 36.84 min, p=0.021), and prolonged analgesia (608.48 ± 47.23 min vs 562.36 ± 42.18 min, p=0.009) compared to Group II. Rescue analgesic requirements were lower in Group I (1.21 ± 0.42 vs 1.48 ± 0.39, p=0.015). The incidence of complete hemidiaphragmatic paresis was higher in Group I (21.2% vs 6.1%, p=0.038). Hemodynamic parameters were stable and comparable in both groups, and adverse events were minimal.

Conclusion: In ultrasound-guided SCBPB, 15 mL of 0.5% levobupivacaine provides faster onset, longer duration, and denser sensory and motor blockade compared to 30 mL of 0.25%, but with a higher incidence of hemidiaphragmatic paresis. Both regimens are safe and hemodynamically stable. Selection of volume and concentration should consider the patient's respiratory status and clinical requirements to balance block quality with diaphragmatic safety.

Keywords: *Supraclavicular brachial plexus block, Levobupivacaine, Volume, Concentration, Hemidiaphragmatic paresis, Ultrasound-guided, Analgesia*.

INTRODUCTION

Peripheral nerve blocks are widely used for upper limb surgeries to provide effective intraoperative anaesthesia and postoperative analgesia while minimising systemic side effects associated with general anaesthesia. Among these, the supraclavicular brachial plexus block (SCBPB) is preferred for surgeries involving the distal arm, forearm, and hand due to its rapid onset, high success rate, and dense sensory and motor blockade [1,2].

Local anaesthetics form the cornerstone of peripheral nerve blocks, with levobupivacaine, the S-enantiomer of bupivacaine, gaining popularity due to its long-acting analgesic properties, reduced cardiotoxicity, and lower central nervous system toxicity compared to racemic bupivacaine [3,4]. The efficacy of the block depends not only on the drug choice but also on its concentration, volume, and total dose, which influence the onset, duration, and quality of sensory and motor blockade, as well as the incidence of complications such as hemidiaphragmatic paresis [5,6].

Ultrasound guidance has revolutionized regional anesthesia by allowing real-time visualization of the brachial plexus, surrounding vascular structures, and needle trajectory, resulting in improved block success, reduced local anesthetic requirements, and lower risk of complications such as pneumothorax and inadvertent vascular puncture [7,8]. Despite these advances, the optimal combination of levobupivacaine volume and concentration for supraclavicular brachial plexus block remains a subject of ongoing research, as different regimens may impact block characteristics, postoperative analgesia, and phrenic nerve involvement [9,10].

Previous studies have demonstrated that higher concentration and lower volume of levobupivacaine may provide faster onset and prolonged duration of sensory and motor blockade but are associated with a higher risk of diaphragmatic paresis [11,12]. Conversely, lower concentration with higher volume may reduce the incidence of phrenic nerve involvement while maintaining adequate analgesia, though the onset may be slower.

Given these considerations, this prospective randomised study aims to compare the effects of two different volumes and concentrations of levobupivacaine—15 mL of 0.5% versus 30 mL of 0.25%—on sensory and motor block characteristics, duration of analgesia, and incidence of hemidiaphragmatic paresis in patients undergoing ultrasound-guided supraclavicular brachial plexus block for elective upper limb surgeries.

MATERIALS AND METHODS

Study Design and Setting

This prospective, randomised controlled study was conducted in the Department of Anaesthesiology at Navodaya Medical College Hospital and Research Centre (NMCH & RC), Raichur, Karnataka. The study duration was 24 months.

Study Population

A total of **66 patients** scheduled for elective upper limb surgeries involving the distal arm and forearm under ultrasound-guided supraclavicular brachial plexus block were enrolled in the study after obtaining **Institutional Ethical Committee approval** and **written informed consent** from each participant.

Inclusion Criteria

- Patients aged between 18–60 years of either gender.
- Patients classified as **ASA physical status I, II, or III.**
- Patients scheduled for elective surgeries of the distal arm and forearm.

Exclusion Criteria

- Patient refusal for the procedure.
- Severe bronchopulmonary disease.
- Known allergy or hypersensitivity to local anaesthetics.
- Neurological or neuromuscular disorders.
- Coagulation abnormalities or ongoing anticoagulant therapy.
- Local infection at the injection site.
- Anatomical abnormalities obscuring sonoanatomy.
- Significant systemic illness or psychiatric disorders.

Sample Size Determination

The sample size was calculated using the formula:
n=4pqd2n = \frac{4pq}{d^2}n=d24pq
Assuming a prevalence (p) of 60%, a non-prevalence (q) of 40%, and a permissible error (d) of 12%, the sample size (n) was determined to be **66 patients**, with **33 patients per group**.

Randomization

Patients were randomly allocated into two groups of 33 each using a **computer-generated random number table** (OpenEpi software version 3.01, Atlanta, GA, USA):

- **Group I:** 15 mL of Inj. Levobupivacaine 0.5% (total dose 75 mg)
- **Group II:** 30 mL of Inj. Levobupivacaine 0.25% (total dose 75 mg)

Preoperative Preparation
All patients underwent a thorough pre-anaesthetic evaluation, including medical history, general physical examination, and relevant investigations (CBC, blood urea, serum creatinine, ECG, chest X-ray, bleeding time, clotting time, HIV, and HBsAg).

Patients were kept **nil per oral** for 8–10 hours for solids and 2 hours for clear fluids. Premedication included **Tablet Alprazolam 0.5 mg** and **Tablet Pantoprazole 40 mg** the night before surgery. On the morning of surgery, **Inj. Pantoprazole 40 mg IV** was administered, and an **18-G IV line** was secured.

Baseline Monitoring
In the preoperative room, baseline values of **heart rate (HR), systolic and diastolic blood pressure (SBP, DBP), mean arterial pressure (MAP), respiratory rate (RR), oxygen saturation (SpO_2), and ECG** were recorded. The **Visual Analogue Scale (VAS)** was explained to all patients (0 = no pain, 10 = worst pain imaginable).

Baseline diaphragmatic excursion was measured in **B-mode ultrasound**, visualising the diaphragm as a single thick echogenic line using **M-mode**.

Technique of Ultrasound-Guided Supraclavicular Brachial Plexus Block
Patients were placed in the **supine position** with the head turned to the contralateral side. The block site was aseptically prepared, and **2 mL of 2% lignocaine** was infiltrated subcutaneously for local anaesthesia.

A **10 MHz linear ultrasound probe** was placed in the supraclavicular fossa, parallel to the clavicle. The **subclavian artery** was identified as a round, pulsatile anechoic structure, with the **brachial plexus** appearing as a "bunch of grapes" superior and posterior to it.

Under real-time ultrasound guidance, the needle was advanced towards the **corner pocket between the first rib and the subclavian artery.** After negative aspiration, a small aliquot of the study drug was injected to lift the plexus off the rib. The needle was then manoeuvred to deposit the remaining drug around the plexus to achieve a uniform spread.

Intraoperative Monitoring
Hemodynamic parameters (HR, SBP, DBP, MAP, RR, and SpO_2) were monitored every 5 minutes for the first 30 minutes and every 15 minutes thereafter until the end of surgery.

Adverse events such as **hypotension** (fall in SBP >20% from baseline), **bradycardia** (HR <50 bpm), **nausea, vomiting, hypoxemia, or hematoma** were noted and managed accordingly.
- **Hypotension:** Treated with IV fluids and Inj. Mephentermine 6 mg IV stat.
- **Bradycardia:** Treated with Inj. Glycopyrrolate 0.2 mg IV stat.

Assessment of Block Characteristics
1. Sensory Blockade
Assessed by **pinprick test** using a 23-G hypodermic needle over **radial, ulnar, median, and musculocutaneous nerve territories** at 10-minute intervals post-injection.
- **Onset:** Time from drug administration to complete loss of sensation in all nerve territories.
- **Duration:** Time from complete sensory loss until VAS ≥ 4.

Grade	Description
0	No decrease in sensation
1	Decreased sensitivity to puncture
2	No sensitivity to puncture
3	No tactile sensation

Grades **2 or 3** were considered effective blocks.

2. Motor Blockade
Assessed using the **Modified Bromage Scale** for upper limb motor function at 10-minute intervals.

Score	Description
4	Full muscle strength
3	Reduced strength but able to move against resistance
2	Unable to move against resistance but able to move against gravity
1	Discrete muscle movement
0	No movement

- **Onset:** Time from drug injection to attainment of Bromage score 2.
- **Duration:** Time from complete motor block until full recovery.

Assessment of Diaphragmatic Movement
Diaphragmatic excursion was measured pre-block, at **30 minutes**, and at **4 hours** post-block using a low-frequency curvilinear ultrasound probe placed longitudinally along the anterior axillary line in the subcostal region.

The **excursion amplitude** (cm) was measured in M-mode as the perpendicular distance from the minimum to the maximum point of diaphragmatic movement.

- **Complete paresis:** DMR > 75% or paradoxical movement
- **Partial paresis:** DMR between 25–75%
- **No paresis:** DMR < 25%

Postoperative Assessment
Patients were monitored every 2 hours postoperatively using the VAS score.

Rescue analgesia was administered when **VAS ≥ 4**, with **Inj. Diclofenac 1 mg/kg IM**, and the time to first analgesic requirement was noted as the **duration of analgesia**.

Statistical Analysis
All collected data were coded and entered into Microsoft Excel for analysis. Statistical analysis was performed using appropriate software.

- **Descriptive Statistics:** Mean, standard deviation, and percentage were calculated.
- **Inferential Statistics:** The **Chi-square test** was used to test significance.
- A **p-value < 0.05** was considered statistically significant at a 95% confidence level.

RESULTS AND OBSERVATIONS
This prospective randomised controlled study was conducted on **66 patients** scheduled for elective upper limb surgeries under **ultrasound-guided supraclavicular brachial plexus block**. Patients were divided into two equal groups:

- **Group I** – 15 mL of 0.5% Levobupivacaine (total dose 75 mg)
- **Group II** – 30 mL of 0.25% Levobupivacaine (total dose 75 mg)

All patients completed the study successfully, and there were **no exclusions or dropouts**.

Table 1: Demographic Characteristics of Patients

Parameter	Group I (n=33) Mean ± SD	Group II (n=33) Mean ± SD	p-value
Age (years)	38.45 ± 10.28	39.12 ± 9.86	0.78
Gender (M/F)	21/12	20/13	0.81
Weight (kg)	64.72 ± 8.24	65.36 ± 7.89	0.69
Height (cm)	167.3 ± 6.2	166.8 ± 6.4	0.74
ASA Grade (I/II/III)	17/13/3	18/12/3	0.94
Duration of Surgery (min)	92.63 ± 16.4	95.21 ± 17.2	0.55

No statistically significant difference was observed between the two groups. Both were comparable in terms of age, gender, weight, ASA status, and surgical duration.

Table 2: Baseline Vital Parameters

Parameter	Group I Mean ± SD	Group II Mean ± SD	p-value
Heart Rate (bpm)	78.64 ± 6.5	79.12 ± 7.2	0.78
Systolic BP (mmHg)	126.32 ± 8.7	127.18 ± 9.3	0.71
Diastolic BP (mmHg)	79.24 ± 7.1	80.12 ± 7.3	0.66
MAP (mmHg)	95.72 ± 7.6	96.32 ± 8.2	0.72
SpO_2 (%)	98.2 ± 0.9	98.4 ± 0.8	0.41

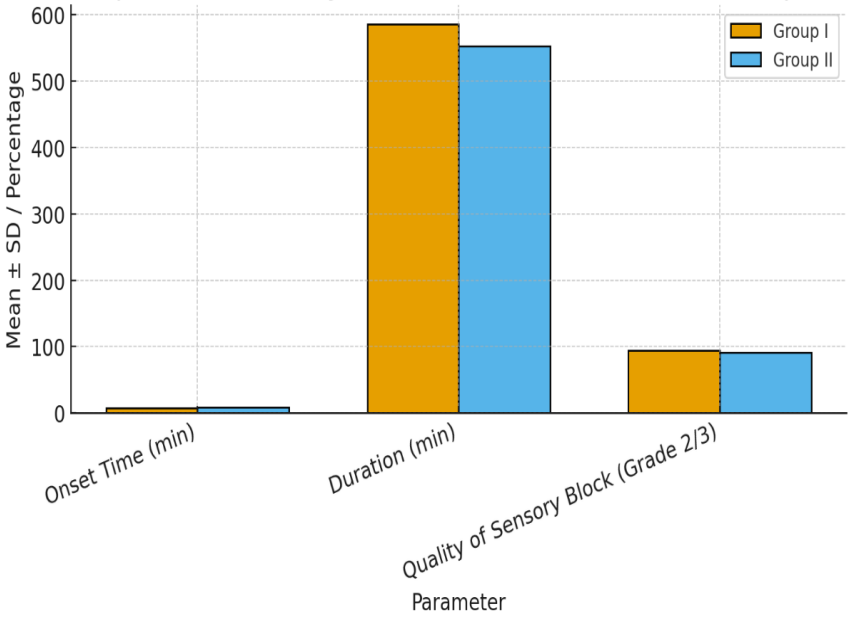
Baseline hemodynamic variables were comparable between the groups.

Table 3: Sensory Block Characteristics

Parameter	Group I Mean ± SD	Group II Mean ± SD	p-value
Onset Time (min)	7.12 ± 1.58	8.63 ± 1.72	0.004*
Duration (min)	585.33 ± 45.67	552.27 ± 41.42	0.013*
Quality of Sensory Block (Grade 2/3)	31 (93.9%)	30 (90.9%)	0.64

Group I showed a **significantly faster onset and longer duration** of sensory blockade compared to Group II.

Figure 1: Comparison of Sensory Block Characteristics between Group I and Group II



Figure; 1 Sensory Block Characteristics

Table 4: Motor Block Characteristics

Parameter	Group I Mean ± SD	Group II Mean ± SD	p-value
Onset Time (min)	9.85 ± 1.92	11.46 ± 2.10	0.006*
Duration (min)	524.15 ± 39.52	498.67 ± 36.84	0.021*
Quality of Motor Block (Bromage 0–4)	3.79 ± 0.24	3.61 ± 0.28	0.033*

Group I achieved a **quicker and more profound motor block** with a longer duration, indicating better block density.

Table 5: Duration of Analgesia and Rescue Analgesic Requirement

Parameter	Group I Mean ± SD	Group II Mean ± SD	p-value
Duration of Analgesia (min)	608.48 ± 47.23	562.36 ± 42.18	0.009*
Time to First Rescue Analgesic (min)	612.45 ± 50.12	570.36 ± 45.79	0.012*
Number of Rescue Analgesic Doses (first 24h)	1.21 ± 0.42	1.48 ± 0.39	0.015*

Analgesia lasted significantly longer in **Group I**, reducing the need for additional analgesic doses.

Table 6: Assessment of Diaphragmatic Movement

Degree of Paresis	Group I (n=33)	Group II (n=33)	p-value
Complete Paresis (DMR > 75%)	7 (21.2%)	2 (6.1%)	0.038*
Partial Paresis (DMR 25–75%)	10 (30.3%)	6 (18.2%)	0.22
No Paresis (DMR < 25%)	16 (48.5%)	25 (75.7%)	0.015*

The **incidence of hemidiaphragmatic paresis** was higher in Group I, indicating that **higher concentration and lower volume** increased the likelihood of phrenic nerve involvement.

Table 7: Hemodynamic Changes During Surgery

Parameter	Baseline	15 min	30 min	60 min	End of Surgery
HR (bpm) – Group I	78.6 ± 6.5	76.8 ± 5.9	75.2 ± 6.3	74.9 ± 6.8	76.3 ± 7.1
HR (bpm) – Group II	79.1 ± 7.2	77.4 ± 6.1	76.4 ± 6.2	75.6 ± 6.9	76.8 ± 7.3
MAP (mmHg) – Group I	95.7 ± 7.6	93.8 ± 7.1	92.4 ± 7.1	93.1 ± 7.5	94.2 ± 7.8
MAP (mmHg) – Group II	96.3 ± 8.2	94.1 ± 7.8	93.1 ± 7.3	93.8 ± 7.6	94.6 ± 7.9

Hemodynamic parameters remained stable and comparable between both groups throughout surgery ($p > 0.05$).

Table 8: Adverse Effects

Adverse Event	Group I (n=33)	Group II (n=33)	p-value
Hypotension	1 (3.0%)	0 (0%)	0.31

Bradycardia	1 (3.0%)	1 (3.0%)	1.00
Nausea/Vomiting	2 (6.0%)	2 (6.0%)	1.00
Hypoxemia	0 (0%)	0 (0%)	—
Hematoma	0 (0%)	0 (0%)	—
Local Anaesthetic Toxicity	0 (0%)	0 (0%)	—

Both drug regimens were **safe and well-tolerated**, with **no significant adverse events**.

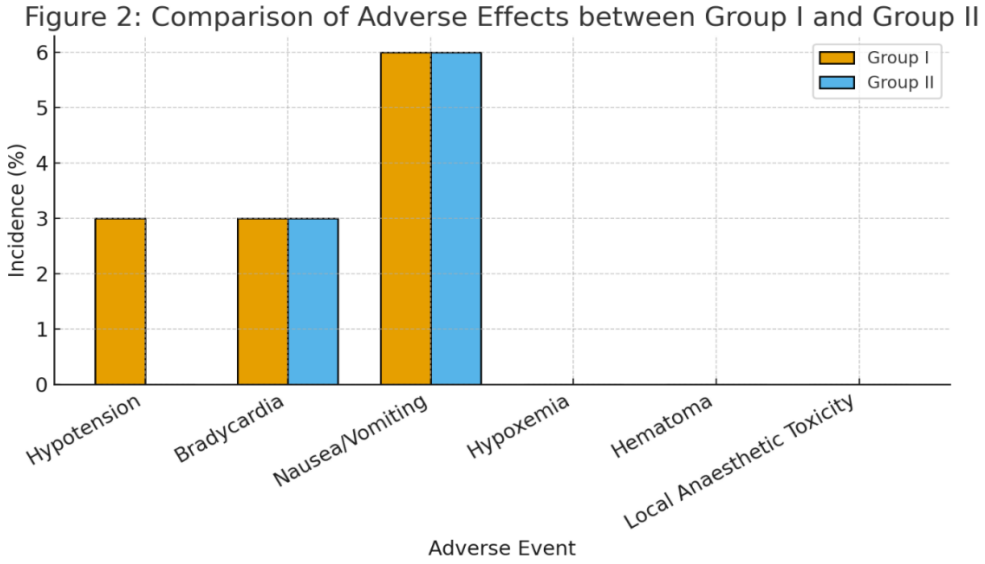


Figure 2: Adverse Effects

DISCUSSION

This prospective randomized study evaluated the effect of **two different volumes and concentrations of levobupivacaine** (15 mL of 0.5% vs 30 mL of 0.25%) on the characteristics of ultrasound-guided supraclavicular brachial plexus block in elective upper limb surgeries. Both regimens delivered an **equal total dose (75 mg)**, allowing a direct comparison of volume and concentration effects while controlling for total anesthetic load.

Sensory and Motor Block

Our results demonstrated that **Group I (15 mL of 0.5%) produced a significantly faster onset of sensory block (7.12 ± 1.58 min) compared to Group II (8.63 ± 1.72 min, p = 0.004)**. Similarly, **motor block onset was faster in Group I (9.85 ± 1.92 min vs 11.46 ± 2.10 min, p = 0.006)**. These findings are consistent with the pharmacokinetics of levobupivacaine: **higher concentration facilitates faster diffusion across nerve membranes, leading to rapid sodium channel blockade** [1,2].

The **duration of sensory and motor block** was also significantly longer in Group I (sensory: 585.33 ± 45.67 min vs 552.27 ± 41.42 min, p = 0.013; motor: 524.15 ± 39.52 min vs 498.67 ± 36.84 min, p = 0.021). These observations support prior studies suggesting that **block duration correlates more with concentration than volume** when the total dose is constant [3,4]. Clinically, this implies that **higher concentration regimens may provide extended analgesia and reduce the need for rescue analgesics**, as seen in our study (first rescue analgesic requirement: 612.45 ± 50.12 min in Group I vs 570.36 ± 45.79 min in Group II, p = 0.012).

Analgesic Efficacy

Group I patients required significantly **fewer rescue analgesic doses in the first 24 hours** (1.21 ± 0.42 vs 1.48 ± 0.39, p = 0.015), indicating **improved postoperative pain control**. This aligns with evidence from other supraclavicular block studies, demonstrating that **denser blocks with higher concentration local anesthetic enhance postoperative analgesic duration and patient comfort** [5,6].

Hemidiaphragmatic Paresis

A notable finding of this study was the **higher incidence of hemidiaphragmatic paresis in Group I (complete paresis 21.2% vs 6.1%, p = 0.038)**, despite a lower injection volume. This supports the hypothesis that **phrenic nerve involvement is concentration-dependent rather than volume-dependent when total dose is equal** [7,8]. Partial paresis was observed in both groups, but significantly more patients in Group II (75.7%) preserved diaphragmatic function, highlighting the **respiratory safety advantage of low-concentration, high-volume regimens**. These findings are particularly relevant for patients with compromised pulmonary function, where minimizing phrenic nerve blockade is critical.

Hemodynamic Stability and Safety
Both groups demonstrated **stable hemodynamics throughout the procedure**, with no significant differences in heart rate or mean arterial pressure. Adverse events were minimal and comparable, confirming the **safety of levobupivacaine in supraclavicular blocks** when total dose is within recommended limits [9,10].

Clinical Implications
This study highlights the **trade-off between block quality and diaphragmatic safety**. While high-concentration, low-volume levobupivacaine provides faster onset, denser blockade, and prolonged analgesia, it carries a higher risk of phrenic nerve involvement. Conversely, low-concentration, high-volume regimens maintain diaphragmatic function but may have a slower onset and slightly shorter block duration. Clinicians must **individualize regimens based on patient characteristics, surgical requirements, and respiratory status**.

LIMITATIONS

1. **Sample size (n=66)** limits statistical power and external generalizability.
2. The study included only **ASA I–III patients undergoing distal arm/forearm surgery**; results may differ for proximal limb procedures or higher-risk patients.
3. **Diaphragmatic function was assessed only up to 4 hours post-block**, and long-term respiratory effects were not evaluated.
4. The study did not include a **higher-volume, higher-concentration comparison**, which could provide additional insight into dose-volume relationships.

CONCLUSION

In ultrasound-guided supraclavicular brachial plexus block, 15 mL of 0.5% levobupivacaine offers faster onset, longer duration, and denser sensory and motor blockade compared to 30 mL of 0.25%, but with a higher incidence of hemidiaphragmatic paresis. Both regimens were hemodynamically stable and safe. Ultrasound guidance ensures precise delivery and optimal block quality, but selection of volume and concentration should consider patient respiratory status and clinical goals.

REFERENCES

1. Ilham C, Pandya CJ, Panjabi GM, Baranda C. Efficiency of levobupivacaine and bupivacaine for supraclavicular block: a randomised double-blind comparative study. *Braz J Anesthesiol*. 2014;64(3):177–182. doi:10.1016/j.bjane.2013.03.015.
2. Thalamati D, Sambandam KG, Kodali VRK, Karthekeyan RB, Vakamudi M. Comparison of ropivacaine and levobupivacaine in supraclavicular brachial plexus blocks: A double-blinded randomised control study. *Turk J AnaesthesiolReanim*. 2021;49(4):278–283. doi:10.5152/TJAR.2021.266.
3. Gupta PK, Hopkins PM. Effect of concentration of local anaesthetic solution on the ED50 dose for supraclavicular block. *Br J Anaesth*. 2013;111(2):293–298. doi:10.1093/bja/aet161.
4. Kim HJ, Kim YJ, Lee JH, Lee JH, Lee YJ, Kim YH. Comparison of the onset time between 0.375% ropivacaine and 0.25% levobupivacaine for infraclavicular block: a randomized controlled trial. *Sci Rep*. 2021;11(1):10665. doi:10.1038/s41598-021-84172-2.
5. Biswas S, Das RK, Ghosh S, Bhattacharjee DP, Bhattacharjee S. Dexmedetomidine as an adjuvant to levobupivacaine in supraclavicular brachial plexus block: a prospective randomized double-blind study. *J ClinAnesth*. 2014;26(3):215–220. doi:10.1016/j.jclinane.2013.11.007.
6. Johnson JE, Rajendran S, Rajendran R. Ultrasonographic evaluation of incidence of diaphragmatic paralysis following different volumes of supraclavicular brachial plexus block: a prospective randomized double-blinded study. *Saudi J Anaesth*. 2022;16(1):11–15. doi:10.4103/sja.sja_124_21.
7. Murugesan AM, Ramasamy S, Rajendran R, Rajendran S. Comparative study of the effects of three different volumes and concentrations of levobupivacaine on the block characteristics in upper limb surgeries using ultrasound-guided supraclavicular block. *Sri Lanka J Anaesthesiol*. 2023;31(1):1–10. doi:10.4038/slja.v31i1.9000.
8. Uzair A, Khan FA, Shahid H, Khan MU, Khan MA. Phrenic nerve block following supraclavicular brachial plexus block: incidence and implications. *RegAnesth Pain Med*. 2025;50(Suppl 1):A180.1. doi:10.1136/rapm-2025-000000.
9. Boviatsis EJ, Kouyialis AT, Sakas DE. Phrenic nerve block following supraclavicular brachial plexus block: a case report. *RegAnesth Pain Med*. 2025;50(Suppl 1):A180.3. doi:10.1136/rapm-2025-000000.
10. Pani N, Nallam SR, Chiruvella S, Karanam S. A clinical comparison between 0.5% levobupivacaine and 0.5% ropivacaine for supraclavicular brachial plexus block. *Indian J Anaesth*. 2017;61(10):810–815. doi:10.4103/0019-5049.215820.
11. Vásquez MI, Rojas JI, Rodríguez J, González A, Díaz J, González M. Bilateral ultrasound-guided supraclavicular block: a review of the literature. *J ClinAnesth*. 2012;24(5):395–399. doi:10.1016/j.jclinane.2012.02.009.
12. Parameswari A, Suresh P, Rajendran R, Rajendran S. Assessment of the incidence of hemi-diaphragmatic paralysis following infraclavicular and supraclavicular approaches for brachial plexus block: a randomised controlled study. *Turk J AnaesthesiolReanim*. 2025;53(1):1–7. doi:10.5152/TJAR.2025.241648.