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# Comparison of 0.5% Ropivacaine and 0.5% Bupivacaine in Supraclavicular Brachial Plexus Block for Upper Limb Surgeries: A Randomized Comparative Study

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## ABSTRACT

**Background**: Supraclavicular brachial plexus block is a commonly used regional anesthesia technique for upper limb surgeries. Bupivacaine and ropivacaine, both long-acting amide local anesthetics, are widely employed, but their relative efficacy and safety profiles remain an area of clinical interest. The present study was conducted to compare the onset, duration of sensory and motor block, duration of postoperative analgesia, and safety of 0.5% ropivacaine versus 0.5% bupivacaine in supraclavicular brachial plexus block for upper limb surgeries.

**Methods:** A prospective, randomized, comparative study was conducted on 60 patients (ASA I–II), aged 18–60 years, undergoing elective upper limb surgeries. Patients were randomly allocated into two groups: Group R (ropivacaine 0.5%, n=30) and Group B (bupivacaine 0.5%, n=30). Sensory and motor block characteristics, duration of analgesia, hemodynamic parameters, and adverse effects were recorded and statistically analyzed.

**Results**: Demographic characteristics were comparable between groups ($p > 0.05$). The onset of sensory (7.8 ± 1.5 min vs. 9.2 ± 1.8 min, p=0.002) and motor block (10.6 ± 1.9 min vs. 12.4 ± 2.1 min, p=0.001) was significantly faster with bupivacaine. The duration of sensory (495.8 ± 52.4 min vs. 410.5 ± 45.2 min, $p<0.001$) and motor block (462.3 ± 48.6 min vs. 375.6 ± 40.8 min, $p<0.001$) was significantly longer in the bupivacaine group. The duration of effective analgesia was also prolonged with bupivacaine (520.7 ± 55.3 min vs. 430.2 ± 48.6 min, $p<0.001$). Hemodynamic parameters remained stable in both groups. Adverse effects such as hypotension, bradycardia, and sedation were minimal and comparable between groups, with no major complications.

**Conclusion**: Both 0.5% ropivacaine and 0.5% bupivacaine are effective for supraclavicular brachial plexus block. However, bupivacaine provides a faster onset and longer duration of sensory and motor block, as well as prolonged postoperative analgesia, with a comparable safety profile to ropivacaine.

**Keywords** – Ropivacaine, Bupivacaine, Supraclavicular brachial plexus block, Regional anesthesia, Upper limb surgeries.

## INTRODUCTION:

Regional anaesthesia has become an integral component of modern anaesthetic practice, particularly for upper limb surgeries where brachial plexus block offers excellent surgical conditions, effective analgesia, and avoidance of airway manipulation. Among the various approaches to the brachial plexus, the supraclavicular block is considered one of the most reliable techniques, providing dense anaesthesia and analgesia for surgeries involving the arm, forearm, and hand due to its compact arrangement of nerve trunks and divisions at this level [1,2].

Traditionally, **bupivacaine**, a long-acting amide local anaesthetic, has been widely used for brachial plexus blocks. It provides prolonged sensory and motor blockade, making it suitable for surgeries lasting several hours [3]. However,

bupivacaine is associated with significant cardiotoxicity and central nervous system toxicity, especially when used in high doses or inadvertently administered intravascularly [4]. This concern has led to the exploration of safer alternatives.

**Ropivacaine**, a newer long-acting amide local anaesthetic, is structurally similar to bupivacaine but formulated as a pure S-enantiomer. This stereoisomeric configuration reduces its affinity for cardiac sodium channels, thereby decreasing cardiotoxic and CNS side effects while maintaining a favourable therapeutic profile [5]. Additionally, ropivacaine produces a relatively greater sensory-motor differentiation, resulting in effective analgesia with earlier recovery of motor function, which is beneficial for early mobilization after upper limb surgeries [6,7].

Several clinical studies have compared ropivacaine and bupivacaine in peripheral nerve blocks. While both drugs provide comparable quality of anaesthesia, ropivacaine has been shown to have a slightly shorter duration of action than bupivacaine, but with a superior safety margin [8]. The choice between these agents depends on the balance between desired duration of analgesia and concern for potential toxicity.

Given the widespread use of supraclavicular brachial plexus block for upper limb procedures, it is essential to evaluate the clinical efficacy, safety, and block characteristics of these two agents in comparable concentrations. Hence, this study was designed to compare **0.5% ropivacaine and 0.5% bupivacaine** in supraclavicular brachial plexus block with respect to onset, duration of sensory and motor blockade, duration of postoperative analgesia, and adverse effects in patients undergoing elective upper limb surgeries.

## Materials and Methods

### Study Design and Setting

This was a prospective, randomized, double-blind, comparative clinical study conducted in the Department of Anaesthesiology at Viswabharathi Medical College, Kurnool after obtaining approval from the Institutional Ethics Committee and written informed consent from all participants.

### Study Population

A total of **60 patients**, aged between **18–60 years**, of either gender, belonging to **ASA physical status I or II**, scheduled for elective upper limb surgeries under supraclavicular brachial plexus block, were enrolled.

### Inclusion Criteria

- Patients aged 18–60 years.
- ASA physical status I and II.
- Scheduled for elective upper limb surgery (forearm, wrist, or hand).
- Duration of surgery expected to be less than 3 hours.
- Patients willing to provide written informed consent.

### Exclusion Criteria

- Patient refusal.
- Known allergy or hypersensitivity to amide local anaesthetics.
- ASA grade III and above.
- Coagulopathy or anticoagulant therapy.
- Local infection at the site of block.
- Pre-existing neurological deficits of the upper limb.
- Severe hepatic, renal, or cardiovascular disease.

### Randomization and Blinding

Patients were randomly allocated into two groups of 30 each using computer-generated random numbers and sealed envelope technique:

- **Group R (n=30):** Received 30 mL of 0.5% ropivacaine.
- **Group B (n=30):** Received 30 mL of 0.5% bupivacaine.

The anaesthesiologist performing the block and the observer recording the outcomes were blinded to the drug used.

### Block Technique

All patients were premedicated with midazolam (0.02 mg/kg IV) and glycopyrrolate (0.2 mg IV). Standard ASA monitoring (ECG, non-invasive blood pressure, $SpO_2$) was applied.

- The supraclavicular brachial plexus block was performed under **ultrasound guidance (high-frequency linear probe, 6–13 MHz)** in the supine position with the head turned to the opposite side.

- After aseptic preparation, a 22-gauge, 50-mm insulated needle was inserted in-plane, and the drug (30 mL of either 0.5% ropivacaine or 0.5% bupivacaine) was injected incrementally with repeated aspiration to avoid intravascular injection.

**Assessment Parameters**

**Onset and Duration of Block**

- **Sensory block**: assessed by pinprick method in dermatomes C5–T1 every 2 minutes until complete block. Onset was defined as the time from completion of injection to loss of pinprick sensation at all sites. Duration was the time from onset until return of normal sensation.
- **Motor block**: assessed using the Modified Bromage Scale for upper limb (0 = normal, 1 = reduced power, 2 = unable to move elbow/wrist, 3 = complete block). Onset was the time from injection to grade 3 motor block. Duration was until full motor recovery.

**Duration of Analgesia**

Time from completion of block to first request for rescue analgesic (VAS $\geq 4$). Rescue analgesia was provided with IV diclofenac 75 mg.

**Hemodynamic Parameters**

Heart rate, systolic and diastolic blood pressure, mean arterial pressure (MAP), and $SpO_2$ were recorded at baseline, every 5 minutes for the first 30 minutes, then every 15 minutes intraoperatively, and hourly postoperatively for 6 hours.

**Adverse Effects**

Patients were monitored for complications such as hypotension (MAP < 60 mmHg), bradycardia (HR < 50 bpm), nausea, vomiting, respiratory depression, pneumothorax, and signs of local anaesthetic systemic toxicity.

**Statistical Analysis**

Data were analyzed using **SPSS version 20.** Continuous variables were expressed as mean ± SD and compared using the **unpaired Student's t-test**. Categorical variables were expressed in percentages and analyzed using the **Chi-square test** as appropriate. A p-value of <0.05 was considered statistically significant.

**RESULTS:**

**Patient Characteristics:**

A total of **60 patients** were enrolled and randomized equally into two groups (Group R: Ropivacaine, n=30; Group B: Bupivacaine, n=30). All patients completed the study.

The demographic variables (age, gender, weight, ASA physical status, and duration of surgery) were comparable between the two groups, with no statistically significant differences ($p > 0.05$) as shown in Table 1

**Table 1. Demographic Characteristics**

| Parameter | Group R (Ropivacaine, n=30) | Group B (Bupivacaine, n=30) | p-value |
|---|---|---|---|
| Age (years, mean ± SD) | 39.8 ± 9.6 | 41.2 ± 8.9 | 0.54 |
| Gender (M/F) | 17/13 | 18/12 | 0.79 |
| Weight (kg, mean ± SD) | 64.5 ± 7.2 | 63.1 ± 6.8 | 0.47 |
| ASA I/II | 20/10 | 21/9 | 0.78 |
| Duration of surgery (min) | 92.4 ± 11.5 | 94.1 ± 12.2 | 0.63 |

The **onset of sensory block** was significantly faster in **Group B** compared to Group R. The **duration of sensory block** was significantly longer in **Group B** than in Group R. The **onset of motor block** was faster in **Group B** compared to Group R. The **duration of motor block** was also longer in **Group B** compared to Group R as shown in Table 2

**Table 2. Characteristics of Sensory and Motor Block**

| Parameter | Group R (Ropivacaine) | Group B (Bupivacaine) | p-value |
|---|---|---|---|
| Onset of sensory block (min) | 9.2 ± 1.8 | 7.8 ± 1.5 | 0.002* |
| Duration of sensory block (min) | 410.5 ± 45.2 | 495.8 ± 52.4 | <0.001* |
| Onset of motor block (min) | 12.4 ± 2.1 | 10.6 ± 1.9 | 0.001* |
| Duration of motor block (min) | 375.6 ± 40.8 | 462.3 ± 48.6 | <0.001* |

The **mean duration of effective analgesia** (time to first rescue analgesic) was significantly longer in **Group B** compared to Group R as shown in Table 3

**Table 3. Duration of Analgesia**

| Parameter | Group R (Ropivacaine) | Group B (Bupivacaine) | p-value |
|---|---|---|---|
| Duration of analgesia (min) | 430.2 ± 48.6 | 520.7 ± 55.3 | <0.001* |

Both groups remained hemodynamically stable throughout the perioperative period. **Mean arterial pressure (MAP)** and **heart rate (HR)** were slightly lower in Group B at 20–30 min after block, but the differences were not statistically significant ($p > 0.05$). No episodes of severe hypotension or bradycardia requiring intervention occurred as shown in Fig 1 & Fig 2

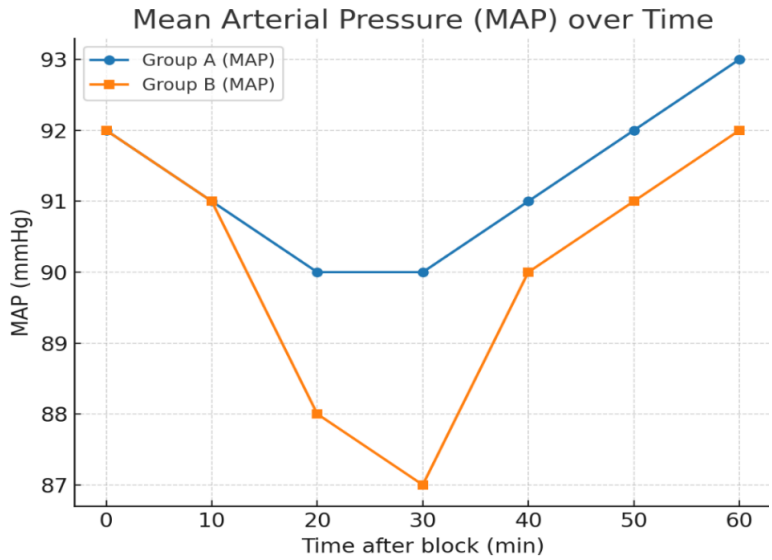


**Figure 1: Mean Arterial Pressure over Time**

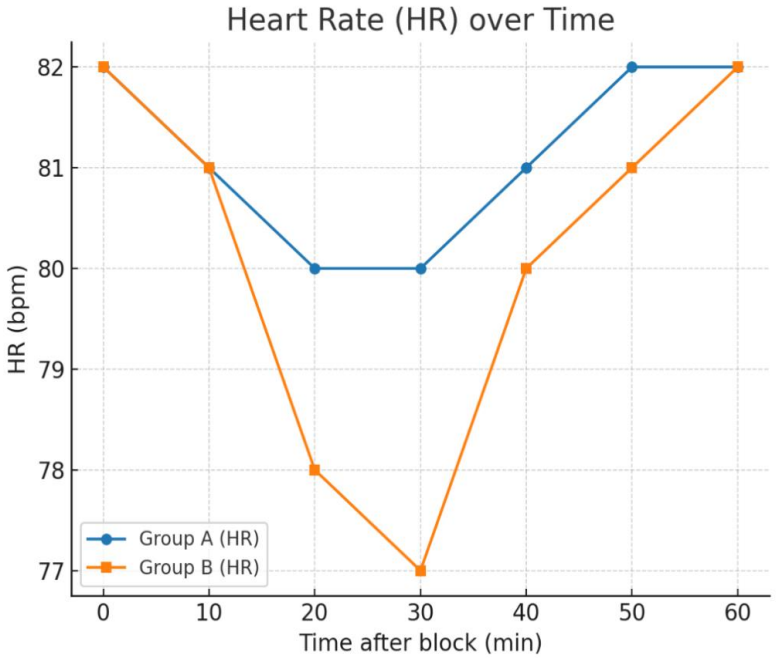


**Figure 2: Heart Rate over Time**

Both drugs were well tolerated, with **no major complications**. Adverse effects were minimal and comparable between groups. Mild sedation was observed in a few patients in Group B. No patient developed systemic toxicity, respiratory depression, or pneumothorax as shown in Table 4

**Table 4. Adverse Effects Observed**

| Side Effect | Group R (n=30) | Group B (n=30) | p-value |
|---|---|---|---|
| Hypotension | 2 (6.6%) | 3 (10%) | 0.64 |
| Bradycardia | 1 (3.3%) | 2 (6.6%) | 0.55 |
| Nausea/Vomiting | 2 (6.6%) | 2 (6.6%) | 1.00 |
| Sedation (Grade 2) | 1 (3.3%) | 3 (10%) | 0.29 |
| Respiratory depression | 0 | 0 | – |

## DISCUSSION:

In this randomized comparative study, we evaluated the clinical efficacy of 0.5% ropivacaine and 0.5% bupivacaine for supraclavicular brachial plexus block in upper limb surgeries. The primary outcomes assessed were block characteristics, duration of analgesia, hemodynamic stability, and adverse effects. Our findings demonstrate that **bupivacaine produced a faster onset and significantly longer duration of sensory and motor block as well as prolonged analgesia compared to ropivacaine**, while both agents maintained stable hemodynamics and were well tolerated.

### Comparison of Block Characteristics

The onset of sensory and motor block was significantly shorter with bupivacaine than with ropivacaine. This finding is consistent with previous studies by Casati et al. [9] who compared the two drugs in brachial plexus block and reported that bupivacaine provided a faster onset of anesthesia than ropivacaine, although ropivacaine was associated with better safety margins due to reduced cardiotoxicity. Similarly, Hickey et al. [10]observed that ropivacaine has a slower onset but is associated with a favorable safety profile compared to bupivacaine.

The duration of sensory and motor block was significantly longer in the bupivacaine group. This is in agreement with Fanelli et al. [11], who found that bupivacaine consistently produces prolonged block duration compared to ropivacaine. However, despite the relatively shorter block duration, ropivacaine still provided adequate anesthesia and postoperative analgesia for intermediate-duration upper limb surgeries, which makes it a reasonable alternative when prolonged motor blockade is undesirable.

### Duration of Analgesia

Patients in the bupivacaine group experienced significantly longer pain-free intervals, highlighting the superior analgesic profile of bupivacaine. Similar results were reported by Klein et al. [12], who compared equianalgesic concentrations of ropivacaine and bupivacaine and found prolonged postoperative analgesia with bupivacaine. Nevertheless, ropivacaine still provided clinically acceptable analgesia, with the advantage of reduced motor impairment, potentially facilitating earlier mobilization. This observation has been supported by McGlade et al. [13], who demonstrated that ropivacaine produces effective analgesia with a shorter duration of motor block compared to bupivacaine.

### Hemodynamic Stability

In our study, both ropivacaine and bupivacaine groups remained hemodynamically stable, with only mild, clinically insignificant decreases in mean arterial pressure and heart rate. This stability correlates with the findings of Knudsen et al. [14], who reported that ropivacaine is less cardiotoxic compared to bupivacaine, offering an added safety margin in high-risk patients. While bupivacaine is known for its potential cardiotoxicity in high plasma concentrations, our study did not encounter such complications, likely due to the limited dose and careful administration under ultrasound and nerve stimulator guidance.

### Adverse Effects

Both agents were well tolerated, with minimal adverse effects. Sedation was slightly more common in the bupivacaine group, although not statistically significant. No major complications such as systemic local anesthetic toxicity, respiratory depression, or pneumothorax were observed. These results are consistent with the reports of Casati et al. [9] and Kuthiala & Chaudhary [15], who emphasized that ropivacaine is associated with fewer central nervous system and cardiovascular toxic effects compared to bupivacaine.

## CONCLUSION:

Both 0.5% ropivacaine and 0.5% bupivacaine are effective for supraclavicular brachial plexus block in upper limb surgeries. While bupivacaine offers faster onset, longer block duration, and prolonged analgesia, ropivacaine provides adequate anesthesia with the advantage of reduced motor blockade and lower cardiotoxic risk. The choice of agent should therefore be individualized based on surgical requirements and patient comorbidities.

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