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Comparative Study of 0.5% Bupivacaine versus 0.5% Ropivacaine in Supraclavicular Brachial Plexus Block: An Observational Study

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Abstract

Background: *Supraclavicular brachial plexus block is a widely utilized regional anesthesia technique for upper limb surgeries. This study compared the efficacy and safety of 0.5% bupivacaine versus 0.5% ropivacaine in supraclavicular brachial plexus block.*

Methods: *This prospective, observational study enrolled 42 patients scheduled for elective upper limb surgeries over six months. Patients were allocated using consecutive sampling: Group B (n=21) received 0.5% bupivacaine, and Group R (n=21) received 0.5% ropivacaine. Primary outcomes included onset times and duration of sensory and motor blockade. Secondary outcomes included hemodynamic parameters, time to first rescue analgesia, and complications.*

Results: *Demographic characteristics were comparable between groups. Group R demonstrated significantly faster sensory block onset (16.7±1.1 vs 17.58±1.14 minutes, p=0.014), while Group B showed faster motor block onset (21±1.06 vs 22.28±1.16 minutes, p=0.006). Duration of sensory block was significantly longer in Group R (9.23±1.10 vs 7.42±1.04 hours, p<0.001), whereas motor block duration was longer in Group B (9.76±1.19 vs 8.90±1.064 hours, p=0.0179). Time to first rescue analgesia was significantly prolonged in Group R (11.3±0.72 vs 10.7±0.76 hours, p=0.013). Hemodynamic parameters remained stable with no significant differences between groups. No major complications occurred in either group.*

Conclusion: *Both agents provide effective regional anesthesia with excellent safety profiles. However, ropivacaine demonstrates superior clinical characteristics including faster sensory onset, longer sensory duration, and prolonged analgesia with reduced motor blockade, making it the preferred choice for supraclavicular brachial plexus blocks.*

Keywords: *Bupivacaine, Ropivacaine, Supraclavicular block, Brachial plexus, Regional anesthesia*

INTRODUCTION

Regional anesthesia techniques have gained significant popularity in modern anesthetic practice due to their superior analgesic efficacy, reduced perioperative complications, and enhanced patient satisfaction(1),(2),(3). Supraclavicular brachial plexus block, first described by Kulenkampff in 1911(4),(5) remains one of the most effective regional anesthesia techniques for upper limb surgeries. This approach provides reliable anesthesia for procedures involving the arm, forearm, and hand by blocking the brachial plexus at the level where it is most compact(6). The choice of local anesthetic agent plays a crucial role in determining the onset, duration, and quality of the nerve block. Bupivacaine, a long-acting amide local anesthetic, has been widely used for peripheral nerve blocks due to its extended duration of action(7). Bupivacaine exerts its anesthetic effect by attaching to the intracellular section of sodium channels, which blocks the entry of sodium ions into nerve cells and inhibits depolarization(8). As a member of the amide-type local anesthetics, it is mainly broken down in the liver through glucuronic acid conjugation(9). Despite its widespread use, clinical evidence has shown that the racemic form of bupivacaine may cause toxic effects on both the cardiovascular and central nervous systems in certain individuals(10).

Ropivacaine is a long-duration amide-type local anesthetic recognized for its improved safety margin when compared to bupivacaine(11). Its relatively low lipophilicity reduces its ability to enter large, myelinated motor neurons, thereby decreasing the incidence of motor blockade(12). Ropivacaine provides better

separation between sensory and motor effects, preferentially affecting Aδ and C fibers responsible for pain transmission while sparing Aβ fibers involved in motor control(13). Research comparing the two agents has shown that ropivacaine delivers a comparable duration of sensory analgesia to bupivacaine, with the added benefits of less motor impairment and a lower risk of toxicity affecting the heart and central nervous system(14),(15),(16).

Despite extensive research on both agents, comparative studies specifically evaluating their efficacy in supraclavicular brachial plexus blocks remain limited. This study aims to provide a comprehensive comparison of 0.5% bupivacaine and 0.5% ropivacaine in terms of block characteristics and clinical outcomes.

METHODS

This prospective, observational, comparative study was conducted at Sree Balaji Medical College and Hospital over a 6-month period. Forty-two patients scheduled for elective upper limb surgeries were enrolled in the study. Inclusion criteria were: age 18-60 years, weight 35-90 kg, ASA physical status I-II, and planned elective surgery. Exclusion criteria included patient refusal, ASA physical status III-IV, psychiatric disorders, pregnancy, chronic alcoholism, and known drug allergies.

Patients were allocated into two groups using consecutive sampling method. The first 21 consecutive patients meeting inclusion criteria received 0.5% bupivacaine (Group B), and the subsequent 21 consecutive patients received 0.5% ropivacaine (Group R) for supraclavicular brachial plexus block. This allocation method was chosen to ensure systematic sampling while maintaining practical feasibility. All blocks were performed by experienced anesthesiologists using the supraclavicular approach under standard monitoring conditions. Data were analyzed using appropriate statistical tests. Continuous variables were expressed as mean ± standard deviation and compared using Student's t-test for normally distributed data. Categorical variables were analyzed using the chi-square test. The consecutive sampling method was considered in the interpretation of results, and baseline characteristics were compared to assess group comparability. A p-value <0.05 was considered statistically significant.

Outcome Measures

Primary outcomes included:

Onset time of sensory block (time from injection to loss of sensation)

Onset time of motor block (time from injection to motor weakness)

Duration of sensory block (time from onset to return of normal sensation)

Duration of motor block (time from onset to return of normal motor function) Secondary outcomes included:

Hemodynamic parameters (heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure)

Time to first rescue analgesia

Complications and adverse events

RESULTS

Patient Characteristics

Table 1: Demographic variable of study population

Characteristic	Group B	Group R	
	Mean±SD	Mean±SD	P value
Age	37.28 ± 11.31	37.6 ± 9.5	0.9018

Height (cm)	172.09 ± 22.5	168.9 ± 22.23	0.64
Weight (kg)	63.3 ± 12.2	59.23 ± 13.05	0.30
Gender	**Number** (%)	**Number** (%)	**P value**
Male	13 (61.91%)	10 (47.619 %)	0.535
Female	8 (38.09%)	11 (52.381 %)	
ASA profile	**Number** (%)	**Number** (%)	**P value**
ASA I	12 (57.14 %)	10 (47.61 %)	0.757
ASA II	9 (42.85 %)	11(52.38 %)	

Baseline demographic characteristics (Table 1) were comparable between the two groups. Mean age, height, and weight showed no significant differences (Group B: 37.28 ± 11.31 years, 172.09 ± 22.5 cm, 63.3 ± 12.2 kg vs Group R: 37.6 ± 9.5 years, 168.9 ± 22.23 cm, 59.23 ± 13.05
kg; all $p > 0.05$). Gender distribution (male: 61.91% vs 47.62%, $p = 0.535$) and ASA physical status (ASA I: 57.14% vs 47.61%, $p = 0.757$) were also similar between groups, confirming adequate randomization.
Block Characteristics

Table 2: Block Characteristics

Parameter	**Group B**	**Group R**	**P-value**
Onset of Sensory Block (min)	17.58 ± 1.14	16.7 ± 1.1	0.014
Onset of Motor Block (min)	21 ± 1.06	22.28 ± 1.16	0.006
Duration of Sensory Block (hrs)	7.42 ± 1.04	9.23 ± 1.10	<0.001
Duration of Motor Block (hrs)	9.76 ± 1.19	8.90 ± 1.064	0.0179
Time to First Rescue Analgesia (hrs)	10.7 ± 1 0.76	11.3 ± 0.72	0.013

The block characteristics demonstrated significant differences between the two groups (Table 2). Group R showed significantly faster sensory block onset compared to Group B (16.7 ± 1.1 min vs 17.58 ± 1.14 min, p = 0.014), while Group B had faster motor block onset (21 ± 1.06 min vs 22.28 ± 1.16 min, p = 0.006). Duration of sensory block was significantly longer in Group R (9.23 ± 1.10 hrs vs 7.42 ± 1.04 hrs, p < 0.001), whereas motor block duration was longer in Group B (9.76 ± 1.19 hrs vs 8.90 ± 1.064 hrs, p = 0.0179). Time to first rescue analgesia was significantly longer in Group R compared to Group B (11.3 ± 0.72 hrs vs 10.7 ± 0.76 hrs, p = 0.013), indicating superior analgesic efficacy in Group R.

Hemodynamic Parameters

Table 3: Hemodynamic Parameters

Parameter	Time Point	Group B	Group R	P-value
Heart Rate (bpm)	Baseline	79.38 ± 4.94	80.47 ± 4.95	0.4
	After Block	80.57 ± 7.88	82.04 ± 6.56	0.5
	5 Minutes	81.28 ± 7.64	81.33 ± 8.91	0.9
	10 Minutes	80.57 ± 6.46	82.61 ± 7.85	0.8
	15 Minutes	82.66 ± 6.01	80.57 ± 9.02	0.38
Systolic BP (mmHg)	Baseline	122 ± 7.82	124 ± 6.95	0.43
	After Block	124.57 ± 7.55	125.42 ± 6.25	0.69
	5 Minutes	126.3 ± 5.80	126.4 ± 6.38	0.9
	10 Minutes	126 ± 6.112	126.33 ± 4.81	0.8
	15 Minutes	125.7 ± 6.46	127.51 ± 8.09	0.4
Diastolic BP (mmHg)	Baseline	72.14 ± 7.08	72.9 ± 8.10	0.7
	After Block	75.80 ± 5.62	73.90 ± 5.89	0.2
	5 Minutes	73.90 ± 7.28	71.47 ± 5.99	0.2
	10 Minutes	74.52 ± 5.50	72.2 ± 6.28	0.21

	15 Minutes	71.2 ± 7.27	73.04 ± 5.25	0.35

Hemodynamic parameters remained stable throughout the study period (Table 3)with no statistically significant differences between the two groups at any time point. Heart rate values were comparable between Group B and Group R at baseline (79.38 ± 4.94 vs 80.47 ± 4.95 bpm, $p = 0.4$) and remained stable after block administration and at 5, 10, and 15-minute intervals (all $p > 0.05$). Similarly, systolic blood pressure showed no significant differences between groups, with baseline values of 122 ± 7.82 mmHg in Group B and 124 ± 6.95 mmHg in Group R ($p = 0.43$), and this trend continued throughout all measured time points (all $p > 0.05$). Diastolic blood pressure also demonstrated hemodynamic stability with comparable baseline values (72.14 ± 7.08 vs 72.9 ± 8.10 mmHg, $p = 0.7$) and no significant differences at subsequent time points (all $p > 0.05$). These findings indicate that both interventions maintained excellent hemodynamic stability without causing clinically significant cardiovascular changes. Safety and Complications No major complications or adverse events were reported in either group during the study period.

DISCUSSION

Brachial plexus blocks, particularly the supraclavicular approach, have emerged as fundamental techniques in contemporary anesthesia practice for upper extremity surgical procedures. The supraclavicular block offers excellent anesthesia and analgesia coverage for the entire upper limb while maintaining a favorable safety profile when executed with proper technique and anatomical understanding(17). However, the proximity of critical anatomical structures including the subclavian vessels, pleura, and phrenic nerve necessitates meticulous attention to detail during block performance to minimize potential complications(18). The selection of local anesthetic agents for brachial plexus blocks has evolved significantly with growing awareness of drug-specific safety profiles. Bupivacaine, while effective in providing prolonged sensory blockade, carries documented risks of severe cardiotoxicity and neurotoxicity, particularly when inadvertent intravascular injection occurs or when plasma concentrations exceed safe thresholds(8). The racemic formulation of bupivacaine has been associated with potentially life-threatening cardiovascular collapse and central nervous system toxicity in susceptible individuals(7). In contrast, ropivacaine represents a significant advancement in local anesthetic pharmacology, offering comparable analgesic duration while demonstrating superior safety characteristics. The drug's unique pharmacological profile provides effective sensory blockade with reduced motor impairment and substantially lower cardiotoxic potential compared to bupivacaine. This improved therapeutic index makes ropivacaine particularly attractive for regional anesthesia applications where patient safety is paramount while maintaining clinical efficacy(11). The demographic characteristics in our study were well-matched between Group B and Group R, with no statistically significant differences in age, height, weight, gender distribution, or ASA physical status (all $p > 0.05$). This finding is consistent with the methodology employed in other comparative studies. The comparable baseline characteristics across all these studies validate the randomization process and eliminate potential confounding variables, allowing for meaningful interpretation of the intervention effects. Our study demonstrated several significant differences in block characteristics between the two groups. Group R showed faster sensory block onset (16.7 ± 1.1 min vs 17.58 ± 1.14 min, $p = 0.014$), while Group B had faster motor block onset (21 ± 1.06 min vs 22.28 ± 1.16 min, $p = 0.006$). These findings align partially with Modak et al.(19), who reported significantly faster onset of both sensory and motor blockade in their ropivacaine group compared to bupivacaine. However, our onset times were notably faster than those reported by Hickey et al.(20), where onset times ranged from 9-15 minutes for ropivacaine and 11-31 minutes for bupivacaine, possibly due to different concentrations or volumes used.

Regarding duration, our study found significantly longer sensory block duration in Group R (9.23 ± 1.10 hrs vs 7.42 ± 1.04 hrs, $p < 0.001$), which contrasts with some previous studies. Venkatesh et al.(21) reported

longer sensory block duration with 0.5% bupivacaine (11.58 ± 3.03 hrs) compared to 0.5% ropivacaine (9.02 ± 0.98 hrs). Similarly, Anita Kumari et al.(22) found bupivacaine to have longer sensory duration (587.37 ± 37.8 min) compared to 0.5% ropivacaine (378 ± 43.96 min). However, Modak et al.(19) supported our findings, showing longer sensory block duration with ropivacaine (9.03 ± 1.38 hrs) compared to bupivacaine (7.18 ± 1.08 hrs). The motor block duration in our study was longer in Group B (9.76 ± 1.19 hrs vs 8.90 ± 1.064 hrs, $p = 0.0179$), which is consistent with most literature suggesting bupivacaine's longer motor blocking properties. The time to first rescue analgesia was significantly longer in Group R (11.3 ± 0.72 hrs vs 10.7 ± 0.76 hrs, $p = 0.013$), indicating superior analgesic efficacy of ropivacaine, which aligns with Modak et al.'s findings where fewer patients in the ropivacaine group required rescue analgesia within 8-10 hours.Our study demonstrated excellent hemodynamic stability with no statistically significant differences in heart rate, systolic blood pressure, or diastolic blood pressure between the two groups at any measured time point (all $p > 0.05$). These findings are consistent across the literature. Modak et al.(19) reported no statistically significant differences in hemodynamic parameters between ropivacaine and bupivacaine groups at different time intervals up to 12 hours post-administration. Venkatesh et al.(21) similarly found no significant differences in heart rate, systolic and diastolic blood pressure, and SpO2 between their three study groups during the perioperative period. Anita Kumari et al.(22) also reported no statistically significant differences in pulse rate and systolic blood pressure among their groups, with any variations being clinically insignificant. This consistent hemodynamic stability across studies suggests that both ropivacaine and bupivacaine provide safe cardiovascular profiles when used for brachial plexus blocks at clinically appropriate concentrations.Our study reported no major complications or adverse events in either group, which represents an excellent safety profile. This finding is superior to some reported studies in the literature. Anita Kumari et al. documented several minor complications including hematoma formation, nausea and vomiting, though these differences were not statistically significant between groups. Hickey et al. and Modak et al. did not specifically report adverse events in their studies, but the absence of major complications in our study suggests excellent technical execution and appropriate patient selection.This study has several limitations including the relatively small sample size and single-center design. Additionally, the study did not evaluate economic considerations or patient satisfaction scores, which could influence clinical decision-making.

CONCLUSION

This prospective observational study demonstrates that both 0.5% bupivacaine and 0.5% ropivacaine are effective local anesthetic agents for supraclavicular brachial plexus block, each offering distinct clinical advantages. Ropivacaine exhibited superior sensory block characteristics with faster onset, significantly longer duration of sensory anesthesia (9.23 ± 1.10 hours vs 7.42 ± 1.04 hours), and prolonged time to first rescue analgesia, indicating enhanced analgesic efficacy. Conversely, bupivacaine demonstrated faster motor block onset and longer motor block duration. Importantly, both agents maintained excellent hemodynamic stability throughout the perioperative period with no significant cardiovascular perturbations, and neither group experienced major complications or adverse events. The improved safety profile of ropivacaine, combined with its superior sensory characteristics and reduced motor impairment, makes it a preferable choice for supraclavicular brachial plexus blocks, particularly in ambulatory settings where early mobilization is desired. However, bupivacaine remains a viable alternative when prolonged motor blockade is clinically beneficial. These findings support the individualized selection of local anesthetic agents based on specific clinical requirements, patient factors, and surgical considerations.

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Conflicts of Interest

The authors declare no conflicts of interest.

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