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Analysis of Onset of Sensory and Motor Blockade by using 0.5% Ropivacaine with that of 0.5% Bupivacaine in Supraclavicular Brachial Plexus Block

Arun N[1], Raghu SP[2], Shivakumara KC[3], Santhosh S Ujjanappa[4]*

[1]Assistant Professor, Dept of Anaesthesiology and Critical Care, Basaveshwara Medical College and Hospital, Chitradurga, Karnataka, India

[2]Associate Professor, Dept of Anaesthesia, Basaveshwara Medical College, Chitradurga, Karnataka, India

[3]Assistant Professor, Basaveshwara Medical College, Chitradurga, Karnataka, India

[4]Assistant Professor, Dept of Emergency Medicine, Basaveshwara Medical College, Chitradurga, Karnataka, India

***Address for Correspondence:** Dr. Santhosh S Ujjanappa, Assistant Professor, Dept of Emergency Medicine, Basaveshwara Medical College, Chitradurga, Karnataka, India
E-mail: santhosh.su@gmail.com

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ABSTRACT

Background: The supraclavicular brachial plexus block provides effective anaesthesia for upper limb surgeries. Ropivacaine and bupivacaine, commonly used in this procedure, differ in onset and duration. While bupivacaine can cause severe cardiac and CNS effects, ropivacaine is considered safer. This study compares the onset and duration of sensory and motor blockade, reviewing various studies to evaluate their efficacy and clinical implications.

Methods: This prospective, randomized, double-blind study compared the effects of 0.5% bupivacaine and 0.5% ropivacaine in 60 ASA I/II patients aged 20-60 years weighing over 50 kg. After ethics approval and informed consent, patients were randomly assigned to receive either bupivacaine or ropivacaine for supraclavicular brachial plexus block. Vital signs, sensory and motor block parameters, adverse events, and analgesia requirements were monitored and analyzed to assess the efficacy and safety of both agents.

Results: This study compares the effects of 0.5% bupivacaine and 0.5% ropivacaine in 60 patients. The Ropivacaine group showed earlier sensory onset (11.93 min) than Bupivacaine (14.33 min), while Bupivacaine had a slower motor onset (19.7 min vs. 14.9 min). Statistical analysis showed significant differences in both sensory and motor block onset times ($p<0.001$), with no significant variation in age, weight, or gender distribution between groups.

Conclusion: This study found Ropivacaine had a faster onset but shorter sensory and motor block duration than Bupivacaine. Both agents were effective, with no significant adverse events or vital parameter changes.

Key-words: Supraclavicular brachial plexus block, Ropivacaine, Bupivacaine, Sensory onset, Motor onset

INTRODUCTION

The supraclavicular brachial plexus block is a local anaesthetic procedure that anaesthetizes the brachial plexus on the area of trunks & its divisions provide adequate anaesthesia for upper body surgeries below the shoulder [1].

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This blockade is also called 'spinal anaesthesia of the upper extremity' due to its extensive coverage & rapid onset of action. The brachial plexus (Fig. 1) is a network of nerves that originates from the cervical spinal cord (C5-T1) and majorly intervenes in the upper limb. In the supraclavicular approach, the anaesthetic is administered where the plexus is most clustered, superior to the clavicle and lateral to the sternocleidomastoid muscle. This location of the brachial plexus provides a dense & predictable blockade, making it a suitable choice for forearm, wrist, and hand surgeries [2].

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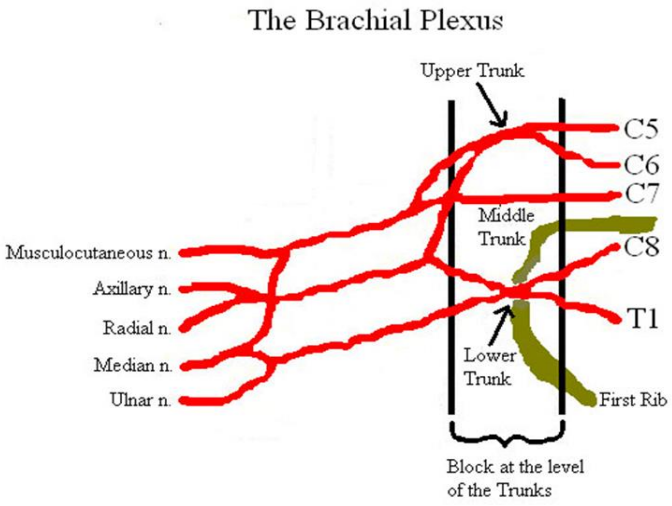

Fig. 1: Schematic diagram of the brachial plexus and its branches
Source:https://www.asra.com/news-publications/asra-updates/blog-landing/legacy-b-blog-posts/2019/08/07/supraclavicular-block?

A variety of adjuvants & local anaesthetics are available, but bupivacaine & ropivacaine are majorly used. Bupivacaine 0.5% & Ropivacaine 0.5% had shown their effectiveness on sensory & motor neuron blockade in brachial plexus block [3,4]. However, in some instances, intravascular injections of bupivacaine cause cardiac arrest, lengthy resuscitation, and a high percentage of fatalities, along with severe CNS & cardiac adverse effects [5,6]. Alternatively, ropivacaine has shown its efficacy due to its lower harmful effects on the cardiovascular and central nervous system than bupivacaine [7,8].

The onset of action is a significant contributing factor to developing anaesthesia; a faster onset of action allows for smooth & on-time surgeries & also, during emergency cases, it plays a key role. Both ropivacaine & bupivacaine show significant effectiveness in supraclavicular brachial plexus motor & sensory neuron blockade. There are several studies available regarding them. Kooloth et al., & Tewari et al. found no significant differences in the onset of sensory & motor neuron blockade and no significant differences in the duration of the blockade [9,10]. However, Modak *et al.* [11] show earlier development & more significant duration of blockade with ropivacaine. In contrast, Patel et al. show an earlier onset of action & more duration of action with bupivacaine [12].

Thus, our study aims to reflect a comprehensive overview of the onset of sensory & motor neuron blockade of ropivacaine & bupivacaine in supraclavicular brachial plexus block by comparing several studies for greater insight into their mechanism of action, efficacy & clinical implications to choose the most suitable anaesthetic agent.

MATERIALS AND METHODS

Research design- This study employed a prospective randomized, controlled, double-blind design conducted at Father Muller Medical College Hospital, Mangalore from October 2016 to October 2018. This study compares the effects of 0.5% bupivacaine and 0.5% ropivacaine in 60 patients aged 20-60 years, weighing over 50 kg, classified as ASA I or II. Following institutional ethics committee approval and informed consent, patients were randomly assigned into two groups (30 each) using the sealed envelope method. Group A received 25 ml of 0.5% bupivacaine, and Group B received 25 ml of 0.5% ropivacaine, with both participants and observers blinded. The supraclavicular brachial plexus block was performed using a standardised technique, and vital parameters (blood pressure, heart rate, oxygen saturation) were recorded. Sensory and motor block parameters, including onset and duration, were assessed using the pinprick method and a modified Bromage scale. Patients were monitored for adverse events such as bradycardia, hypotension, and headache, and analgesia was administered if required. Data were analysed to evaluate the efficacy and safety of the two anaesthetic agents.

Inclusion and Exclusion Criteria

Inclusion criteria:

- Patients between ages 20-60 years undergoing elective upper limb surgeries.
- ASA class 1 and 2.
- There is no history of allergy or sensitivity to the above-mentioned drugs.

Exclusion criteria

- Uncooperative and unwilling patient
- Hypersensitivity to Drugs
- History of neurologic or seizure disorder.
- ASA grade III and IV
- Women with pregnancy

Statistical analysis- Power analysis from similar studies suggests that a sample size of 30 patients/ group is

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required to get the power of the study to 80%, with a 0.05 level of significance. All data was fed into the IBM SPSS software; mean and standard deviation were used for continuous data, and median with non-parametric data. The two groups were compared using a paired t-test to measure hemodynamic parameters. If achieved, $p<0.05$ and confidence intervals of >95% were considered significant. $p>0.05$ is considered statistically significant. $p<0.001$ is considered to be highly significant.

RESULTS

Fig. 2 shows the comparison of mean age between the two groups, indicating a slight difference. The Bupivacaine group has a mean age of 38.23 years, while the Ropivacaine group has a slightly lower mean age of 36 years. Both groups have the same sample size (N=30), ensuring comparability. While there is a marginal variation in the mean age, this difference is not substantial and likely does not influence the outcomes related to sensory and motor block onset.

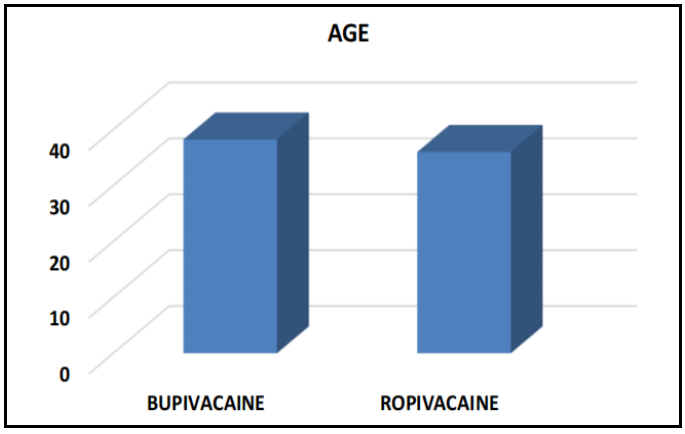

Fig. 2: Comparison of Age Between Groups

Fig. 3 shows the comparison of mean weight between the two groups, revealing minimal variation. The Bupivacaine group has a mean weight of 65.27 kg, while the Ropivacaine group has a slightly higher mean weight of 66.4 kg. Both groups consist of 30 participants, ensuring a balanced sample size. This negligible difference in mean weight suggests that it is unlikely to significantly impact the observed differences in the sensory and motor block onset times between the two groups.

Fig. 4 shows that gender distribution in both groups was comparable. There is no statistically significant difference. The two groups were comparable in age, gender, and weight.

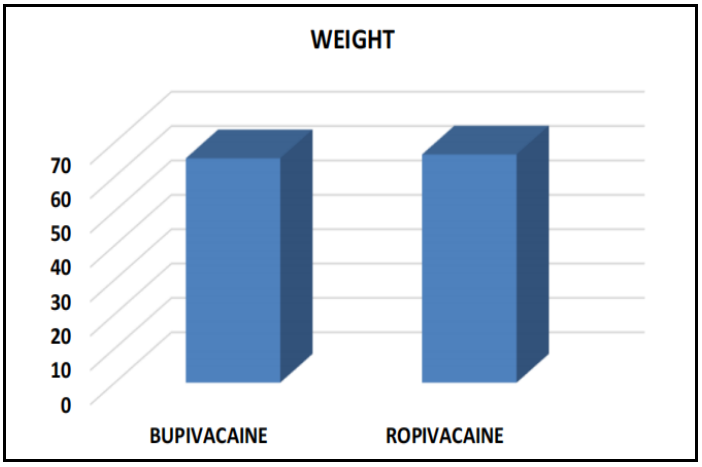

Fig. 3: Comparison of mean weight between the two groups

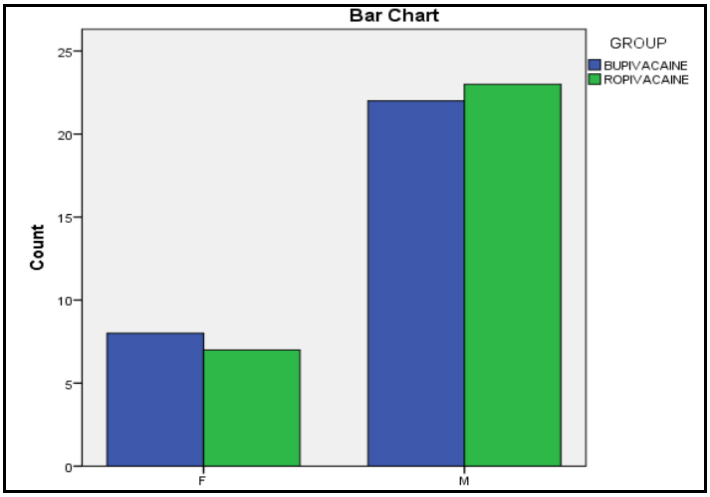

Fig. 4: Gender distribution among two groups.

Fig. 5 shows the comparison of sensory and motor onset of the block between the two groups, revealing significant differences. The sensory onset of the block occurs earlier in the Ropivacaine group, with a mean onset time of 11.93 minutes, compared to 14.33 minutes in the Bupivacaine group, which is statistically highly significant ($p<0.001$). Conversely, the motor onset of the block is delayed in the Ropivacaine group, with a mean onset time of 14.9 minutes, compared to 19.7 minutes in the Bupivacaine group, also statistically highly significant ($p<0.001$). These findings highlight that while Ropivacaine facilitates a quicker sensory block, Bupivacaine leads to a slower motor block onset, emphasizing their differing pharmacodynamic profiles.

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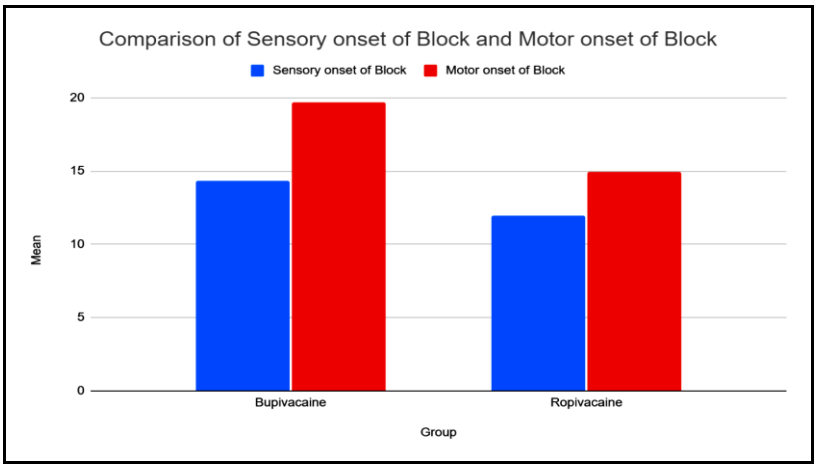

Fig. 5: Comparison of Sensory onset of Block and Motor onset of Block

Table 1 summarises the statistical comparison of age and weight between the Bupivacaine and Ropivacaine groups. For age, the Bupivacaine group has a slightly higher mean age (38.23 years) compared to the Ropivacaine group (36 years), with standard deviations of 8.123 and 11.326, respectively. However, the difference is insignificant (t=0.878, df=58, p=0.384). Similarly, for weight, the Ropivacaine group has a slightly higher mean weight (66.4 kg) compared to the Bupivacaine group (65.27 kg), with standard deviations of 6.673 and 5.854, respectively. This difference is also not statistically significant (t=-0.699, df=58, p=0.487). These results suggest that age and weight are comparable between the two groups and are unlikely to influence the observed outcomes.

Table 1: Comparison of Age and Weight Between Bupivacaine and Ropivacaine Groups

	Group	N	Mean	Std. Deviation	T	Df	p-value
Age	Bupivacaine	30	38.23	8.123			
	Ropivacaine	30	36	11.326	0.878	58	0.384
Weight	Bupivacaine	30	65.27	5.854			
	Ropivacaine	30	66.4	6.673	-0.699	58	0.487

Table 2 illustrates the gender distribution across the Bupivacaine and Ropivacaine groups, each containing 30 participants for a total of 60 individuals. Among females, 8 (26.7%) are in the Bupivacaine group, and 7 (23.3%) are in the Ropivacaine group, representing 25% of the total sample. Among males, 22 (73.3%) are in the Bupivacaine group, and 23 (76.7%) are in the Ropivacaine group, accounting for 75% of the total sample. The gender distribution is comparable between the groups, with a higher proportion of males than females in both, ensuring balance and reducing potential bias in gender-related outcomes.

Table 2: Gender Distribution Between Bupivacaine and Ropivacaine Groups

Crosstab					
			Group		Total
			Bupivacaine	Ropivacaine	
Gender	F	Count	8	7	15
		% within Group	26.7%	23.3%	25.0%

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Crosstab					
			Group		Total
	M	Count	22	23	45
		% within Group	73.3%	76.7%	75%
Total		Count	30	30	60

Table 3 shows that the sensory onset of the block between the two groups shows that the onset of the block is earlier in group B with a mean value of 11.93 min compared to group A with a mean value of 14.33 min and is statistically significant. This difference was statistically highly significant($p<0.001$). On the other hand, the Motor onset of the block is higher in Group A, with a mean value of 19.7 min, compared to Group B, which has a mean value of 14.9 min and is statistically significant. This difference is statistically highly significant ($p<0.001$).

Table 3: Comparison of onset sensory and motor block

	Group	N	Mean	Std. Deviation	T	Df	p-value
Sensory onset of Block	Bupivacaine	30	14.33	1.561	7.205	47.722	<0.001
	Ropivacaine	30	11.93	0.944			
Motor onset of Block	Bupivacaine	30	19.7	1.557	14.526	47.139	<0.001
	Ropivacaine	30	14.9	0.923			

Table 4: Comparative Analysis of Onset and Duration of Sensory and Motor Blockade: Ropivacaine vs. Bupivacaine Across Multiple Studies

Study	Anaesthetic agent	Onset of sensory blockade (In minutes)	Onset of motor blockade (In minutes)	Duration of sensory blockade (In hours)	Duration of motor blockade (In hours)
Hickey *et al.* [17]	0.5% Ropivacaine	13-31	48-132	7-14	11-17
	0.5% bupivacaine	18-58	48-111	5-16	9-12
Klein *et al.* [18]	0.5% Ropivacaine	<6	7-9	12-25	Not specified
	0.5% bupivacaine				
Kooloth *et al.* [9]	0.5% Ropivacaine	10.73±3.11	14.33±4.92	9-11	8-9
	0.5% bupivacaine	12.00±2.88	15.30±5.01	8-10	8-10

Patel *et al.* [12]	0.5% Ropivacaine	7.58	18.87	Ropivacaine: shorter; Bupivacaine: longer	Ropivacaine: shorter; Bupivacaine: longer
	0.5% bupivacaine	4.61	11.00		
Joshi *et al.* [13]	0.5% Ropivacaine	14.9±0.7	11.90±0.59	Similar between groups	Similar between groups
	0.5% bupivacaine	19.4±1.2	14.39±1.12		
Ali *et al.* [14]	0.5% Ropivacaine	8.05±03.21	13±3.69	7-10	7-9
	0.5% bupivacaine	9.1±3.16	15.05±4.21	11-13	10-13
Tripathi *et al.* [15]	0.5% Ropivacaine	4.22±1.52	8.92±2.92	9.72±2.73	8.53±1.92
	0.5% bupivacaine	13.83±3.49	15.86±3.72	9.77±0.75	9.77±0.75
Venkatesh *et al.* [19]	0.5% Ropivacaine	17.79±5.03	22.23±4.05	9.02±0.98	8.29±0.92
	0.5% bupivacaine	16.85±6.67	21.45±4.45	11.58±3.03	12.94±3.09
Kumari *et al.* [16]	0.5% Ropivacaine	5.20±0.768	8.30±0.657	6-8	8-9
	0.5% bupivacaine	6.63±0.496	8.95±0.405	9-10	10-12

DISCUSSION

Several studies show that both 0.5% ropivacaine & 0.5% bupivacaine have significant effectiveness on sensory & motor neuron blockade in supraclavicular brachial plexus block. Table 1 shows almost no significant differences between the onset of sensory & motor blockade and the duration of sensory & motor blockade. However, minute variances in several studies are required for closer examination.

As an example, Patel et al. showed that the onset of sensory and motor blockade for ropivacaine was higher than for bupivacaine, although the duration of action bupivacaine showed longer duration than ropivacaine [12]. In the case of Joshi *et al*. we observed faster onset with bupivacaine as compared to ropivacaine but the duration of action was similar for both agents [13].

Ali *et al.* show a slightly higher duration of blockade for bupivacaine than ropivacaine which coincides with Tripathi *et al.* where we also observed shorter onset & longer duration with bupivacaine [14,15]. Anita et al also showed shorter onset & longer duration with bupivacaine [16].

Although there are no marginal differences between the effectiveness of bupivacaine & ropivacaine, we still observe that in some cases, bupivacaine has more effectiveness than ropivacaine. We also have to take note that bupivacaine can cause severe side effects in the cardiac & central nervous system, which are slightly lesser for ropivacaine [17,18].

Both ropivacaine and bupivacaine have their own pros & cons, but they are still significantly effective for the supraclavicular brachial plexus sensory & motor neuron blockade. Further studies are required to properly understand the efficacy, properties, and side effects along with clinical outcomes of bupivacaine & ropivacaine [18,19].

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CONCLUSIONS

This study compared the efficacy and safety of 0.5% bupivacaine and 0.5% ropivacaine in the supraclavicular brachial plexus block. Both anaesthetic agents demonstrated comparable safety profiles, with no significant differences in patient demographics or adverse effects. However, there were notable differences in their pharmacodynamic profiles. Ropivacaine facilitated a significantly quicker sensory onset (mean: 11.93 minutes) compared to bupivacaine (mean: 14.33 minutes). In contrast, bupivacaine exhibited a slower motor onset (mean: 19.7 minutes) than ropivacaine (mean: 14.9 minutes), with both differences being highly statistically significant ($p < 0.001$). These findings highlight that ropivacaine may be preferable for procedures requiring faster sensory blockade, while bupivacaine may be suitable for scenarios where delayed motor block onset is acceptable.

CONTRIBUTION OF AUTHORS

Research concept- Arun N, Shivakumara KC
Research design- Santhosh S Ujjanappa
Supervision- Raghu SP
Materials- Arun N, Shivakumara KC
Data collection- Santhosh S Ujjanappa
Data analysis and Interpretation- Raghu SP
Literature search- Arun N, Shivakumara KC
Writing article- Santhosh S Ujjanappa
Critical review- Raghu SP
Article editing- Arun N, Shivakumara KC
Final approval- Raghu SP

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