

The Observational Study of Effects of Bupivacaine And Ropivacaine in Patients Undergoing Both Bone Fracture Surgeries Under Axillary Brachial Plexus Block

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Abstract

Background: Axillary brachial plexus block is an established regional anaesthetic technique for upper-limb surgery. Bupivacaine and ropivacaine are long-acting local anaesthetic agents with differences in their onset and duration of sensory and motor blockade. The present study compared the clinical characteristics of 0.5% bupivacaine and 0.75% ropivacaine in patients undergoing both-bone forearm fracture surgery under axillary brachial plexus block.

Materials and Methods: This observational study was conducted in the Department of Anaesthesiology at Saveetha Medical College and Hospital, Chennai, over a period of six months in 2023. A total of 40 patients aged 18–55 years, belonging to ASA physical status I or II and scheduled for both-bone fracture surgery under axillary brachial plexus block, were included. Patients were divided into two groups of 20 each. Group B received 0.5% bupivacaine, while Group R received 0.75% ropivacaine. Sensory and motor block characteristics were assessed, including onset and duration of blockade. Perioperative heart rate, systolic blood pressure and diastolic blood pressure were recorded. Postoperative pain was assessed using the Visual Analogue Scale, and the time to first rescue analgesia was documented.

Results: The baseline demographic characteristics were comparable between the groups. The mean onset of sensory block was significantly shorter with ropivacaine than with bupivacaine (6.10 ± 1.13 vs. 14.85 ± 2.49 minutes; $p < 0.0001$). Similarly, the onset of motor block was significantly faster with ropivacaine (9.00 ± 1.18 vs. 22.70 ± 2.79 minutes; $p < 0.0001$). The duration of sensory blockade was significantly longer with ropivacaine (489 ± 54.58 vs. 399 ± 63.71 minutes; $p < 0.0001$), whereas the duration of motor blockade was significantly longer with bupivacaine (498 ± 54.00 vs. 441 ± 63.71 minutes; $p = 0.0041$). The mean time to first rescue analgesia was significantly longer in the ropivacaine group (720 ± 61.64 vs. 624 ± 33.22 minutes; $p < 0.0001$). Heart rate and systolic blood pressure remained comparable between the groups at the assessed time points, while a significant difference in diastolic blood pressure was observed only at 5 minutes.

Conclusion: Both 0.5% bupivacaine and 0.75% ropivacaine provided effective axillary brachial plexus blockade for both-bone forearm fracture surgery with overall stable perioperative haemodynamic parameters. Ropivacaine demonstrated a faster onset of sensory and motor blockade, longer sensory blockade and a longer duration before first rescue analgesia, whereas bupivacaine produced a longer duration of motor blockade. These differences may be considered when selecting the local anaesthetic according to the desired sensory and motor block characteristics.

Keywords: Bupivacaine; Ropivacaine; Axillary brachial plexus block; Both-bone forearm fracture; Sensory block; Motor block; Rescue analgesia.

Introduction

Upper limb surgical procedures frequently require effective regional anaesthesia to provide adequate intraoperative anaesthesia and postoperative analgesia while maintaining haemodynamic stability and minimizing the need for systemic analgesic medications. The brachial plexus provides the principal neural supply to the upper limb, and blockade of the plexus at the axillary level is an established regional anaesthetic technique for procedures involving the forearm and hand. Ultrasound guidance has further facilitated identification of the relevant neural and vascular structures and improved the precision of axillary brachial plexus blockade.¹

The axillary approach to brachial plexus blockade targets the terminal branches of the plexus around the axillary artery and is particularly useful for surgeries involving the distal upper limb. Knowledge of the anatomy of the axilla, brachial plexus and forearm is essential for successful performance of the block and for minimizing complications.^{2,3} The clinical application of axillary brachial plexus block has therefore been extensively described for upper-limb surgical procedures.²

Bupivacaine is a long-acting amide local anaesthetic that has been widely used for peripheral nerve blockade because of its effective sensory and motor anaesthetic properties. However, concerns regarding its potential cardiotoxicity and prolonged motor blockade have encouraged the evaluation of alternative long-acting local anaesthetic agents.⁴ Ropivacaine is another long-acting amide local anaesthetic developed for regional anaesthesia, with pharmacological properties that have led to its increasing use in peripheral nerve blocks.⁵

Several clinical studies have compared ropivacaine with bupivacaine for brachial plexus blockade. Kaur et al. compared bupivacaine and ropivacaine in patients undergoing forearm surgery under axillary brachial plexus block, demonstrating the clinical utility of both

agents for this approach.⁴ Venkatesh et al. subsequently compared 0.5% bupivacaine with 0.5% and 0.75% ropivacaine for supraclavicular brachial plexus block, providing further evidence regarding the characteristics of these agents in upper-limb regional anaesthesia.⁵ Soni and Parikh also evaluated the sensory and motor block produced by ropivacaine and bupivacaine in supraclavicular blockade.⁶

The effectiveness of postoperative analgesia is an important consideration when selecting a local anaesthetic for upper-limb surgery. Ropivacaine has been investigated not only as a sole local anaesthetic but also in combination with adjuvants for improving postoperative analgesia following ultrasound-guided supraclavicular brachial plexus block. Kumari et al. evaluated postoperative analgesia following the addition of clonidine or dexmedetomidine to ropivacaine in patients undergoing upper-limb surgery.⁷ Ropivacaine has also been studied in other approaches to brachial plexus blockade, including posterior brachial plexus block, demonstrating its applicability across different regional anaesthetic techniques.⁸

The anatomical considerations of the forearm, including the radius and ulna, are particularly relevant in patients undergoing forearm fracture surgery.^{9,10} Both-bone forearm fractures require operative fixation in many patients, making reliable anaesthesia and adequate postoperative analgesia important components of perioperative management. Against this background, comparison of different long-acting local anaesthetic agents for axillary brachial plexus block is clinically relevant.

Therefore, the present study was undertaken to observe and compare the effects of 0.5% bupivacaine and 0.75% ropivacaine in patients undergoing both-bone fracture surgeries under axillary brachial plexus block, with particular emphasis on the onset and duration of sensory and motor blockade, time to first rescue analgesia, and perioperative haemodynamic parameters.

Materials and Methods

This observational study was conducted in the Department of Anaesthesiology, Saveetha medical College and Hospital, Chennai, during a study period of 6 months in 2023. The study included 40 adult patients of either sex, aged 18–55 years, who were scheduled to undergo both-bone fracture surgery under axillary brachial plexus block. Ethical approval was obtained from the Ethical and Research Committee of Saveetha medical College and Hospital, and written informed consent was obtained from all participants before enrolment. The study population comprised 40 patients, who were divided into two equal groups of 20 patients each: Group B (n=20) received 0.5% bupivacaine, while Group R (n=20) received 0.75% ropivacaine. Adult patients aged 18–55 years, of either sex, belonging to ASA physical status I or II, scheduled for elective surgery under axillary brachial plexus block, and without a history of allergy or sensitivity to local anaesthetic agents were included; patients with mild controlled comorbidities such as diabetes mellitus, hypertension, asthma, or thyroid disease were also eligible. Patients aged below 18 or above 55 years, those with ASA grade III or above, severe cardiovascular or chronic pulmonary disease, renal failure, hepatic dysfunction, morbid obesity, bleeding disorders, patient refusal, or those requiring subsequent general anaesthesia because adequate sensory anaesthesia was not achieved within 30 minutes were excluded. After ethical approval and informed consent, eligible patients were advised 8 hours of fasting, and the procedure was explained in their mother tongue. Preoperative assessment included detailed history, history of drug allergy and previous surgery, measurement of height, weight and BMI, and investigations including blood group, haemoglobin, random blood glucose, bleeding time, clotting time, serology and PT-INR. Following preoperative assessment, patients were shifted to the operation theatre, intravenous access was secured and standard monitoring was established. After painting and draping of the forearm region, an axillary brachial plexus block was performed under strict aseptic precautions and ultrasound guidance with the patient in the supine position using a 22-gauge Quincke needle, and the assigned study drug was administered. Patients were positioned for surgery after satisfactory sensory and motor blockade had been achieved. Heart rate, oxygen saturation and blood pressure were recorded before and after administration of the study drug and at regular intervals during the procedure. Sensory and motor blockade and pain scores were assessed before and after the block. Sensory blockade was assessed using the pin-prick method, while motor blockade was assessed using the Bromage scale. The time required for onset, peak effect and duration of sensory and motor blockade was recorded at regular intervals, along with regression of motor blockade and the time to first rescue analgesia during the postoperative period. Postoperative pain was assessed using the Visual Analogue Scale (VAS), with pain graded from 0 to 10. All relevant observations were recorded and subsequently compared between the bupivacaine and ropivacaine groups.

RESULTS:

Table 1. Baseline demographic characteristics of the study population

Characteristic	Group B: Bupivacaine (n=20)	Group R: Ropivacaine (n=20)	P value	Significance
Age group (years)			0.0713	Non-significant
18–35	7 (35.0%)	3 (15.0%)		
36–45	6 (30.0%)	6 (30.0%)		
46–55	7 (35.0%)	11 (55.0%)		
Gender			0.7055	Non-significant
Male	16 (80.0%)	15 (75.0%)		

Female	4 (20.0%)	5 (25.0%)		
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Table 2. Hemodynamic parameters following axillary brachial plexus block

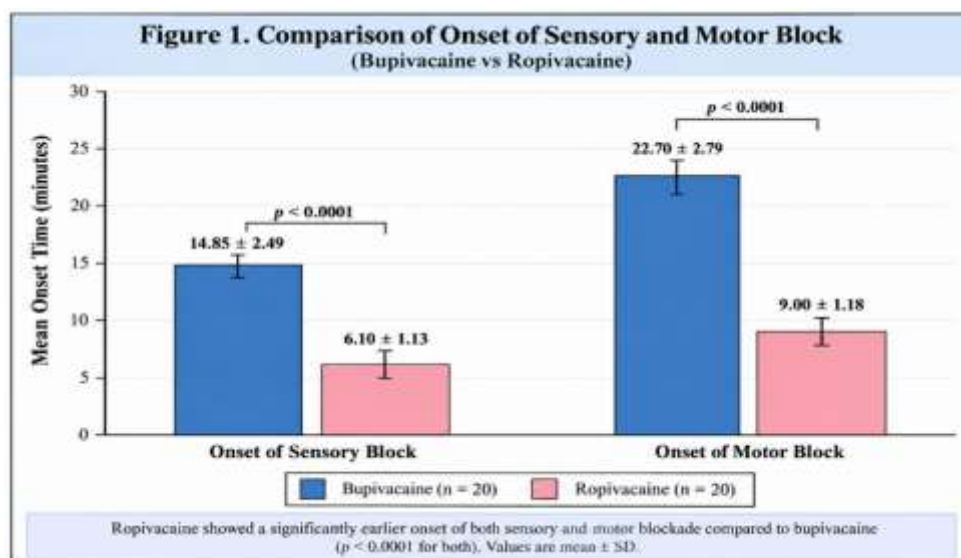
Time point	Group B: Bupivacaine Mean $\pm$ SD	Group R: Ropivacaine Mean $\pm$ SD	P value	Significance
Heart rate (beats/min)				
Baseline	79.25 $\pm$ 5.71	78.05 $\pm$ 6.17	0.5271	Non-significant
After block	80.40 $\pm$ 6.32	77.75 $\pm$ 6.29	0.1917	Non-significant
5 min	78.90 $\pm$ 6.51	77.25 $\pm$ 7.36	0.4573	Non-significant
30 min	78.15 $\pm$ 6.95	77.75 $\pm$ 6.74	0.8544	Non-significant
Systolic BP (mmHg)				
Baseline	124.50 $\pm$ 10.71	123.50 $\pm$ 12.85	0.7906	Non-significant
After block	124.15 $\pm$ 9.91	123.90 $\pm$ 13.40	0.9469	Non-significant
5 min	122.00 $\pm$ 12.06	124.30 $\pm$ 12.59	0.5587	Non-significant
30 min	123.50 $\pm$ 11.70	122.60 $\pm$ 12.17	0.8128	Non-significant
Diastolic BP (mmHg)				
Baseline	79.85 $\pm$ 6.23	77.55 $\pm$ 8.42	0.3323	Non-significant
After block	82.25 $\pm$ 5.12	78.15 $\pm$ 9.19	0.0722	Non-significant
5 min	80.90 $\pm$ 6.74	76.40 $\pm$ 6.22	0.0344	Significant
30 min	78.50 $\pm$ 7.08	76.70 $\pm$ 9.23	0.4931	Non-significant

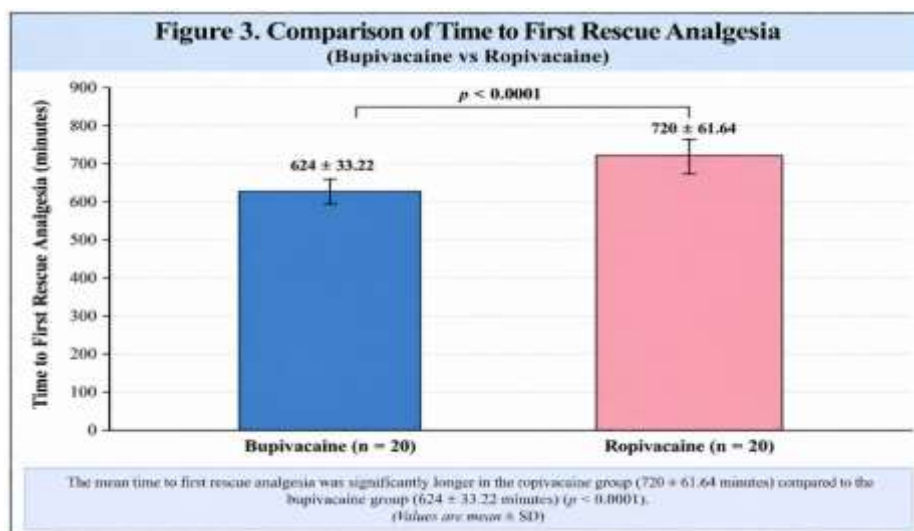
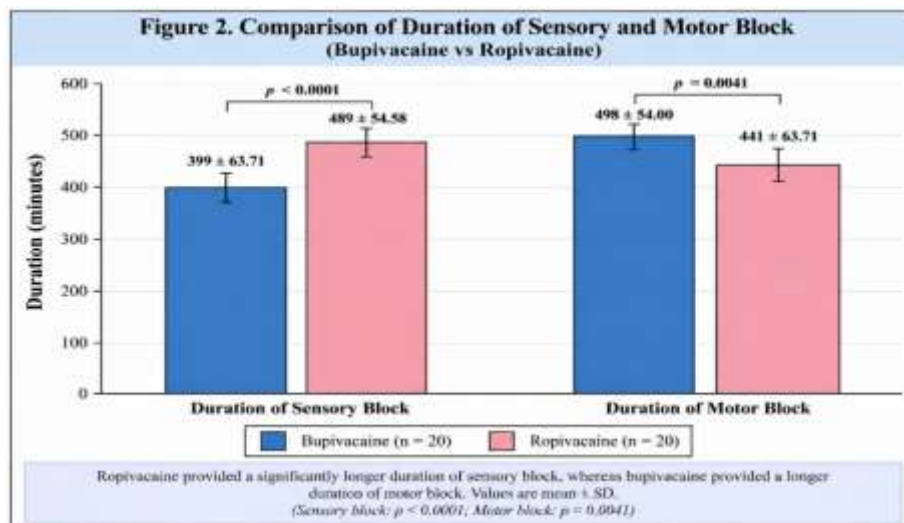
Table 3. Onset and duration of sensory and motor blockade

Block characteristic	Group B: Bupivacaine Mean $\pm$ SD (min)	Group R: Ropivacaine Mean $\pm$ SD (min)	P value	Significance
Onset of sensory block	14.85 $\pm$ 2.49	6.10 $\pm$ 1.13	<0.0001	Significant
Onset of motor block	22.70 $\pm$ 2.79	9.00 $\pm$ 1.18	<0.0001	Significant
Duration of sensory block	399 $\pm$ 63.71	489 $\pm$ 54.58	<0.0001	Significant
Duration of motor block	498 $\pm$ 54.00	441 $\pm$ 63.71	0.0041	Significant

Table 4. Postoperative analgesia and time to first rescue analgesia

Outcome	Group B: Bupivacaine Mean $\pm$ SD	Group R: Ropivacaine Mean $\pm$ SD	P value	Significance
Time to first rescue analgesia (min)	624 $\pm$ 33.22	720 $\pm$ 61.64	<0.0001	Significant
Time to first rescue analgesia (hours), approximately	10.4 h	12.0 h	—	—





DISCUSSION:

The present observational study included 40 patients undergoing both-bone forearm fracture surgeries under axillary brachial plexus block, with 20 patients receiving 0.5% bupivacaine (Group B) and 20 patients receiving 0.75% ropivacaine (Group R). The demographic characteristics were comparable between the two groups. The mean heart rate and blood pressure remained stable throughout the perioperative period without significant intergroup differences. Ropivacaine demonstrated a significantly faster onset of sensory block (6.10 ± 1.13 min vs. 14.85 ± 2.49 min) and motor block (9.00 ± 1.18 min vs. 22.70 ± 2.79 min) compared to bupivacaine. The duration of sensory block was significantly longer in the ropivacaine group (489 ± 54.58 min vs. 399 ± 63.71 min), whereas the duration of motor block was significantly longer in the bupivacaine group (498 ± 54.00 min vs. 441 ± 63.71 min). Furthermore, the time to first rescue analgesia was significantly prolonged with ropivacaine (720 ± 61.64 min) compared with bupivacaine (624 ± 33.22 min), indicating superior postoperative analgesia with ropivacaine.

The present study compared the clinical effects of 0.5% bupivacaine and 0.75% ropivacaine administered through ultrasound-guided axillary brachial plexus block in patients undergoing both-bone forearm fracture surgeries. The primary outcomes evaluated included onset and duration of sensory and motor blockade, haemodynamic stability and duration of postoperative analgesia.

In the present study, the demographic characteristics of both groups were comparable, with no statistically significant difference in age and gender distribution. Similar observations have been reported by Hickey et al. who demonstrated comparable baseline characteristics between patients receiving ropivacaine and bupivacaine for brachial plexus blockade.¹⁸ Comparable demographic profiles were also reported by Neal et al., who emphasized the importance of balanced baseline characteristics in studies evaluating upper extremity regional anaesthesia.²⁵

The haemodynamic parameters remained stable in both groups throughout the study period. No clinically significant differences were observed in heart rate or systolic blood pressure between the groups. This finding is consistent with the observations of Satapathy et

al., who reported that axillary brachial plexus block is associated with excellent cardiovascular stability due to minimal sympathetic blockade.¹⁵ Similar findings were described by Neal et al., who noted that peripheral nerve blocks provide effective anaesthesia while maintaining haemodynamic stability.²⁵

A major finding of the present study was the significantly faster onset of both sensory and motor blockade in the ropivacaine group. The mean onset time for sensory blockade was 6.10 minutes in the ropivacaine group compared with 14.85 minutes in the bupivacaine group, while motor blockade occurred at 9.00 minutes and 22.70 minutes respectively. Similar findings were reported by Kaur et al., who observed a faster onset of sensory and motor blockade with ropivacaine during axillary brachial plexus block.⁴ Venkatesh et al. also reported earlier establishment of blockade with higher concentrations of ropivacaine compared with bupivacaine in brachial plexus block procedures.⁵

The duration of sensory blockade was significantly prolonged in the ropivacaine group compared with the bupivacaine group. Patients receiving ropivacaine experienced sensory blockade for approximately 489 minutes, whereas patients receiving bupivacaine demonstrated sensory blockade for approximately 399 minutes. Similar results were documented by Hickey et al., who observed prolonged sensory anaesthesia with ropivacaine while maintaining an acceptable safety profile.¹⁸ Kuthiala and Chaudhary further highlighted the favourable pharmacological characteristics of ropivacaine, including prolonged sensory blockade with relatively lower systemic toxicity.²¹

Interestingly, although sensory blockade lasted longer with ropivacaine, the duration of motor blockade was significantly greater with bupivacaine. The motor block duration was 498 minutes in the bupivacaine group compared with 441 minutes in the ropivacaine group. This finding supports the concept of differential blockade associated with ropivacaine, whereby sensory fibres are preferentially affected while allowing earlier recovery of motor function. Similar observations were reported by Bertini et al., who demonstrated shorter motor blockade with ropivacaine despite satisfactory sensory anaesthesia.³³ McGlade et al. also observed earlier recovery of motor function with ropivacaine during axillary brachial plexus anaesthesia.³⁵

Postoperative analgesia is an important determinant of patient satisfaction and recovery. In the present study, the time to first rescue analgesia was significantly longer in patients receiving ropivacaine than in those receiving bupivacaine. The mean duration before the requirement of rescue analgesia was approximately 12 hours in the ropivacaine group compared with 10.4 hours in the bupivacaine group. Similar findings were reported by Kumari et al., who demonstrated prolonged postoperative analgesia with ropivacaine-based brachial plexus blocks.⁷ Mageswaran et al. also reported effective and prolonged postoperative analgesia with ropivacaine in upper-limb regional anaesthesia.³⁷

The favourable clinical profile of ropivacaine observed in the present study can be explained by its pharmacological characteristics. Ropivacaine is a pure S-enantiomer with lower lipid solubility and reduced cardiotoxicity compared with bupivacaine, while still providing prolonged sensory blockade and adequate postoperative pain relief.²¹ George and Liu described ropivacaine as a long-acting local anaesthetic with a greater degree of sensory-motor differentiation, making it particularly useful for peripheral nerve blocks.¹⁹ Similar pharmacological advantages have been highlighted by Shankar and Chakole in their review of ropivacaine.²²

Overall, the findings of the present study suggest that 0.75% ropivacaine provides faster onset of blockade, longer duration of sensory anaesthesia, earlier motor recovery and prolonged postoperative analgesia compared with 0.5% bupivacaine when used for axillary brachial plexus block in both-bone forearm fracture surgeries. These characteristics may contribute to improved perioperative patient comfort and enhanced postoperative recovery.

CONCLUSION

In this observational study of patients undergoing both-bone forearm fracture surgery under axillary brachial plexus block, both 0.5% bupivacaine and 0.75% ropivacaine provided effective surgical anaesthesia with overall stable perioperative haemodynamic parameters. Ropivacaine demonstrated a significantly faster onset of sensory and motor blockade, with a longer duration of sensory blockade and a significantly prolonged time to first rescue analgesia compared with bupivacaine. Conversely, bupivacaine produced a significantly longer duration of motor blockade. These findings indicate that, within the study population, 0.75% ropivacaine provided faster sensory and motor block onset and more prolonged postoperative analgesia, whereas 0.5% bupivacaine produced more prolonged motor blockade. Thus, both agents were clinically effective for axillary brachial plexus block, with differences in their block characteristics that may be considered when selecting the local anaesthetic according to the desired duration and profile of sensory and motor blockade.

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