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Effectiveness Of Nalbuphine As An Adjuvant To Ropivacaine In Ultrasound Guided Supraclavicular Brachial Plexus Block - A Randomised Control Study

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ABSTRACT

Introduction: Supraclavicular brachial plexus block (SCBPB) provides excellent anaesthesia for upper limb surgeries. Ropivacaine is commonly used due to its favourable safety profile, but its single-shot effect may not suffice for prolonged postoperative analgesia. Nalbuphine, a mixed κ-agonist and μ-antagonist opioid, is a promising adjuvant with effective analgesia and minimal side effects. This study aims to evaluate the effect of adding nalbuphine (10 mg) to 0.75% ropivacaine in ultrasound-guided supraclavicular brachial plexus block.

Materials and Methods: This randomised controlled study included 60 patients undergoing upper limb surgeries, divided into two groups (n=30). Group A received 20 mL of 0.75% ropivacaine with 10 mg nalbuphine; Group B received 20 mL of 0.75% ropivacaine with 1 mL normal saline. Ultrasound-guided SCBPB was performed, and onset and duration of sensory and motor block, duration of analgesia, and hemodynamic parameters were assessed.

Results: Group A demonstrated significantly faster sensory (3.9 ± 1.2 vs 9.0 ± 1.8 min) and motor block onset (7.1 ± 1.4 vs 11.8 ± 2.0 min) compared to Group B ($p < 0.001$). Duration of motor block (810 ± 45 vs 665 ± 40 min) and analgesia (1020 ± 60 vs 801 ± 50 min) were significantly longer in Group A ($p < 0.001$). Hemodynamic and respiratory parameters remained stable in both groups, and no adverse effects were reported.

Conclusion: Nalbuphine (10 mg) significantly improves the onset and duration of sensory and motor blockade, as well as postoperative analgesia, when used as an adjuvant to ropivacaine in SCBPB, without compromising safety.

Keywords: Nalbuphine, Supraclavicular Brachial Plexus Block, Ropivacaine. ..

1. INTRODUCTION

Supraclavicular brachial plexus block (SCBPB) is a frequently employed regional anaesthetic technique for upper limb surgeries, providing excellent intraoperative anaesthesia and prolonged postoperative analgesia while reducing the need for systemic opioids and their associated side effects. Administered at the level where the brachial plexus is most compact, this approach ensures dense anaesthesia with a small volume of local anaesthetic and good surgical field exposure [1]. The use of ultrasound guidance has further refined the technique by allowing real-time visualization of neural structures, improving the accuracy of needle placement, and reducing complications such as pneumothorax or vascular injury [2,3].

Ropivacaine, a long-acting amide local anaesthetic, is commonly used in SCBPB due to its lower cardiotoxicity and neurotoxicity compared to bupivacaine [4]. It provides satisfactory anaesthesia and analgesia, but its single-shot duration may be inadequate for extended postoperative pain control [5]. This has led to investigations into adjuvants that can prolong the effect of ropivacaine without increasing adverse effects..

Opioids have been widely explored as adjuvants in regional anaesthesia because of their synergistic analgesic properties with local anaesthetics [6,7] Nalbuphine, a synthetic opioid with mixed κ-agonist and μ-antagonist properties, offers effective analgesia with a ceiling effect on respiratory depression, thus reducing opioid-related adverse effects [8]. It has a rapid onset (2–3 minutes), moderate duration of action (3–6 hours), cardiovascular stability, and minimal side effects at commonly used doses (0.2–0.4 mg/kg) [9,10].

Evidence supports the use of nalbuphine in regional anaesthesia, including supraclavicular blocks, for enhancing the quality and duration of sensory and motor block when used with ropivacaine [11,12]. It also reduces the need for additional postoperative analgesics without significantly increasing complications.

This study aims to evaluate the effect of adding nalbuphine (10 mg) to 0.75% ropivacaine in ultrasound-guided supraclavicular brachial plexus block. The objectives include comparing the onset of sensory and motor blockade, duration of motor block, and duration of postoperative analgesia between the nalbuphine and control groups, as well as identifying any associated complications or adverse effects.

2. MATERIALS AND METHODS

This randomized controlled study was conducted over a period of 18 months, from June 2023 to December 2024, at Adichunchanagiri Hospital and Research Centre, B.G. Nagara, Nagamangala Taluk, Mandya District. The study population included patients undergoing upper limb surgical procedures. Ethical clearance was obtained from the institutional ethics committee, and written informed consent was taken from all participants. A purposive sampling technique was used for patient recruitment. Inclusion criteria were adults aged 18 to 55 years of either sex, belonging to ASA physical status I or II, and with body weight ranging between 50 and 80 kg. Patients with a history of bleeding disorders, convulsions, severe neurological deficits, major organ dysfunction, local infection at the block site, morbid obesity, pregnancy or lactation, or those unwilling to give consent were excluded.

A total of 60 patients were enrolled and randomly assigned into two groups of 30 each using a computer-generated randomization table. Group A received Ropivacaine 0.75% 20 mL plus 10 mg Nalbuphine (1 mL), while Group B received Ropivacaine 0.75% 20 mL plus 1 mL normal saline. All patients were premedicated the night before surgery with oral alprazolam 0.5 mg and ranitidine 150 mg. They were advised nil per oral status after 10 PM. On the day of surgery, standard monitoring was initiated, including non-invasive blood pressure, ECG, heart rate, and pulse oximetry. Intravenous access was secured with an 18G cannula in the contralateral limb, and IV midazolam 0.04 mg/kg was administered for premedication.

An ultrasound-guided supraclavicular brachial plexus block was performed using a 10–12 MHz linear probe (LOGIQ E, GE Healthcare System) placed in the coronal oblique plane. After aseptic preparation and local infiltration, a 22G, 50 mm insulated block needle was introduced using an in-plane approach. The brachial plexus was visualized lateral to the subclavian artery above the first rib. The prepared drug solution was injected incrementally over 3–5 minutes, observing for centrifugal spread around the plexus. If the local anesthetic spread was inadequate, needle repositioning was done before injecting the remainder. Patients were assessed for onset and duration of sensory and motor block intraoperatively and postoperatively.

Sensory block was evaluated using the pin-prick method with a 25-gauge needle every minute until complete block was achieved. Sensory scoring was done as follows: 0 – sharp pain, 1 – touch sensation only, 2 – no sensation. Motor block was assessed using the modified Bromage scale: 0 – able to raise extended arm; 1 – able to flex elbow and move fingers; 2 – unable to flex elbow but able to move fingers; 3 – complete motor block. The time of onset and duration of both sensory and motor block were recorded. Pain intensity was assessed using the Visual Analogue Scale (VAS), where 0 indicated no pain and 10 represented the worst pain experienced. Duration of analgesia was defined as the time from block administration to the first request for rescue analgesia. All adverse events were monitored and managed accordingly.

The sample size was calculated based on the primary outcome—duration of sensory block. A 25% change in the duration of sensory block was considered clinically significant, assuming a standard deviation of 33% of the mean. With a power of 80% and α error of 0.05, the required sample size per group was estimated to be 27. To account for possible dropouts, 30 patients were enrolled in each group, totaling 60 participants. Data were compiled in Microsoft Excel and analyzed using SPSS version 28.0. Continuous variables were expressed as mean ± standard deviation and compared using the Student's t-test. Categorical variables were expressed as frequencies and percentages and analyzed using the Chi-square test. A p-value < 0.05 was considered statistically significant.

3. RESULTS

The age distribution between the groups was comparable, with the majority in both Group A (60%) and Group B (73.3%) falling in the 30–39 years category. Gender was similarly distributed, with males comprising 66.7% in Group A and 73.3% in Group B. ASA Grade I predominated in both groups, without significant differences across all baseline variables ($p > 0.05$) (Table 1).

Table 1: Baseline Characteristics of Study Participants

Variable		Group A (n = 30)	Group B (n = 30)	*P*-value
Age Group	**20–29 years**	7 (23.3%)	7 (23.3%)	0.216
	30–39 years	18 (60.0%)	22 (73.3%)	
	40–49 years	5 (16.7%)	1 (3.3%)	
Gender	**Male**	20 (66.7%)	22 (73.3%)	0.573
	Female	10 (33.3%)	8 (26.7%)	
ASA Grade	**Grade I**	25 (83.3%)	21 (70.0%)	0.222
	Grade II	5 (16.7%)	9 (30.0%)	

Group A demonstrated significantly faster onset of both sensory (3.9 ± 1.2 min) and motor (7.1 ± 1.4 min) block compared to Group B (9.0 ± 1.8 min and 11.8 ± 2.0 min, respectively). Additionally, the duration of motor block and analgesia was notably longer in Group A (810 ± 45 min and 1020 ± 60 min) than in Group B (665 ± 40 min and 801 ± 50 min), all with $p < 0.001$ (Table 2).

Table 2: Onset and Duration of Sensory and Motor Block

Parameter	Group A (Mean ± SD)	Group B (Mean ± SD)	*P*-value
Onset of Sensory Block (min)	3.9 ± 1.2	9.0 ± 1.8	<0.001
Onset of Motor Block (min)	7.1 ± 1.4	11.8 ± 2.0	<0.001
Duration of Motor Block (min)	810 ± 45	665 ± 40	<0.001
Duration of Analgesia (min)	1020 ± 60	801 ± 50	<0.001

Heart rate remained stable and comparable across all time intervals in both groups, with no statistically significant differences observed at any point during the 12-hour monitoring period ($p > 0.05$) (Table 3).

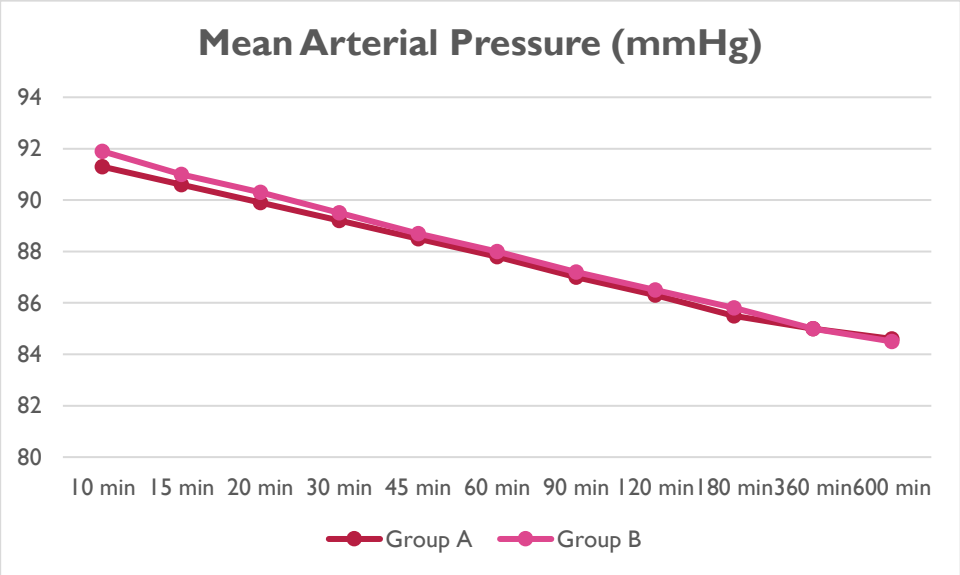
Table 3: Heart Rate Comparison (beats per minute)

Time (min)	Group A (Mean ± SD)	Group B (Mean ± SD)	*P*-value
0 min	75.97 ± 4.2	74.57 ± 4.0	0.125
5 min	75.53 ± 4.3	74.70 ± 4.1	0.827
10 min	76.20 ± 4.5	74.23 ± 4.2	0.924
15 min	74.23 ± 4.1	74.60 ± 4.0	0.827
20 min	74.97 ± 4.2	74.20 ± 4.3	0.737
30 min	75.60 ± 4.3	74.17 ± 4.4	0.843
45 min	75.10 ± 4.4	74.13 ± 4.2	0.811
60 min	75.93 ± 4.2	74.10 ± 4.3	0.839
90 min	75.67 ± 4.3	74.00 ± 4.2	0.865

120 min	75.70 ± 4.5	74.47 ± 4.4	0.743
180 min	75.60 ± 4.4	74.20 ± 4.3	0.940
360 min	75.57 ± 4.3	74.23 ± 4.1	0.697
600 min	75.73 ± 4.2	74.63 ± 4.0	0.822
720 min	75.57 ± 4.1	74.77 ± 4.2	0.422

Mean arterial pressure (MAP) gradually declined over time in both groups, with values ranging from 91.3 ± 5.8 mmHg to 84.6 ± 5.8 mmHg in Group A and 91.9 ± 5.6 mmHg to 84.5 ± 5.6 mmHg in Group B. Minor differences at a few time points were statistically significant, though not clinically meaningful (Figure 1).

Figure 1: Line chart showing Mean Arterial Pressure (mmHg)



Oxygen saturation remained within normal limits in both groups throughout, with no significant differences at any recorded time point. Values ranged between 97.53% and 98.33% in Group A and 97.63% to 98.40% in Group B ($p > 0.05$) (Table 4).

Table 4: Oxygen Saturation (SpO_2)

Time (min)	Group A (Mean ± SD)	Group B (Mean ± SD)	*P*-value
0 min	98.10 ± 0.5	98.30 ± 0.5	0.205
5 min	98.10 ± 0.4	98.07 ± 0.4	0.191
10 min	97.70 ± 0.6	98.10 ± 0.6	0.160
15 min	97.77 ± 0.5	97.67 ± 0.5	0.177
20 min	98.03 ± 0.5	97.67 ± 0.5	0.189
30 min	97.53 ± 0.6	98.27 ± 0.6	0.211
45 min	97.83 ± 0.5	97.63 ± 0.5	0.192
60 min	97.90 ± 0.5	97.90 ± 0.5	0.194
90 min	97.77 ± 0.6	98.10 ± 0.6	0.196
120 min	98.23 ± 0.5	98.40 ± 0.5	0.207

180 min	98.33 ± 0.5	98.37 ± 0.5	0.216
360 min	97.83 ± 0.6	98.17 ± 0.6	0.209
600 min	97.93 ± 0.5	98.37 ± 0.5	0.143

Respiratory rate was consistently similar between both groups, maintaining a mean of approximately 15.37 breaths per minute. Although a few time points showed statistically significant values, the differences were minimal and not clinically relevant (Table 5).

Table 5: Respiratory Rate (RR)

Time (min)	Group A (Mean ± SD)	Group B (Mean ± SD)	*P*-value
0 min	15.37 ± 0.50	15.37 ± 0.49	0.498
5 min	15.37 ± 0.62	15.37 ± 0.49	0.350
10 min	15.40 ± 0.50	15.40 ± 0.50	0.037
15 min	15.37 ± 0.49	15.37 ± 0.49	0.138
20 min	15.37 ± 0.49	15.37 ± 0.49	0.535
30 min	15.37 ± 0.49	15.40 ± 0.50	0.820
45 min	15.37 ± 0.49	15.37 ± 0.49	0.780
60 min	15.37 ± 0.49	15.37 ± 0.49	0.150
90 min	15.37 ± 0.49	15.37 ± 0.49	0.884
120 min	15.37 ± 0.49	15.37 ± 0.49	0.533
180 min	15.37 ± 0.50	15.37 ± 0.50	0.505
360 min	15.37 ± 0.49	15.37 ± 0.49	0.042
600 min	15.37 ± 0.50	15.37 ± 0.50	0.038

4. DISCUSSION

The supraclavicular brachial plexus block (SCBPB) remains a cornerstone in anaesthetic management for upper limb surgeries due to its ability to provide effective intraoperative anaesthesia and prolonged postoperative analgesia. The anatomical compactness of the brachial plexus at the supraclavicular level allows for reliable and dense blockade with smaller volumes of local anaesthetic, optimizing tourniquet tolerance and reducing systemic analgesic requirements. Ropivacaine, a long-acting amide local anaesthetic, offers favourable sensory and motor block profiles with reduced cardiotoxicity compared to bupivacaine, making it a safer and preferred agent in regional anaesthesia [1]. However, the limited duration of analgesia following a single-shot block has prompted the exploration of various adjuvants to enhance and prolong analgesic efficacy.

Nalbuphine, a mixed κ-agonist and μ-antagonist opioid, has emerged as a potential adjuvant due to its potent analgesic properties, minimal side effect profile, cardiovascular stability, and ceiling effect on respiratory depression [3]. Its onset within 2–3 minutes and duration of action lasting 3–6 hours make it well-suited for perioperative pain control. Notably, nalbuphine is not subject to stringent controlled drug regulations, increasing its accessibility, especially in outpatient and short-stay surgical settings. Its role in peripheral nerve blocks is being increasingly recognized, although further evidence is needed to establish its definitive place in regional anaesthesia practice [11,12].

The current study evaluated the effect of adding nalbuphine (10 mg) to 0.75% ropivacaine in ultrasound-guided SCBPB. The demographic distribution between the two groups was comparable, with no significant differences in age, gender, or ASA grade. These findings are consistent with previous studies, such as those by Madan et al. and Yadav et al., which also employed nalbuphine-ropivacaine combinations in similar clinical settings [13,14]. Hemodynamic parameters, including systolic and diastolic blood pressure, heart rate, and SpO_2, remained stable throughout the perioperative period in both groups, reaffirming the cardiovascular safety of nalbuphine as an adjuvant.

Our results demonstrate that the addition of nalbuphine significantly accelerated the onset of both sensory (3.9 ± 1.2 min vs 9.0 ± 1.8 min) and motor (7.1 ± 1.4 min vs 11.8 ± 2.0 min) blockade compared to ropivacaine alone. These findings align with prior studies67 and suggest enhanced nerve fiber penetration or synergism between the local anaesthetic and the opioid. Furthermore, motor block duration (810 ± 45 min in Group A vs 665 ± 40 min in Group B) and analgesia duration (1020 ± 60 min vs 801 ± 50 min) were significantly prolonged in the nalbuphine group ($p < 0.001$), offering improved postoperative pain control and potentially reducing the need for rescue analgesics. These results are supported by other studies reporting similar trends in sensory and motor block enhancement with nalbuphine [13-15].

No significant complications were observed in either group, further supporting the safety of nalbuphine in peripheral nerve blocks. This reinforces the clinical utility of nalbuphine as a valuable adjuvant in prolonging analgesia duration without compromising patient safety or hemodynamic stability.

Limitations: Despite encouraging results, this study has some limitations. The sample size was relatively small, limiting broader generalizability. The study focused solely on upper limb surgeries; hence, findings may not be applicable to other surgical settings or nerve blocks. Additionally, long-term outcomes, such as the development of chronic pain or late complications, were not assessed. The controlled environment may not reflect real-world variations in surgical practices or patient comorbidities. Larger multicentric studies with extended follow-up periods are needed to confirm these findings and explore nalbuphine's broader applicability in regional anaesthesia.

5. CONCLUSION

The addition of nalbuphine (10 mg) to 0.75% ropivacaine in ultrasound-guided supraclavicular brachial plexus block significantly improved block quality by accelerating the onset and prolonging the duration of both sensory and motor blockade, along with extending postoperative analgesia. These benefits were achieved without compromising hemodynamic stability or causing adverse effects, highlighting the safety and efficacy of nalbuphine as an adjuvant. Thus, nalbuphine enhances the clinical utility of ropivacaine in peripheral nerve blocks and represents a valuable strategy for optimizing perioperative analgesia in upper limb surgeries

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