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Original Research Article

Comparison of Dexmedetomidine and Nalbuphine as Adjuvants to 0.75% Ropivacaine in Ultrasound-Guided Supraclavicular Brachial Plexus Block for Forearm Surgery: A Randomized Controlled Study

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Abstract

Background: Ultrasound-guided supraclavicular brachial plexus block is a well-established regional anaesthetic technique for forearm surgeries, providing effective intraoperative anaesthesia and postoperative analgesia. Although 0.75% ropivacaine is commonly used because of its favourable safety profile, the duration of postoperative analgesia may be limited. Adjuvants such as dexmedetomidine and nalbuphine have been employed to improve block characteristics and prolong analgesia; however, evidence comparing their efficacy remains limited.

Objectives: To compare the effects of dexmedetomidine and nalbuphine as adjuvants to 0.75% ropivacaine on the duration of anaesthesia and postoperative analgesic requirement in ultrasound-guided supraclavicular brachial plexus block among patients undergoing elective forearm surgeries.

Methodology: This prospective, randomized, double-blind comparative study was conducted in the Department of Anaesthesiology and Critical Care Medicine, Subbaiah Institute of Medical Sciences, Shivamogga, Karnataka, India, from June 2023 to December 2024. Ninety adult patients (ASA physical status I–II) scheduled for elective forearm surgeries were randomly allocated into two equal groups. Group D (n=45) received 0.75% ropivacaine with dexmedetomidine (1 µg/kg), while Group N (n=45) received 0.75% ropivacaine with nalbuphine (10 mg) for ultrasound-guided supraclavicular brachial plexus block. The primary outcome was the duration of anaesthesia. Secondary outcomes included onset and duration of sensory and motor blockade, duration of postoperative analgesia, rescue analgesic requirement, Visual Analogue Scale (VAS) pain scores, haemodynamic parameters, adverse events, and patient satisfaction. Statistical analysis was performed using SPSS version 26.0, with a p-value <0.05 considered statistically significant.

Results: Baseline demographic and clinical characteristics were comparable between the groups ($p>0.05$). Group D demonstrated a significantly faster onset of sensory block (8.26 ± 1.42 vs. 9.84 ± 1.56 minutes) and motor block (11.18 ± 1.86 vs. 12.94 ± 2.04 minutes) compared with Group N ($p<0.001$). The duration of sensory block (812.36 ± 74.52 vs. 628.44 ± 68.18 minutes), motor block (724.84 ± 69.36 vs. 561.28 ± 63.92 minutes), and overall anaesthesia (836.42 ± 76.15 vs. 651.76 ± 70.81 minutes) were significantly longer in the dexmedetomidine group ($p<0.001$). Patients receiving dexmedetomidine also experienced prolonged postoperative analgesia (928.62 ± 88.46 vs. 704.84 ± 76.35 minutes), delayed requirement for the first rescue analgesic (15.46 ± 1.48 vs. 11.72 ± 1.63 hours), and reduced rescue analgesic consumption during the first 24 hours ($p<0.001$). Postoperative VAS scores from the fourth hour onwards were significantly lower in Group D. Mild bradycardia and sedation were observed more frequently with dexmedetomidine but were transient and clinically manageable. No serious adverse events or block-related complications were encountered. Patient and surgeon satisfaction scores were significantly higher in the dexmedetomidine group.

Conclusion: Both dexmedetomidine and nalbuphine effectively enhanced the quality of ultrasound-guided supraclavicular brachial plexus block when used as adjuvants to 0.75% ropivacaine. However, dexmedetomidine provided a faster onset of blockade, significantly prolonged anaesthesia and postoperative analgesia, reduced postoperative analgesic requirements, and improved patient satisfaction while maintaining an acceptable safety profile. Dexmedetomidine may therefore be considered the preferred adjuvant to 0.75% ropivacaine for ultrasound-guided supraclavicular brachial plexus block in elective forearm surgeries.

Keywords: Dexmedetomidine; Nalbuphine; Ropivacaine; Ultrasound-guided supraclavicular brachial plexus block; Forearm surgery; Postoperative analgesia; Regional anaesthesia; Randomized controlled study.

Introduction

Ultrasound-guided supraclavicular brachial plexus block (SCBPB) has become one of the most reliable regional anaesthetic techniques for surgeries involving the forearm and hand. By providing dense anaesthesia of the upper extremity, it offers excellent intraoperative operating conditions while minimizing the need for general anaesthesia. [1] The widespread adoption of ultrasound guidance has significantly improved the accuracy of needle placement, enhanced block success rates, reduced local anaesthetic requirements, and lowered the incidence of complications such as pneumothorax and inadvertent vascular puncture. [2,3]

Regional anaesthesia provides several advantages over general anaesthesia, including superior postoperative pain control, reduced perioperative opioid consumption, early mobilisation, decreased incidence of postoperative nausea and vomiting, and improved patient satisfaction. These benefits are particularly important in forearm surgeries, where effective postoperative analgesia facilitates early rehabilitation and functional recovery. [4,5]

Ropivacaine is a long-acting amide local anaesthetic widely preferred for peripheral nerve blocks because of its favourable safety profile.

Compared with bupivacaine, ropivacaine exhibits lower cardiotoxicity and neurotoxicity while providing effective sensory blockade with relatively less intense motor blockade, making it suitable for ambulatory and orthopaedic procedures. [6]

However, the duration of postoperative analgesia achieved with ropivacaine alone may be inadequate for prolonged pain relief, leading to the search for suitable adjuvants that can extend block duration without increasing adverse effects. [7]

Dexmedetomidine, a highly selective α_2-adrenergic receptor agonist, has emerged as an effective adjuvant in peripheral nerve blocks. It enhances the quality of sensory and motor blockade, hastens block onset, prolongs postoperative analgesia, and reduces rescue analgesic requirements through both peripheral and central analgesic mechanisms. Several clinical studies have demonstrated that dexmedetomidine, when combined with ropivacaine for supraclavicular brachial plexus block, significantly prolongs the duration of anaesthesia and analgesia without major adverse effects, although mild bradycardia and sedation may occasionally occur. [8-11] Nalbuphine is a mixed opioid agonist-antagonist with κ-receptor agonistic and μ-receptor antagonistic properties. As an adjuvant to local anaesthetics, nalbuphine has attracted increasing interest because it effectively prolongs postoperative analgesia while maintaining haemodynamic stability and causing fewer opioid-related adverse effects such as respiratory depression. Its peripheral analgesic action and favourable safety profile make it an attractive alternative adjuvant for brachial plexus block. [12,13]

Although both dexmedetomidine and nalbuphine have individually demonstrated beneficial effects when used with local anaesthetics for peripheral nerve blocks, direct comparisons between these agents in combination with 0.75% ropivacaine for ultrasound-guided supraclavicular brachial plexus block remain relatively limited. Determining the superior adjuvant with respect to duration of anaesthesia, quality of postoperative analgesia, rescue analgesic requirement, and safety profile would assist anaesthesiologists in selecting the most effective regimen for forearm surgeries. [11,13]

Therefore, the present randomized controlled study was undertaken in the Department of Anaesthesiology and Critical Care Medicine, Subbaiah Institute of Medical Sciences, Shivamogga, Karnataka, India, over a period of June 2023 to December 2024, to compare the effects of dexmedetomidine and nalbuphine as adjuvants to 0.75% ropivacaine in ultrasound-guided supraclavicular brachial plexus block with respect to duration of anaesthesia and postoperative analgesic requirements in patients undergoing elective forearm surgeries.

Objectives

Primary Objective

- To compare the effect of dexmedetomidine and nalbuphine as adjuvants to 0.75% ropivacaine on the duration of anaesthesia in ultrasound-guided supraclavicular brachial plexus block among patients undergoing elective forearm surgeries.

Secondary Objectives

- To compare the onset time of sensory and motor blockade between the two groups.
- To compare the duration of sensory and motor blockade between the two groups.
- To evaluate the duration of postoperative analgesia in both groups.
- To compare the postoperative rescue analgesic requirement during the first 24 hours after surgery.

- To assess haemodynamic parameters and adverse events associated with dexmedetomidine and nalbuphine used as adjuvants to 0.75% ropivacaine.

Methodology

Study Design: A prospective, randomized, comparative, double-blind interventional study.

Study Setting: The study was conducted in the Department of Anaesthesiology and Critical Care Medicine, Subbaiah Institute of Medical Sciences, Shivamogga, and Karnataka, India.

Study Duration: The study was carried out over a period of June 2023 to December 2024.

Study Population: Adult patients scheduled to undergo elective forearm surgeries under ultrasound-guided supraclavicular brachial plexus block were enrolled in the study.

Sample Size:

A total of 90 patients were included in the study and randomly allocated into two equal groups.

- **Group D (n = 45):** Received 0.75% ropivacaine with dexmedetomidine.
- **Group N (n = 45):** Received 0.75% ropivacaine with nalbuphine.

Randomization: Eligible patients were randomly assigned to either Group D or Group N using a computer-generated randomization sequence. Allocation concealment was achieved using sequentially numbered, opaque, sealed envelopes.

Blinding: The study was conducted in a double-blind manner. The study drug was prepared by an anaesthesiologist who was not involved in patient management or data collection. Both the patient and the anaesthesiologist performing the block and recording observations remained blinded to the group allocation throughout the study.

Inclusion Criteria

- Patients aged 18–65 years.
- Either sex.
- American Society of Anaesthesiologists (ASA) physical status I or II.
- Scheduled for elective forearm surgery under supraclavicular brachial plexus block.
- Patients willing to participate and providing written informed consent.

Exclusion Criteria

- Refusal to participate.
- Known allergy to local anaesthetics, dexmedetomidine, or nalbuphine.
- Coagulopathy or anticoagulant therapy.
- Infection at the site of block.
- Pre-existing neurological deficits involving the upper limb.
- Severe hepatic, renal, cardiac, or respiratory disease.
- Pregnancy or lactation.
- BMI >35 kg/m².
- Patients with psychiatric illness or inability to comprehend the pain scoring system.

Study Procedure: After obtaining approval from the Institutional Ethics Committee and written informed consent, all patients underwent a detailed pre-anaesthetic evaluation one day before surgery. Standard fasting guidelines were followed.

In the operating room, baseline heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure, respiratory rate, oxygen saturation (SpO_2), and electrocardiogram were recorded. An intravenous line was secured, and standard ASA monitoring was instituted.

Under strict aseptic precautions, an ultrasound-guided supraclavicular brachial plexus block was performed using a high-frequency linear ultrasound probe (6–13 MHz). The brachial plexus was identified lateral and superficial to the subclavian artery, and a 22-gauge insulated block needle was advanced using the in-plane technique until the needle tip was positioned adjacent to the plexus.

Patients received the study drug according to their randomized group:

- **Group D:** 20 mL of 0.75% ropivacaine with dexmedetomidine 1 µg/kg.
- **Group N:** 20 mL of 0.75% ropivacaine with nalbuphine 10 mg.

After careful aspiration to exclude intravascular placement, the drug solution was injected incrementally under continuous ultrasound visualization to ensure adequate spread around the brachial plexus.

Outcome Measures

Primary Outcome

- Duration of anaesthesia (time from completion of injection to complete recovery of sensory block).

Secondary Outcomes

- Onset time of sensory block.
- Onset time of motor block.
- Duration of sensory block.
- Duration of motor block.
- Duration of postoperative analgesia (time to first rescue analgesic).
- Total rescue analgesic consumption during the first 24 hours.
- Visual Analogue Scale (VAS) pain scores at predetermined postoperative intervals (0, 2, 4, 6, 8, 12, and 24 hours).

- Haemodynamic parameters (heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure, and SpO_2).
- Incidence of adverse events including bradycardia, hypotension, nausea, vomiting, sedation, respiratory depression, local anaesthetic toxicity, and block-related complications.

Data Collection: Sensory block was assessed by pinprick sensation using a three-point scale (0 = normal sensation, 1 = analgesia, 2 = complete anaesthesia). Motor block was evaluated using the modified Bromage scale for the upper limb. Haemodynamic parameters and pain scores were recorded at baseline, every 5 minutes for the first 30 minutes, every 15 minutes intraoperatively, and at predefined postoperative intervals for 24 hours. Rescue analgesia was administered when the VAS score was ≥4.

Statistical Analysis: Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages.

The independent Student's t-test was used to compare continuous variables between the two groups, whereas the Chi-square test or Fisher's exact test was applied for categorical variables.

Repeated measures analysis of variance (ANOVA) was used for comparison of haemodynamic parameters over time. A p-value of <0.05 was considered statistically significant.

Results

Table 1: Baseline demographic and clinical characteristics

Variable	Group D (Dexmedetomidine) (n=45)	Group N (Nalbuphine) (n=45)	p value
Age (years), Mean ± SD	39.84 ± 10.26	41.22 ± 9.68	0.512
Male, n (%)	28 (62.2)	30 (66.7)	0.654
Female, n (%)	17 (37.8)	15 (33.3)	
Weight (kg), Mean ± SD	67.84 ± 8.12	68.53 ± 7.74	0.682
BMI (kg/m²), Mean ± SD	24.48 ± 2.61	24.92 ± 2.84	0.451
ASA I, n (%)	29 (64.4)	27 (60.0)	0.669
ASA II, n (%)	16 (35.6)	18 (40.0)	

Table 1 compares the baseline demographic and clinical characteristics of patients in the two study groups.

The mean age of patients was 39.84 ± 10.26 years in Group D and 41.22 ± 9.68 years in Group N (p=0.512). The majority of participants were males in both groups (62.2% vs. 66.7%). Mean body weight and body mass index were comparable between the groups with no statistically significant differences (p>0.05). Similarly, the distribution of ASA physical status I and II was comparable in both groups (p=0.669).

These findings indicate that both groups were well matched at baseline, thereby minimizing potential confounding due to demographic or clinical variables.

Table 2: Comparison of block characteristics

Variable	Group D (n=45)	Group N (n=45)	t value	p value
Onset of sensory block (min)	8.26 ± 1.42	9.84 ± 1.56	5.04	<0.001
Onset of motor block (min)	11.18 ± 1.86	12.94 ± 2.04	4.28	<0.001
Duration of sensory block (min)	812.36 ± 74.52	628.44 ± 68.18	12.18	<0.001
Duration of motor block (min)	724.84 ± 69.36	561.28 ± 63.92	11.6	<0.001
Duration of anaesthesia (min)	836.42 ± 76.15	651.76 ± 70.81	11.96	<0.001

Table 2 demonstrates the comparison of sensory and motor block characteristics between the two groups. Patients receiving dexmedetomidine as an adjuvant exhibited a significantly faster onset of sensory block (8.26 ± 1.42 minutes) compared to the nalbuphine group (9.84 ± 1.56 minutes, p<0.001). Likewise, the onset of motor block was significantly shorter in Group D (11.18 ± 1.86 minutes) than in Group N (12.94 ± 2.04 minutes, p<0.001). The duration of sensory block (812.36 ± 74.52 minutes vs. 628.44 ± 68.18 minutes), duration of motor block (724.84 ± 69.36 minutes vs. 561.28 ± 63.92 minutes), and overall duration of anaesthesia (836.42 ± 76.15 minutes vs. 651.76 ± 70.81 minutes) were all significantly prolonged in the dexmedetomidine group (p<0.001 for all comparisons). These findings suggest that dexmedetomidine provides superior block characteristics compared to nalbuphine when used as an adjuvant to 0.75% ropivacaine.

Table 3: Postoperative analgesia and rescue analgesic requirement

Variable	Group D (n=45)	Group N (n=45)	t value	p value
Duration of postoperative analgesia (min)	928.62 ± 88.46	704.84 ± 76.35	12.88	<0.001
Time to first rescue analgesia (hours)	15.46 ± 1.48	11.72 ± 1.63	11.34	<0.001
Total rescue analgesic doses (24 hours)	1.31 ± 0.47	2.09 ± 0.61	6.84	<0.001

Table 3 compares postoperative analgesic outcomes between the study groups. The duration of postoperative analgesia was significantly longer in Group D (928.62 ± 88.46 minutes) than in Group N (704.84 ± 76.35 minutes, p<0.001). Patients in the dexmedetomidine group also experienced a significantly longer interval before requiring the first rescue analgesic (15.46 ± 1.48 hours) compared to those receiving nalbuphine (11.72 ± 1.63 hours, p<0.001). Furthermore, the total number of rescue analgesic doses required during the first 24 postoperative hours was significantly lower in Group D (1.31 ± 0.47) than in Group N (2.09 ± 0.61, p<0.001). These results indicate that dexmedetomidine provides more prolonged and effective postoperative pain relief.

Table 4: Visual Analogue Scale (VAS) scores

Postoperative Interval	Group D	Group N	p value
2 hours	0.36 ± 0.49	0.51 ± 0.55	0.176
4 hours	0.84 ± 0.63	1.42 ± 0.71	<0.001
6 hours	1.49 ± 0.76	2.64 ± 0.81	<0.001
8 hours	2.18 ± 0.84	3.67 ± 0.86	<0.001
12 hours	3.29 ± 0.82	4.93 ± 0.91	<0.001
24 hours	2.67 ± 0.74	3.58 ± 0.82	<0.001

Table 4 presents the postoperative pain scores measured using the Visual Analogue Scale (VAS). Pain scores were comparable between the two groups at 2 hours after surgery (p=0.176).

However, from the fourth postoperative hour onwards, Group D consistently demonstrated significantly lower VAS scores than Group N. At 4, 6, 8, 12, and 24 hours, the differences in pain scores were statistically highly significant (p<0.001).

The lower VAS scores observed in the dexmedetomidine group reflect superior postoperative analgesia and reduced pain intensity throughout the first postoperative day.

Table 5: Intraoperative haemodynamic parameters

Parameter	Group D	Group N	p value
Baseline Heart Rate (beats/min)	80.84 ± 8.26	81.42 ± 7.94	0.731
Intraoperative Mean Heart Rate (beats/min)	71.26 ± 6.42	76.88 ± 6.85	<0.001
Baseline Mean Arterial Pressure (mmHg)	93.84 ± 6.48	94.12 ± 6.31	0.834
Intraoperative Mean Arterial Pressure (mmHg)	86.42 ± 5.64	89.36 ± 5.92	0.018
Mean SpO_2 (%)	99.16 ± 0.78	99.09 ± 0.74	0.664

Table 5 compares the haemodynamic parameters between the two study groups. Baseline heart rate and mean arterial pressure were similar in both groups, with no statistically significant differences (p>0.05).

During surgery, Group D demonstrated a significantly lower mean heart rate (71.26 ± 6.42 beats/min) compared to Group N (76.88 ± 6.85 beats/min, p<0.001). Likewise, the intraoperative mean arterial pressure was modestly but significantly lower in the dexmedetomidine group (86.42 ± 5.64 mmHg) than in the nalbuphine group (89.36 ± 5.92 mmHg, p=0.018).

Oxygen saturation remained stable and comparable between the groups throughout the procedure (p=0.664). Overall, dexmedetomidine provided better haemodynamic stability without compromising oxygenation.

Table 6: Adverse events

Adverse Event	Group D (n=45)	Group N (n=45)	p value
Bradycardia	4 (8.9%)	1 (2.2%)	0.168
Hypotension	3 (6.7%)	2 (4.4%)	0.643
Nausea/Vomiting	1 (2.2%)	3 (6.7%)	0.307
Sedation (Ramsay Score 2–3)	6 (13.3%)	2 (4.4%)	0.138
Respiratory depression	0	0	—
Local anaesthetic toxicity	0	0	—
Pneumothorax	0	0	—
Vascular puncture	1 (2.2%)	1 (2.2%)	1

Table 6 summarizes the incidence of adverse events observed during the study. Bradycardia occurred in four patients (8.9%) in Group D and one patient (2.2%) in Group N, while hypotension was observed in three patients (6.7%) and two patients (4.4%), respectively.

Although these events were numerically more frequent in the dexmedetomidine group, the differences were not statistically significant ($p>0.05$). Mild sedation was more common in Group D (13.3%) than in Group N (4.4%), but this difference also did not reach statistical significance. Nausea and vomiting occurred infrequently in both groups.

Importantly, no cases of respiratory depression, local anaesthetic systemic toxicity, or pneumothorax were encountered. The incidence of vascular puncture was low and comparable in both groups. Overall, both adjuvants demonstrated a favourable safety profile.

Table 7: Overall block success and patient satisfaction

Variable	Group D (n=45)	Group N (n=45)	p value
Successful block without supplementation	44 (97.8%)	43 (95.6%)	0.557
Conversion to general anaesthesia	1 (2.2%)	2 (4.4%)	0.557
Patient satisfaction score (1–10)	9.51 ± 0.62	8.78 ± 0.83	<0.001
Surgeon satisfaction score (1–10)	9.42 ± 0.58	8.84 ± 0.74	<0.001

Table 7 compares the overall success of the supraclavicular block and satisfaction scores between the two groups. Successful completion of surgery without the need for supplemental anaesthesia was achieved in 97.8% of patients in Group D and 95.6% in Group N, with no statistically significant difference ($p=0.557$). Conversion to general anaesthesia was required in only one patient in the dexmedetomidine group and two patients in the nalbuphine group. Patient satisfaction scores were significantly higher in Group D (9.51 ± 0.62) compared with Group N (8.78 ± 0.83, $p<0.001$). Similarly, surgeon satisfaction scores were significantly better in the dexmedetomidine group (9.42 ± 0.58 vs. 8.84 ± 0.74, $p<0.001$). These findings indicate that dexmedetomidine not only improved block quality and analgesia but also enhanced overall patient and surgeon satisfaction.

Discussion

Ultrasound-guided supraclavicular brachial plexus block has become an integral component of anaesthetic management for upper limb surgeries because it provides effective intraoperative anaesthesia, prolonged postoperative analgesia, and facilitates early recovery. Although ropivacaine is widely preferred due to its favourable safety profile and lower cardiotoxicity, its duration of analgesia may not always be sufficient to cover the postoperative pain period. Consequently, several pharmacological adjuvants have been investigated to enhance block quality and prolong analgesia without increasing adverse effects. The present study compared dexmedetomidine and nalbuphine as adjuvants to 0.75% ropivacaine in ultrasound-guided supraclavicular brachial plexus block among patients undergoing elective forearm surgeries. The baseline demographic variables, including age, sex, body weight, BMI, and ASA physical status, were comparable between the two study groups. This homogeneity ensured that the observed differences in block characteristics and analgesic outcomes were attributable to the study drugs rather than patient-related confounding factors. Similar baseline comparability has been reported in previous randomized controlled studies comparing different adjuvants in brachial plexus block. [14-16]

One of the principal findings of the present study was the significantly faster onset of both sensory and motor blockade in patients receiving dexmedetomidine compared with nalbuphine. The enhanced onset observed with dexmedetomidine may be explained by its ability to inhibit hyperpolarization-activated cation currents, thereby facilitating rapid conduction blockade in peripheral nerves. Additionally, α_2-adrenergic receptor activation enhances the local anaesthetic effect by increasing membrane hyperpolarization and suppressing nerve impulse transmission. These pharmacological properties likely account for the earlier onset achieved with dexmedetomidine. Similar observations have been reported by Swami et al., Esmaoglu et al., and Agarwal et al., who demonstrated significantly shorter onset times when dexmedetomidine was added to ropivacaine or bupivacaine for brachial plexus block. [17-19]

The present study also demonstrated that dexmedetomidine significantly prolonged the duration of sensory blockade, motor blockade, and overall duration of anaesthesia compared with nalbuphine. Prolongation of neural blockade is one of the most desirable characteristics of an adjuvant because it ensures prolonged surgical anaesthesia and improves postoperative comfort. Dexmedetomidine is believed to prolong peripheral nerve block by producing vasoconstriction around the injection site, reducing systemic absorption of the local anaesthetic, and exerting direct inhibitory effects on nerve fibre conduction. The prolonged

sensory blockade observed in our study is consistent with the findings reported by Abdallah and Brull, who concluded that dexmedetomidine consistently extends the duration of peripheral nerve blocks when used with long-acting local anaesthetics. [20] Likewise, Vorobeichik et al. reported significant prolongation of analgesia with perineural dexmedetomidine in their systematic review and meta-analysis. [21]

An important outcome of this study was the significantly prolonged postoperative analgesia observed in the dexmedetomidine group. Patients receiving dexmedetomidine experienced a longer pain-free period, delayed requirement for the first rescue analgesic, and reduced total analgesic consumption during the first 24 postoperative hours. Effective postoperative pain management contributes substantially to patient comfort, facilitates early mobilisation, and decreases opioid consumption. Dexmedetomidine achieves prolonged analgesia through synergistic interaction with local anaesthetics and modulation of nociceptive pathways at both peripheral and central levels. The reduced rescue analgesic requirement observed in our study agrees with the findings of Al-Mustafa et al., Kaygusuz et al., and several subsequent randomized trials demonstrating superior postoperative analgesia with dexmedetomidine compared with other adjuvants. [22-24]

Although nalbuphine also significantly enhanced postoperative analgesia when added to ropivacaine, its overall effect was less pronounced than that observed with dexmedetomidine. Nalbuphine produces analgesia through activation of peripheral κ-opioid receptors and antagonism of μ-opioid receptors, thereby providing prolonged analgesia with a lower incidence of respiratory depression and other opioid-related adverse effects. Several investigators, including Gupta et al. and Biswas et al., have demonstrated that nalbuphine is an effective adjuvant in brachial plexus block, producing longer analgesia than local anaesthetic alone. [22,26] However, direct comparisons have generally shown dexmedetomidine to provide superior prolongation of both sensory block and postoperative analgesia, which is in agreement with the present findings.

Postoperative pain assessment using the Visual Analogue Scale further supported the superiority of dexmedetomidine. Pain scores remained comparable during the immediate postoperative period, reflecting effective surgical anaesthesia in both groups. However, from the fourth postoperative hour onwards, patients in the dexmedetomidine group consistently reported lower VAS scores than those receiving nalbuphine. These findings indicate that the analgesic benefit of dexmedetomidine extends well into the postoperative period, reducing both pain intensity and the need for supplemental analgesics. Similar postoperative pain profiles have been described in previous comparative studies evaluating dexmedetomidine as an adjuvant in peripheral nerve blocks. [20,21]

Haemodynamic stability is an important consideration while selecting adjuvants for regional anaesthesia. In the present study, baseline haemodynamic variables were similar between the groups. During surgery, patients receiving dexmedetomidine exhibited modest reductions in heart rate and mean arterial pressure compared with the nalbuphine group. These changes were expected because of the sympatholytic properties of dexmedetomidine and remained within clinically acceptable limits without requiring significant intervention. Oxygen saturation remained stable throughout the perioperative period in both groups. These observations are consistent with previous reports demonstrating that dexmedetomidine provides stable haemodynamics when used in appropriate doses during regional anaesthesia. [22,23]

The incidence of adverse effects was low in both groups. Although bradycardia and mild sedation occurred slightly more frequently with dexmedetomidine, these events were transient, clinically manageable, and did not necessitate discontinuation of the study drug. Importantly, no patient developed respiratory depression, local anaesthetic systemic toxicity, pneumothorax, or persistent neurological complications. The absence of serious complications may also reflect the use of ultrasound guidance, which improves needle visualization and reduces the likelihood of inadvertent vascular puncture or pleural injury. These findings reinforce the favourable safety profiles of both dexmedetomidine and nalbuphine as adjuvants in peripheral nerve blocks. [27,28]

The significantly higher patient and surgeon satisfaction scores observed in the dexmedetomidine group are clinically meaningful. Faster onset of block, prolonged analgesia, reduced need for rescue medication, and favourable operating conditions collectively contribute to improved perioperative experience. Enhanced patient satisfaction is increasingly recognized as an important indicator of the quality of regional anaesthesia and perioperative care. [29, 30] Our findings suggest that dexmedetomidine offers tangible clinical advantages beyond prolongation of analgesia alone.

The findings of the present study should be interpreted in the context of certain limitations. The study was conducted at a single tertiary care centre with a relatively modest sample size, which may limit the generalizability of the results. Long-term

neurological follow-up was not performed, and therefore delayed complications could not be evaluated. Sedation was assessed clinically rather than using advanced objective monitoring techniques. Furthermore, only one dose of each adjuvant was evaluated, and dose-response relationships were not explored. Future multicentre studies involving larger populations and different dosage regimens would provide stronger evidence regarding the optimal adjuvant for supraclavicular brachial plexus block.

Overall, the present study demonstrates that both dexmedetomidine and nalbuphine are effective adjuvants to 0.75% ropivacaine for ultrasound-guided supraclavicular brachial plexus block. However, dexmedetomidine consistently produced faster block onset, significantly prolonged sensory and motor blockade, extended postoperative analgesia, reduced rescue analgesic consumption, and resulted in higher patient satisfaction while maintaining an acceptable safety profile. These findings support the use of dexmedetomidine as a preferred adjuvant to ropivacaine for elective forearm surgeries performed under ultrasound-guided supraclavicular brachial plexus block.

Conclusion

The present study demonstrated that both dexmedetomidine and nalbuphine, when used as adjuvants to 0.75% ropivacaine in ultrasound-guided supraclavicular brachial plexus block, provided effective anaesthesia and satisfactory postoperative analgesia for patients undergoing elective forearm surgeries.

However, dexmedetomidine was associated with a significantly faster onset of sensory and motor blockade, longer duration of anaesthesia, prolonged postoperative analgesia, delayed requirement for rescue analgesics, and lower postoperative analgesic consumption compared with nalbuphine.

Although dexmedetomidine produced a slightly higher incidence of mild bradycardia and sedation, these effects were clinically manageable and did not result in serious complications. Haemodynamic parameters remained stable in both groups, and no major block-related adverse events were observed.

Based on the findings of this study, dexmedetomidine appears to be a superior adjuvant to 0.75% ropivacaine compared with nalbuphine for ultrasound-guided supraclavicular brachial plexus block in elective forearm surgeries. Its ability to enhance block quality, extend postoperative analgesia, reduce rescue analgesic requirements, and improve patient satisfaction makes it a valuable adjunct in contemporary regional anaesthesia practice. Further multicentre studies with larger sample sizes are recommended to validate these findings and establish optimal dosing strategies for routine clinical use.

References

1. Neal JM, Gerancher JC, Hebl JR, Ilfeld BM, McCartney CJL, Franco CD, et al. Upper extremity regional anesthesia: Essentials of our current understanding. Reg Anesth Pain Med. 2009;34(2):134-70.
2. Marhofer P, Harrop-Griffiths W, Kettner SC, Kirchmair L. Fifteen years of ultrasound guidance in regional anaesthesia: Part 1. Br J Anaesth. 2010;104(5):538-46.
3. Sites BD, Chan VW, Neal JM, Weller R, Grau T, Koscielniak-Nielsen ZJ, et al. The American Society of Regional Anesthesia and Pain Medicine and the European Society of Regional Anaesthesia and Pain Therapy joint committee recommendations for education and training in ultrasound-guided regional anesthesia. Reg Anesth Pain Med. 2010;35(Suppl 2):S74-80.
4. Hadzic A. Textbook of Regional Anesthesia and Acute Pain Management. 2nd ed. New York: McGraw-Hill Education; 2017.
5. Brown DL. Atlas of Regional Anesthesia. 5th ed. Philadelphia: Elsevier; 2020.
6. McClure JH. Ropivacaine. Br J Anaesth. 1996;76(2):300-7.
7. Kuthiala G, Chaudhary G. Ropivacaine: A review of its pharmacology and clinical use. Indian J Anaesth. 2011;55(2):104-10.
8. Swami SS, Keniya VM, Ladi SD, Rao R. Comparison of dexmedetomidine and clonidine as an adjuvant to local anaesthesia in supraclavicular brachial plexus block: A randomised double-blind prospective study. Indian J Anaesth. 2012;56(3):243-9.
9. Esmaoglu A, Yegenoglu F, Akin A, Turk CY. Dexmedetomidine added to levobupivacaine prolongs axillary brachial plexus block. Anesth Analg. 2010;111(6):1548-51.
10. Agarwal S, Aggarwal R, Gupta P. Dexmedetomidine prolongs the effect of bupivacaine in supraclavicular brachial plexus block. J Anaesthesiol Clin Pharmacol. 2014;30(1):36-40.
11. Abdallah FW, Brull R. Facilitatory effects of perineural dexmedetomidine on neuraxial and peripheral nerve block: A systematic review and meta-analysis. Br J Anaesth. 2013;110(6):915-25.
12. Vorobeichik L, Brull R, Abdallah FW. Evidence basis for using perineural dexmedetomidine to enhance the quality of brachial plexus nerve blocks: A systematic review and meta-analysis. Br J Anaesth. 2017;118(2):167-81.
13. Al-Mustafa MM, Abu-Halaweh SA, Aloweidi AS, Murshidi MM, Ammari BA, Awwad ZM,

et al. Effect of dexmedetomidine added to spinal bupivacaine for urological procedures. Saudi Med J. 2009;30(3):365-70.
14. Kaygusuz K, Kol IO, Duger C, Gursoy S, Ozturk H, Kayacan U, et al. Effects of adding dexmedetomidine to levobupivacaine in axillary brachial plexus block. Curr Ther Res Clin Exp. 2012;73(3):103-11.
15. Gupta K, Singh S, Gupta PK, Rastogi B, Jain M, Gupta A. Nalbuphine as an adjuvant to local anaesthetic in supraclavicular brachial plexus block: A randomized controlled study. Anaesth Pain Intensive Care. 2016;20(4):450-5.
16. Biswas S, Das RK, Mukherjee G, Ghose T. Nalbuphine as an adjuvant to bupivacaine in ultrasound-guided supraclavicular brachial plexus block: A randomized prospective study. Indian J Pain. 2017;31(2):89-94.
17. Gupta N, Gupta A, Singh TK. Comparative evaluation of dexmedetomidine versus nalbuphine as adjuvants to ropivacaine in supraclavicular brachial plexus block. J Clin Diagn Res. 2019;13(8):UC01-UC05.
18. Tiwari AK, Tomar GS, Agrawal J. Comparison of dexmedetomidine and nalbuphine as adjuvants to ropivacaine in ultrasound-guided supraclavicular brachial plexus block. Indian J Clin Anaesth. 2021;8(2):210-5.
19. Verma V, Rana S, Chaudhary SK, Chandel A. Ultrasound-guided supraclavicular brachial plexus block with dexmedetomidine versus nalbuphine as adjuvants to ropivacaine: A prospective randomized study. Anaesth Essays Res. 2022;16(3):289-95.
20. El-Boghdadly K, Brull R, Sehmbi H, Abdallah FW, Chan VW, De Silva AP, et al. Perineural adjuncts for peripheral nerve block. Br J Anaesth. 2021;127(2):276-92.
21. Kirksey MA, Haskins SC, Cheng J, Liu SS. Local anesthetic peripheral nerve block adjuvants for prolongation of analgesia: A systematic qualitative review. PLoS One. 2015;10(9):e0137312.
22. Hussain N, Goldar G, Ragina N, Banfield L, Laffey JG, Abdallah FW. Supraclavicular and infraclavicular brachial plexus blocks for upper limb surgery: A systematic review and meta-analysis. Anesthesiology. 2016;124(2):361-78.
23. Elsharkawy H, Pawa A, Mariano ER. Interfascial plane blocks: Back to basics. Reg Anesth Pain Med. 2018;43(4):341-6.
24. Chin KJ, Mariano ER, El-Boghdadly K. Advancing regional anaesthesia practice through ultrasound guidance and evidence-based techniques. Anaesthesia. 2021;76(Suppl 1):55-63.
25. Miller RD, Cohen NH, Eriksson LI, Fleisher LA, Wiener-Kronish JP, Young WL, et al. Miller's Anesthesia. 9th ed. Philadelphia: Elsevier; 2020.
26. Butterworth JF, Mackey DC, Wasnick JD. Morgan and Mikhail's Clinical Anesthesiology. 7th ed. New York: McGraw-Hill Education; 2022.
27. Hadzic A. Hadzic's Peripheral Nerve Blocks and Anatomy for Ultrasound-Guided Regional Anesthesia. 3rd ed. New York: McGraw-Hill Education; 2022.
28. El-Boghdadly K, Chin KJ. Regional anaesthesia in the modern era: Benefits, risks and future directions. Anaesthesia. 2020;75 (Suppl 1):e74-e81.
29. Hussain N, Brull R, Sheehy B, Essandoh M, Stahl DL, Weaver TE, et al. Does the addition of perineural dexmedetomidine improve analgesia after brachial plexus block? A systematic review and meta-analysis. Reg Anesth Pain Med. 2018;43(6):595-604.
30. Singh PM, Borle A, Trikha A, Sinha A, Goudra BG. Role of dexmedetomidine as an adjuvant in peripheral nerve blocks: A meta-analysis of randomized controlled trials. J Clin Anesth. 2017;38:1-10.