



Effect of dexmedetomidine versus nalbuphine on the onset and duration of sensory and motor block: A randomized prospective single-blinded controlled study.

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Abstract

Background:

The present study was conducted to compare dexmedetomidine and nalbuphine as adjuvants to levobupivacaine in supraclavicular brachial plexus block with respect to onset and duration of sensory and motor block, duration of analgesia, and hemodynamic changes.

Methods:

A randomized, prospective, single-blinded controlled study was conducted among 110 patients aged 18–55 years belonging to ASA grade I and II undergoing upper limb surgeries under supraclavicular brachial plexus block. Patients were randomly allocated into two groups of 55 each. Group LD received levobupivacaine with dexmedetomidine, while Group LN received levobupivacaine with nalbuphine. Sensory block onset, motor block onset, duration of sensory and motor block, duration of analgesia, pulse rate, mean arterial pressure, and oxygen saturation were assessed.

Results:

The mean age of participants in Group LD and Group LN was 36.40±10.89 years and 39.18±12.05 years, respectively. Dexmedetomidine significantly reduced the onset time of sensory block (7.29±0.76 min vs 10.07±1.11 min; p<0.001) and motor block (13.09±0.84 min vs 16.27±0.98 min; p<0.001). Duration of sensory block (13.21±1.16 h vs 12.14±1.11 h; p<0.001), motor block (10.01±1.04 h vs 7.30±0.74 h; p<0.001), and analgesia (13.83±0.78 h vs 12.07±0.99 h; p<0.001) were significantly prolonged in Group LD. Pulse rate and mean arterial pressure were significantly lower in Group LD at 60 min, 2 h, and 6 h. Oxygen saturation remained stable and comparable between groups throughout the study.

Conclusion:

Both dexmedetomidine and nalbuphine serve as effective adjuncts to levobupivacaine for supraclavicular brachial plexus blockade. Dexmedetomidine provides enhanced efficacy through rapid onset and extended analgesia, whereas nalbuphine presents a cost-effective option with a commendable safety profile.

Recommendation:

Dexmedetomidine may be preferred as an adjuvant to levobupivacaine for supraclavicular brachial plexus block due to its faster onset and prolonged analgesic effect, while nalbuphine can be considered a cost-effective alternative.

Keywords: dexmedetomidine, nalbuphine, analgesia, brachial plexus block, motor blockade.

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Introduction

Pain is an aversive sensation comprising both sensory and emotional elements. Effective perioperative pain management is crucial for enhancing patient outcomes, and

regional anaesthesia is vital in accomplishing this objective. It may be utilised independently or in conjunction with general anaesthesia to ensure adequate analgesia. Upper limb nerve blocks are extensively utilised in orthopaedic and

plastic operations as a substitute for general anaesthesia, providing optimal operating circumstances, total muscular relaxation, and stable intraoperative hemodynamics.(1).

The supraclavicular method for brachial plexus blockade is a dependable and often employed technique for administering anaesthesia to the lower arm, elbow, forearm, and hand. This method focuses on the distal trunks and proximal branches of the brachial plexus. The block is executed by placing the needle around 1 cm superior to the midpoint of the clavicle, following the identification of the subclavian artery. (2). The needle is advanced laterally to the artery in a downward and backwards trajectory until paraesthesia is induced, signifying closeness to the nerve bundle. A local anaesthetic is subsequently administered into the brachial plexus sheath. (3). This method, while effective, may entail problems including pneumothorax, hoarseness resulting from recurrent laryngeal nerve blocking (particularly prevalent on the right side), and Horner's syndrome. (4).

Levobupivacaine is a long-acting local anaesthetic that reversibly obstructs nerve conduction in sensory, motor, and sympathetic fibres by reducing sodium ion influx through voltage-gated channels. It is metabolised in the liver by cytochrome P450 enzymes, specifically CYP1A2 and CYP3A4, and is regarded as less cardiotoxic than bupivacaine.(5).

Adjuvants are frequently used with local anaesthetics to improve block quality, accelerate onset, and extend duration. Dexmedetomidine, an alpha-2 adrenergic agonist, facilitates analgesia by suppressing the release of substance P in the spinal cord and demonstrates neuroprotective characteristics. Nalbuphine, a synthetic opioid agonist-antagonist belonging to the phenanthrene class, provides effective analgesia similar to that of morphine.(6).

The objective of the present study was to compare dexmedetomidine and nalbuphine as adjuvants to levobupivacaine in supraclavicular brachial plexus block with respect to onset and duration of sensory and motor blockade, duration of analgesia, and hemodynamic parameters.

Materials & methods

Study Design

The present study was a randomized, prospective, single-blinded controlled study conducted to compare the effects of dexmedetomidine and nalbuphine as adjuvants to levobupivacaine in supraclavicular brachial plexus block for upper limb surgeries.

Study Setting and Duration

The study was conducted in the Department of Anaesthesiology and Critical Care at Dharanidhar Medical

College and Hospital, Odisha, India, after obtaining approval from the Institutional Ethics Committee. The study was carried out over a period of one year among patients undergoing elective upper limb surgeries under supraclavicular brachial plexus block.

Study Population

A total of 110 patients scheduled for elective upper limb surgeries were included in the study.

Sample Size

The sample size was calculated based on previous studies evaluating dexmedetomidine and nalbuphine as adjuvants in regional anaesthesia. Considering a confidence interval of 95%, study power of 80%, and expected difference in duration of analgesia between the groups, a total sample size of 110 participants was determined. The participants were equally divided into two groups, with 55 patients in each group.

Inclusion Criteria

Patients fulfilling the following criteria were included in the study:

- American Society of Anesthesiologists (ASA) physical status I and II
- Patients aged between 18 and 55 years
- Both male and female patients
- Body weight between 55 and 80 kg
- Patients posted for elective upper limb surgeries under supraclavicular brachial plexus block
- Patients willing to participate in the study and provide written informed consent

Exclusion Criteria

Patients with the following conditions were excluded from the study:

- Refusal to participate in the study
- Bleeding disorders or patients receiving anticoagulant therapy
- Local infection at the site of injection
- Known allergy to study drugs
- History of cardiac, respiratory, renal, neurological, or musculoskeletal disease
- Pregnant women
- Patients with psychiatric disorders
- History of drug or alcohol abuse
- Expected duration of surgery greater than 4 hours

Randomization and Allocation

The enrolled patients were randomly allocated into two groups of 55 participants each using a computer-generated randomization sequence.

- Group LD: Levobupivacaine with dexmedetomidine
- Group LN: Levobupivacaine with nalbuphine

Allocation concealment was achieved using sequentially numbered opaque sealed envelopes prepared by an independent investigator. The envelopes were opened immediately before administration of the study drug.

Blinding

The study was single-blinded, in which the participants were unaware of the group allocation. The investigator assessing the outcomes recorded the observations according to the study protocol.

Pre-Anaesthetic Evaluation

All patients underwent detailed pre-anaesthetic evaluation, including history taking, physical examination, airway assessment, and routine laboratory investigations. Patients were kept nil per os for at least 6 hours before surgery. Written informed consent was obtained from all participants before inclusion in the study.

Baseline parameters, including pulse rate, mean arterial pressure, oxygen saturation (SpO₂), respiratory rate, and electrocardiography, were recorded before administration of the block.

Study Intervention

After shifting the patient to the operating room, intravenous access was secured, and standard monitors, including non-invasive blood pressure, pulse oximetry, and electrocardiography, were attached.

Under strict aseptic precautions, a supraclavicular brachial plexus block was performed with the patient in a supine position, and the head turned to the opposite side.

Group LD

Patients in Group LD received:

- 20 mL of 0.5% levobupivacaine combined with dexmedetomidine 1 µg/kg diluted in normal saline.

Group LN

Patients in Group LN received:

- 20 mL of 0.5% levobupivacaine combined with nalbuphine 10 mg diluted in normal saline.

The study drugs were prepared by an anaesthesiologist not involved in patient assessment.

Outcome Measures

Primary Outcomes

- Onset of sensory block
- Onset of motor block
- Duration of sensory block
- Duration of motor block

Secondary Outcomes

- Duration of postoperative analgesia
- Pulse rate
- Mean arterial pressure (MAP)
- Oxygen saturation (SpO₂)
- Adverse effects and complications

Assessment of Block Characteristics

Sensory Block Assessment

Sensory block was assessed using pinprick sensation over the dermatomes supplied by the radial, median, musculocutaneous, and ulnar nerves at regular intervals after administration of the block.

The onset of sensory block was defined as the time interval between completion of drug injection and complete loss of pinprick sensation.

Duration of sensory block was defined as the time from the onset of sensory blockade until complete recovery of sensation.

Motor Block Assessment

Motor block was assessed using the modified Bromage scale for upper limb movements.

The onset of motor block was defined as the time interval between completion of drug injection and complete motor paralysis.

The duration of motor block was defined as the time from the onset of motor blockade until complete recovery of motor function.

Duration of Analgesia

Duration of analgesia was defined as the time interval between administration of the block and the first request for rescue analgesia by the patient.

Hemodynamic Monitoring

Pulse rate, mean arterial pressure, and oxygen saturation were recorded at baseline, 5 minutes, 15 minutes, 30 minutes, 60 minutes, 2 hours, 6 hours, 12 hours, and 24 hours following administration of the block.

Patients were monitored throughout the perioperative period for adverse effects such as bradycardia, hypotension, nausea, vomiting, respiratory depression, pneumothorax, and neurological complications.

Independent Student's t-test was used for comparison of quantitative variables between the two groups, whereas the Chi-square test was used for categorical variables. A p-value less than 0.05 was considered statistically significant.

Statistical Analysis

Data were entered into a Microsoft Excel spreadsheet and analyzed using Statistical Package for Social Sciences (SPSS) software version 23.0. Continuous variables were expressed as mean $\pm$ standard deviation, while categorical variables were expressed as frequency and percentage.

Results

A total of 110 participants were assessed and randomized equally into two groups of 55 participants each. All participants received the allocated intervention and were included in the final analysis. No participant was lost to follow-up.

AGE:

Table 1: Shows the age distribution and p-values in the two groups

Age Group	Group-A	Group-B	P value
<30yr	24	18	
31-40yr	8	11	
41-55yr	23	26	
TOTAL	55	55	
Mean $\pm$ SD	36.40 $\pm$ 10.89	39.18 $\pm$ 12.05	0.20

SEX:

Table 2: Shows the sex ratio in the respective groups.

	Group-A	Group-B	P value
MALE	28	29	0.74
FEMALE	27	26	

WEIGHT:

Table 3: Shows the weight distribution and p-values in the two groups

Group	No.	Minimum (kg)	Maximum (kg)	Mean $\pm$ SD	P value
A	55	55	80	69.47 $\pm$ 7.54	0.68
B	55	55	80	68.90 $\pm$ 7.10	

ASA PHYSICAL STATUS:

Table 4: Shows the ASA ratio in two groups.

	Group-A	Group-B	P- value
ASA 1	29	25	> 0.85
ASA 2	26	30	

ONSET OF SENSORY BLOCK:

Table 5: Shows the onset of sensory block in the two groups

Onset of sensory block (min)	Group -A	Group -B	P value
Mean $\pm$ SD	7.29 $\pm$ 0.76	10.07 $\pm$ 1.11	< 0.001

ONSET OF MOTOR BLOCK:

Table 6: Shows the onset of motor block in the two groups

Onset of motor block (min)	Group -A	Group -B	P value
Mean $\pm$ SD	13.09 $\pm$ 0.84	16.27 $\pm$ 0.98	<0.001

Table 7: Shows the onset of sensory block in the two groups

Duration of sensory block (min)	Group-A	Group-B	P value
Mean $\pm$ SD	13.21 $\pm$ 1.16	12.14 $\pm$ 1.11	<0.001

Table 8: Shows the onset of sensory block in the two groups

Duration of motor block (min)	Group-A	Group-B	P value
Mean $\pm$ SD	10.01 $\pm$ 1.04	7.30 $\pm$ 0.74	<0.001

Table 9: Shows the duration of analgesia in the two groups

Duration of analgesia (hours)	Group-A	Group-B	P value
Mean $\pm$ SD	13.83 $\pm$ 0.78	12.07 $\pm$ 0.99	<0.001

Table 10: Shows the pulse rate at different time intervals in two groups.

Time	Group-A Mean $\pm$ SD	Group-B Mean $\pm$ SD	P value	Significance
0 min	76.70 $\pm$ 5.71	78.07 $\pm$ 3.79	0.14	NS
5 min	74.56 $\pm$ 5.61	75.03 $\pm$ 4.13	0.61	NS
15 min	71.03 $\pm$ 5.88	72.09 $\pm$ 4.25	0.28	NS
30 min	66.89 $\pm$ 6.09	68.65 $\pm$ 4.38	0.084	NS
60 min	60.61 $\pm$ 5.96	69.03 $\pm$ 5.06	<0.001	S
2 hours	56.61 $\pm$ 5.77	65.83 $\pm$ 5.11	<0.001	S
6 hours	64.01 $\pm$ 6.08	69.30 $\pm$ 4.99	<0.001	S
12 hours	69.27 $\pm$ 6.05	71.21 $\pm$ 5.18	0.07	NS
24 hours	74.52 $\pm$ 5.79	76.18 $\pm$ 4.74	0.10	NS

* NS = Not Significant, S = Significant

Table 11: shows the mean arterial blood pressure (MAP) at different time intervals.

Time	Group-A Mean $\pm$ SD	Group-B Mean $\pm$ SD	P value	Significance
0 min	94.23 $\pm$ 4.16	95.12 $\pm$ 3.25	0.21	NS
5 min	90.47 $\pm$ 4.06	91.27 $\pm$ 3.25	0.25	NS
15 min	85.34 $\pm$ 4.38	86.47 $\pm$ 3.07	0.12	NS

30 min	81.01 ± 4.38	82.27 ± 3.13	0.08	NS
60 min	71.05 ± 3.96	80.36 ± 3.97	<0.0001	S
2 hours	65.12 ± 3.54	83.74 ± 3.37	<0.0001	S
6 hours	76.94 ± 3.54	87.29 ± 3.50	<0.0001	S
12 hours	89.34 ± 3.47	90.49 ± 3.36	0.08	NS
24 hours	92.65 ± 3.63	93.67 ± 3.36	0.12	NS

* NS = Not Significant, Sig = Significant

TWO GROUPS

Table 12: Shows the mean oxygen saturation (SpO2) at different time intervals.

Time	Group-A Mean ± SD	Group-B Mean ± SD	P value	Significance
0 min	98.48 ± 0.86	98.47 ± 0.66	0.10	NS
5 min	98.43 ± 0.94	98.61 ± 0.68	0.20	NS
15 min	98.48 ± 0.86	98.63 ± 0.70	0.31	NS
30 min	98.09 ± 1.04	98.32 ± 1.01	0.23	NS
60 min	98.32 ± 1.01	98.34 ± 0.90	0.90	NS
2 hours	98.32 ± 0.90	98.45 ± 0.76	0.41	NS
6 hours	98.63 ± 0.70	98.52 ± 0.93	0.48	NS
12 hours	98.63 ± 0.67	98.40 ± 0.93	0.13	NS
24 hours	98.52 ± 0.68	98.48 ± 0.86	0.78	NS

* NS = Not Significant, Sig = Significant

Discussion

Brachial plexus block has become a widely accepted anaesthetic technique for upper limb surgeries due to its ability to provide effective intraoperative anaesthesia and prolonged postoperative analgesia while avoiding the adverse effects associated with general anaesthesia.(7). The use of levobupivacaine, a safer alternative to bupivacaine with lower cardiotoxicity, enhances the safety profile of this regional technique. However, when used alone, levobupivacaine may produce a shorter duration of action and occasionally an incomplete block, necessitating the use of adjuvants to improve its efficacy.(8).

In the present study, dexmedetomidine and nalbuphine were evaluated as adjuvants to levobupivacaine for supraclavicular brachial plexus block. The findings demonstrate that dexmedetomidine significantly hastened the onset of both sensory and motor blockade compared to nalbuphine. These results are consistent with previous studies, such as those conducted by Dwivedi N, Choudhuri P, Nayar P, where dexmedetomidine showed a faster onset of block. The faster onset may be attributed to its action on α_2 -adrenergic receptors, leading to inhibition of norepinephrine release and enhanced neuronal blockade. (9).

Furthermore, the duration of sensory block, motor block, and analgesia was prolonged in the dexmedetomidine group compared to the nalbuphine group. This prolonged analgesic effect aligns with findings from studies by Bupivacaine I et al. and Fawal SM El et al., supporting the superior efficacy of dexmedetomidine in extending postoperative pain relief. Nalbuphine, being a kappa receptor agonist and mu antagonist, also provided effective analgesia, though slightly inferior to dexmedetomidine. (10), (11).

Hemodynamically, dexmedetomidine was associated with lower pulse rate and mean arterial pressure, which may be explained by its sympatholytic properties. Although these changes were statistically significant, they remained clinically manageable.(12). Importantly, no major adverse effects were observed in either group, indicating that both adjuvants are safe for clinical use. In conclusion, both dexmedetomidine and nalbuphine are effective adjuvants to levobupivacaine in supraclavicular brachial plexus block. However, dexmedetomidine offers the advantages of faster onset and prolonged analgesia, while nalbuphine remains a cost-effective alternative with a favorable safety profile.(13).

Conclusion

The supraclavicular approach to brachial plexus block is a widely used and effective technique for providing anaesthesia in upper limb surgeries. It offers the advantage of stable intraoperative conditions and prolonged postoperative analgesia while avoiding the adverse effects associated with general anaesthesia. In this study, both dexmedetomidine and nalbuphine proved to be effective adjuvants when combined with levobupivacaine.

The findings demonstrated that dexmedetomidine significantly hastened the onset of both sensory and motor blockade compared to nalbuphine. Additionally, it prolonged the duration of sensory and motor block as well as postoperative analgesia, making it a superior adjuvant in terms of efficacy. However, dexmedetomidine was associated with a significant reduction in pulse rate and mean arterial pressure intraoperatively. Despite these hemodynamic changes, oxygen saturation remained stable. Overall, both drugs were safe, with dexmedetomidine providing enhanced analgesic benefits.

Limitations

The study was conducted at a single center with a relatively small sample size, which may limit generalizability. Long-term postoperative outcomes and patient satisfaction were not evaluated.

Generalizability

The findings of the present study may apply to adult patients undergoing upper limb surgeries under supraclavicular brachial plexus block in similar tertiary care settings.

Registration

The study was not registered in any clinical trial registry.

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List of abbreviations

- ASA – American Society of Anesthesiologists
- MAP – Mean Arterial Pressure
- SpO₂ – Peripheral Oxygen Saturation
- SD – Standard Deviation
- LD – Levobupivacaine + Dexmedetomidine

- LN – Levobupivacaine + Nalbuphine

Conflict of interest

Conflict of Interest: The authors declare no conflict of interest.

Data availability

Data Availability Statement: The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions:

Panchanana Sethi: Concept and study design

Mrutyunjay Sahoo: Statistical analysis and manuscript drafting

Rojalin Sahoo: Data collection and supervision

Ananta Narayan Patra: Literature review and manuscript editing

Dukhia Charan Kisku: Data interpretation and follow-up

Author biography

The authors are faculty members and residents from the Departments of Anaesthesiology and Community Medicine with research interests in regional anaesthesia, perioperative analgesia, and critical care medicine.

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