ORIGINAL ARTICLE ASIAN JOURNAL OF MEDICAL SCIENCES

# A comparative study of efficacy of intravenous dexmedetomidine with perineural dexmedetomidine as adjuvant to ropivacaine in supraclavicular brachial plexus block in upper limb surgery

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Submission: 04-03-2024 Revision: 26-05-2024 Publication: 01-07-2024

## ABSTRACT

**Background:** In supraclavicular brachial plexus block, to prolong the duration of analgesia, many adjuvants have been tried in the past in many studies but an ideal adjuvant remains yet to be discovered. Dexmedetomidine, a selective Alfa-2 adrenergic agonist when added to local anesthetic has been reported to prolong the block duration and post-operative analgesia in various regional blocks. **Aims and Objectives:** The aims and objectives are to study the onset and duration of sensory and motor blockade, postoperative analgesia, and hemodynamic effects of addition of dexmedetomidine with ropivacaine in supraclavicular brachial plexus block. **Materials and Methods:** Sixty patients aged between 18 and 60 years, American Society of Anesthesiologists class I and II, of both sexes, scheduled for upper limb surgery under supraclavicular brachial plexus block were randomly allocated into 2 groups. Group-A received 20 mL of 0.5% ropivacaine in brachial plexus block with 1 μg/kg dexmedetomidine as adjuvant perineurally and Group-B received 20 mL 0.5% ropivacaine in brachial plexus block with dexmedetomidine intravenous infusion at 1 μg/kg over 10 min. Intraoperatively non-invasive blood pressure, heart rate, $SpO_2$, and sedation were recorded every 5 min for the first 10 min and every 15 min thereafter till the end. Time of first rescue analgesic, intensity of postoperative pain, and total analgesic required were recorded. **Results:** Onset of sensory and motor block was faster in Group-A than Group-B. Duration of analgesia was prolonged in Group-A than Group-B. Hemodynamic stability was better maintained in Group-A than Group-B. Sedation was better in Group B. **Conclusion:** Dexmedetomidine as adjuvant to ropivacaine in supraclavicular brachial plexus block is more efficacious in providing faster onset of motor and sensory blocks and prolonging duration of postoperative analgesia with better hemodynamic stability.

**Key words:** Adjuvant; Analgesia; Perineural; Ropivacaine; Dexmedetomidine

**Access this article online**

**Website:** http://nepjol.info/index.php/AJMS

**DOI:** 10.3126/ajms.v15i7.43940

**E-ISSN:** 2091-0576

**P-ISSN:** 2467-9100



## INTRODUCTION

Supraclavicular brachial plexus block is many times called as "spinal anesthesia of the upper extremity."[1] It is a popular mode of anesthesia for various upper limb surgeries, due to its effectiveness in terms of cost, performance, margin of safety, and good post-operative analgesia.[2] It provides rapid onset, dense anesthesia of the arm with a single injection.[3] It provides most effective block for the upper extremity and also ensures post-operative analgesia without side effects.[4] It is done at the distal trunk and proximal division level. At this point, the brachial plexus is compact and a small volume of local anesthetic provides rapid onset of reliable blockade of brachial plexus. Blockade of brachial

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plexus (C5-T1) will allow for surgical anesthesia for elbow, forearm, and hand surgeries.

Several different techniques have been described, but despite modifications to the original Kulenkampff method, the major disadvantage of these blind approaches remains, the small but significant risk of pneumothorax.[5-7] This risk has been reported to be zero in expert hands; other series quotes an incidence of pneumothorax as high as 6.1%.[8,9] When using a landmark technique for the regional blockade, poor localization of nerves can result due to anatomical variation or trauma to the region and result in failed anesthesia or cause morbidity. In the upper limb, surface ultrasound can clearly identify neural elements of the brachial plexus as well as surrounding structures.[10-12] Ultrasound-guided brachial plexus block gains the advantage of accurate nerve localization, real-time visualization of brachial plexus, blood vessels, needle placement, and local anesthetic spread. It minimizes the number of needle attempts.

Various adjuvants, which will prolong the duration of analgesia, were tried in many trials with lesser side effects but yet the ideal adjuvant remains undiscovered. Dexmedetomidine is highly selective (8 times more selective than clonidine)[13] and potent α2-adrenergic agonist. When used in systemic route, it has analgesic, antihypertensive, sedative, and anesthetic-sparing effects.[14] It has been proved that adding dexmedetomidine to local anesthetics prolongs the block duration and duration of post-operative analgesia in various regional blocks.[15-18]

It has been reported to improve the efficacy of intrathecal, caudal, and epidural anesthesia.[19] Its use in peripheral nerve blocks has recently been described. Very few trials are done to study the efficacy of using dexmedetomidine as an adjuvant in the supraclavicular block.

We decided to study the onset and duration of sensory and motor blockade, postoperative analgesia, sedation, and hemodynamic effects using dexmedetomidine in combination with local anesthetics.

### Aims and objectives

To compare the efficacy of perineural dexmedetomidine with intravenous dexmedetomidine as adjuvant to ropivacaine in supraclavicular brachial plexsus block in respect to onset and duration of block, post operative analgesia,hemodynamic stability, sedation and adverse effect.

## MATERIALS AND METHODS

This is institution-based prospective interventional study carried out at the orthopedic operation theater in NRS Medical College and Hospital, Kolkata, between January 2020 and June 2021.

### Inclusion criteria

Patients of age group between 18 and 60 years of the American Society of Anesthesiologists (ASA) grade 1 and 2 were placed for upper limb surgery.

### Exclusion criteria

(1) 2nd/3rd-degree heart block, (2) Pregnant and lactating females, (3) Hypersensitivity to any drugs used in the study, (4) Patients with respiratory compromise, (5) Patients on anticoagulants, (6) Pneumothorax/pneumonectomy on opposite site, (7) Local infection, (8) Patient refusal.

Preoperative laboratory investigations such as complete hemogram, blood sugar (fasting and post-prandial), urea, creatinine, serum electrolytes, chest X-ray (posterior-anterior view), and ECG of all 12 leads were done.

Sampling design was simple random sampling. Participants were randomly allocated to the groups using "sealed envelope technique". After taking approval from the institutional ethical committee and written informed consent, 60 patients aged between 18 and 60 years of ASA 1 and 2 both sexes were divided into 2 groups.

Group A received 20 mL of 0.5% ropivacaine in brachial plexus block along with 1 μg/kg dexmedetomidine as adjuvant perineurally.

Group B received 20 mL 0.5% ropivacaine in brachial plexus block along with dexmedetomidine infusion intravenously 1 μg/kg in 50 mL normal saline over 10 min.

On arrival in the operation theater holding area after taking informed consent, 18G iv cannula was secured in contralateral forearm and Ringer's lactate was started by infusion at 100 mL/h.

On shifting to operation theater, standard monitors including pulse oxymeter, non-invasive blood pressure, and ECG were attached. Patient baseline vitals were recorded before giving supraclavicular brachial plexus block. Position – The patient was placed in the supine position and head turned to the opposite side. A rolled towel was placed between the shoulders along the spine so as to expose the area properly. The anesthesiologist was at the head end of the table. The patient was asked to lift the head so as to bring the clavicular head of sternocleidomastoid into prominence. The index finger was placed lateral to the muscle and the interscalene groove was palpated. The subclavian artery was palpated in the lower part of the interscalene groove. After aseptic preparation, a skin wheal was raised at this point which is 2–3 cm above

the midpoint and perpendicular to the clavicle with 2 mL lignocaine. The pulsation of the subclavian artery at this point was felt. 0.5 mA current was set in the nerve locator, after that 5 cm nerve locator needle was introduced downward backward and medially and contraction of the muscles of the forearm and hand was noted. After that, in group A, 20 mL 0.5% ropivacaine with 1 μg/kg dexmedetomidine, and in group B, patient 20 mL ropivacaine was given through the nerve locator needle when the current was 0.4 mA. Sensory blockade was tested by pinprick along the distribution of radial, ulnar, and median nerve. Motor blockade was tested by using bromage scale. After confirming adequate sensory and motor blockade, dexmedetomidine infusion was started in group B patient. Parameters including systolic blood pressure, diastolic blood pressure, heart rate (HR), $SpO_2$, Ramsay Sedation Scale were recorded every 5 min for the first 10 min and every 15 min till the end of the surgery. All the surgery was about 1 h of duration. Time of the first rescue analgesic was noted using Visual Analog Scale (VAS) and injection diclofenac 75 mg im was given as rescue analgesic when VAS score exceeded 3 in the postoperative period. In block failure, general anesthesia was given.

### Statistical analysis

Sample size was estimated using the time of the first analgesic request as the main primary variable. On the basis of previous study assuming within group SD of 120 min, we needed to study 30 experimental subjects per group to be able to reject the null hypothesis that the population means of the groups are equal with probability (power) 0.85. Raw data were entered into MS Excel spreadsheet and analyzed using Pearson's Chi-square test. Normally distributed continuous variables were analyzed using ANOVA test. Independent t-test and Chi-square test were used for the comparisons. The P≤0.05 was considered statistically significant.

## RESULTS

There were no significant differences between 2 groups with regard to demographic data such as age, sex, weight, type of surgery, and duration of surgery (Table 1). Table 2 shows the intraoperative HR of the two groups at 5 min interval and their P-value. Onset of sensory block in Group A was 5.2±0.8 (min) which was faster than in Group B which was 13.2±0.8 (min), which is statistically significant (Table 3). Onset of motor block in group A was 9.7±1.0 (min) that was faster than in group B which was 22.7±1.09 (min) and it was also statistically significant (Table 3). As shown in Table 4, mean duration of sensory block in group A was 4.1±0.4 (h) which was prolonged than in group B which was 2.9±0.49 (h). Table 4 shows that the mean duration of motor block in group A was 2.7±0.3 (h) which was prolonged than in group B which was 1.6±0.4 (h) with a significant P-value. Mean duration of analgesia in group A was 10.8±1.2 (h) which was prolonged than in group B which was 6.9±1.2 (h), with a significant P-value as shown in Table 5 and Figure 1. Table 6 and Figure 2 show that 6 patients in group B had Ramsay Sedation Score >3 whereas in group A, 2 patients had sedation score >3.

Table 1 shows no statistically significant difference exists for any parameters between the groups (P>0.05). Hence, the groups were comparable.

**Table 1: Demographic data and surgical characteristics**

| Parameters | Group A (Mean±SD) | Group B (Mean±SD) | P-value |
|---|---|---|---|
| Age (years) | 9.5±7.9 | 4.8±7.4 | 0.77 |
| Weight (kg) | 61.7±5.2 | 60.7±4.9 | 0.219 |
| Sex ratio (male/female) | 18/12 | 17/1 | 0.941 |
| ASA grading (I/II) | 22/8 | 21/9 | 0.662 |
| Type of surgery | | | |
| Lower end of humerus | 10 | 10 | 0.702 |
| Radius | 12 | 1 | |
| Hand | 8 | 7 | |
| Duration of surgery (min) | 50.0±12.0 | 49.5±12.6 | 0.118 |

**Table 2: Comparison of mean heart rate in different time intervals**

| Time intervals | Group A (Mean±SD) | Group B (Mean±SD) | P-value |
|---|---|---|---|
| 5 min | 73.7±6.9 | 68.1±6.4 | 0.015 |
| 10 min | 70.4±7.1 | 62.1±6.4 | 0.004 |
| 15 min | 67.1±7.4 | 58.1±6. | 0.022 |
| 20 min | 64.5±8.7 | 55.4±6. | 0.010 |
| 25 min | 66.8±7.5 | 56.1±6.4 | 0.01 |
| 30 min | 68.3±7.2 | 59.3±6.3 | 0.001 |
| 45 min | 70.5±7.4 | 61.4±7.7 | 0.004 |
| 60 min | 71.7±6.2 | 64.0±7.7 | 0.046 |

**Table 3: Comparison of onset of block between 2 groups using student unpaired t-test is shown below**

| Variables | Group A (Mean±SD) | Group B (Mean±SD) | P-value |
|---|---|---|---|
| Onset of sensory block (min) | 5.2±0.8 | 13.2±0.8 | 0.043 |
| Onset of motor block (min) | 9.7±1.0 | 22.7±1.0 | 0.018 |

**Table 4: Comparison of duration of block between 2 groups using student unpaired t-test is shown below**

| Variables | Group A (Mean±SD) | Group B (Mean±SD) | P-value |
|---|---|---|---|
| Duration of sensory block (h) | 4.1±0.4 | 2.9±0.4 | 0.008 |
| Duration of motor block (h) | 2.7±0.3 | 1.6±0.4 | 0.011 |

**Table 5: Post-operative duration of analgesia in two groups using student unpaired t-test**

| Variable | Group A (Mean±SD) | Group B (Mean±SD) | P-value |
|---|---|---|---|
| Duration of analgesia in hours | 10.8±1.2 | 6.9±1.2 | 0.006 |

**Table 6: Incidence of sedation according to Ramsey sedation score using Chi-square test**

| Variable | Group A | Group B | P-value |
|---|---|---|---|
| Ramsay's sedation score >3 | 2 (6%) | 6 (20%) | 0.001 |

**Table 7 : Comparison of side effects between 2 groups**

| Variables | Group A (%) | Group B (%) | P-value |
|---|---|---|---|
| Hypotension | 3 (10) | 7 (23) | 0.04 |
| Bradycardia | 4 (13) | 11 (36) | 0.003 |
| Respiratory depression | 1 (3) | 2 (6) | 0.241 |
| Nausea and vomiting | 4 (13) | 5 (16) | 0.915 |
| LA toxicity | 0 (0) | 0 (0) | |
| Neurological deficit | 0 (0) | 0 (0) | |

Table 2 shows statistically significant differences (P<0.05) exist for mean HR in all the time intervals between the groups using Student unpaired t-test.

Table 7 shows that statistically significant (P<0.05) exist for hypotension and bradycardia between the groups. Comparison was done between 2 groups using Chi-square test.

## DISCUSSION

In our study, onset of sensory and motor block is faster in perineural dexmedetomidine group than intravenous dexmedetomidine group. Total duration of sensory and motor block is more in perineural dexmedetomidine group than intravenous dexmedetomidine group. Duration of analgesia is also more when adjuvant dexmedetomidine is given in perineural route than intravenous. Over all side effects including sedation is less in perineural dexmedetomidine group compared to intravenous dexmedetomidine group.

In 2010, Esmaoglu et al.,[17] evaluated the effect of adding dexmedetomidine (100 μg) to 0.5% levobupivacaine for axillary blockade. They concluded that with dexmedetomidine, onset time was shortened, duration of motor and sensory block was increased and also the time for first analgesic use. In our study, dexmedetomidine when added as an adjuvant to ropivacaine duration of motor and

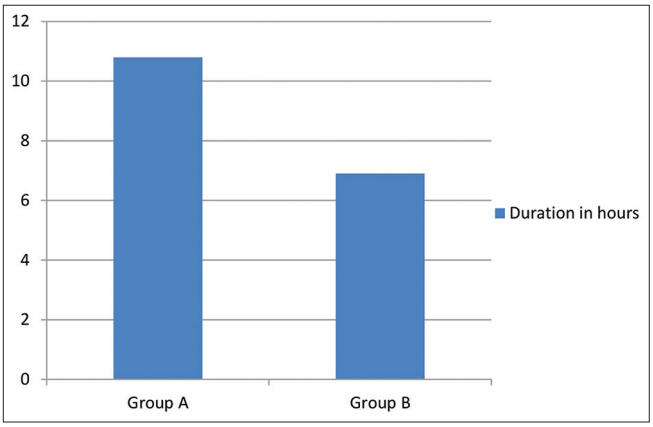


**Figure 1:** Comparison the duration of analgesia of two groups

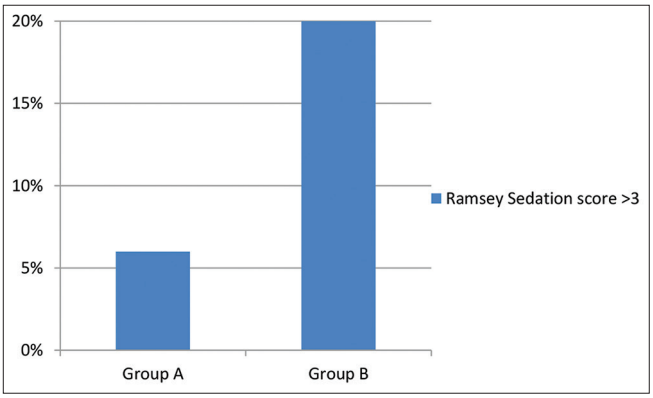


**Figure 2:** Ramsay sedation (score >3) incidence in percentage in the two study groups

sensory block was prolonged. Furthermore, the duration of analgesia was prolonged with better patient satisfaction using VAS scale.

Agarwal et al.,[20] concluded that, dexmedetomidine when added as an adjuvant to bupivacaine in supraclavicular brachial plexus block, the time of onset of the block shortens. The duration of motor and sensory block and postoperative analgesia prolongs significantly. In our study, dexmedetomidine when added as an adjuvant to ropivacaine time of onset of sensory and motor block was shortened and duration of block was prolonged.

Esmaoglu et al.,[17] in their study used 40 mL of 0.5% of levobupivacaine with 100 μg of dexmedetomidine, but we considered 20 mL of 0.5% ropivacaine considering peripheral action of dexmedetomidine. Our study demonstrated that dexmedetomidine reduced dosage of local anesthetics in the peripheral nerve block as instead of using 40 mL of levobupivacaine we used only 20 mL of ropivacaine.

A study done by Kang et al.,[21] showed that i.v. dexmedetomidine at a dose of 2.0 μg/kg significantly increased the duration of analgesia when compared with

0.5 μg/kg, 1 μg/kg, and placebo in patients undergoing arthroscopic shoulder surgery under brachial plexus block. We considered 1 μg/kg of dexmedetomidine in both group A and group B to avoid the difference of results shown in the above studies, but more hemodynamic instability was observed in group B, as dexmedetomidine was given through intravenous route in our study.

In 2019 Somsunder et al.,[22] compared efficacy of perineural dexmedetomidine with intravenous dexmedetomidine as adjuvant to levobupivacaine in supraclavicular brachial plexus block and concluded that i.v. dexmedetomidine is equally effective as compared to perineural dexmedetomidine with respect to onset and duration of block. However, in our study, perineural dexmedetomidine was more efficacious in terms of prolonging the onset and duration of block than i.v. dexmedetomidine as mean duration of sensory block was 4.1 h in group A whereas it was 2.9 h in group B.

Abdallah et al.,[23] demonstrated that both perineural and i.v. dexmedetomidine can effectively prolong the interscalene block duration and reduce opioid consumption without prolonging motor blockade, which was in accordance with our study.

The incidence of hypotension and sedation was more in group B when compared with group A. We administered 1 μg/kg dexmedetomidine infusion over 10 min.[1] Hence, lower dosage and prolonged infusions are advisable in future studies to provide hemodynamic stability without compromising block effect and post-operative analgesia.

Plasma concentration of dexmedetomidine and norepinephrine would have helped to get a clear picture of hemodynamic effects when used along with different routes. We recommend more randomized multicenter study to be considered to know efficacy of i.v. dexmedetomidine when used with different local anesthetics in supraclavicular brachial plexus block.

### Limitations of the study

Limitations of our study were that (1) it was prospective observational study and the possibility of bias cannot be ruled out. (2) The use of ultrasound might have reduced ropivacaine dosage. However, in our institution, there is no availability of ultrasound machine for regional nerve block at our Anaesthesiology Department. (3) Small sample size. (4) Inadequate time period of follow-up.

## CONCLUSION

From the above study, we can conclude that the addition of perineural dexmedetomidine as an adjuvant to ropivacaine in supraclavicular brachial plexus block for upper limb surgery has the following effects, (1) Faster onset of sensory block, (2) faster onset of motor block, (3) longer duration of sensory and motor block, (4) lesser number of rescue analgesics in post-operative period, (5) comfortable sedation intraoperatively without any need for airway assistance.

## ACKNOWLEDGMENT

The authors are acknowledged to the Department of Anaesthesiology and Orthopaedic, NRS Medical College and Hospital, Kolkata-14, West Bengal, India.

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**Authors Contribution:**
**NR-** Literature survey, prepared first draft of manuscript, implementation of study protocol, data collection, data analysis, manuscript preparation and submission of article; **MBM-** Concept, design, clinical protocol, manuscript preparation, editing, and manuscript revision; **MR-** Design of study, statistical analysis, and interpretation; **BKH-** Review manuscript, literature survey, preparation of figures, and coordination.

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**Source of Support:** Nil, **Conflicts of Interest:** None declared.