RESEARCH PAPER

Comparative Evaluation of Dexmedetomidine and Dexamethasone as Adjuvants in Supraclavicular Brachial Plexus Block

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ABSTRACT

Introduction: Supraclavicular brachial plexus block is widely used for upper limb surgeries. Adding adjuvants to local anaesthetics can enhance block characteristics and prolong postoperative analgesia. Dexmedetomidine and dexamethasone are two commonly used adjuvants with distinct pharmacological profiles.

Aim: To compare the effects of dexmedetomidine (0.5 µg/kg) and dexamethasone (8 mg) as adjuvants to 0.5% bupivacaine in supraclavicular brachial plexus block for upper limb surgeries.

Materials and Methods: This randomised, double-blind study was conducted at the Department of Anaesthesiology, Dhiraj Hospital, S.B.K.S. Medical Institute, Vadodara, Gujarat, India (CTRI/2025/08/092384). Sixty ASA grade I-II patients aged 18-65 years scheduled for elective upper limb surgeries were randomly allocated into two groups of 30 each. Group D received 20 mL of 0.5% bupivacaine with dexmedetomidine (0.5 µg/kg) and Group DX received 20 mL of 0.5% bupivacaine with dexamethasone (8 mg) via ultrasound-guided supraclavicular block. Onset and duration of sensory and motor block, duration of analgesia, haemodynamic parameters, sedation scores, and complications were recorded. Data were analysed using unpaired Student's t-test and Chi-square test with $p<0.05$ considered significant.

Results: Group D showed significantly faster onset of sensory block (10.61±2.00 vs 13.37±1.41 min, $p<0.001$) and motor block (12.95±1.97 vs 16.22±1.84 min, $p<0.001$) compared to Group DX. However, Group DX demonstrated significantly longer duration of analgesia (702.57±47.43 vs 600.83±52.92 min, $p<0.001$) and duration of sensory block (564.33±44.63 vs 534.97±38.30 min, $p=0.008$). Duration of motor block was comparable between groups ($p=0.076$). Bradycardia was observed in 33.3% patients in Group D and none in Group DX ($p=0.001$). Sedation scores were significantly higher in Group D ($p<0.001$).

Conclusion: Dexmedetomidine provides faster onset of block whereas dexamethasone offers significantly longer duration of analgesia with a superior safety profile. Dexamethasone may be preferred when prolonged postoperative analgesia is the primary goal.

Keywords: *Adjuvants, Brachial plexus, Bupivacaine, Nerve block, Postoperative analgesia*
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INTRODUCTION

Brachial plexus block is a well-established regional anaesthesia technique for upper limb surgeries, offering advantages over general anaesthesia including reduced stress response, superior intraoperative analgesia, and extended postoperative pain relief [1]. Among various approaches, the supraclavicular brachial plexus block (SCBPB) provides dense anaesthesia with rapid onset due to the compact arrangement of nerve trunks at this level

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[2]. Ultrasound guidance has further improved the accuracy and safety of this technique [3].

To enhance the quality and duration of peripheral nerve blocks, various adjuvants have been explored in combination with local anaesthetics. These include clonidine, dexmedetomidine, dexamethasone, midazolam, neostigmine, and magnesium sulphate [4-7]. The addition of adjuvants aims to hasten the onset, prolong the duration of block and analgesia, and reduce the total dose of local anaesthetic required.

Dexmedetomidine, a highly selective alpha-2 adrenoreceptor agonist, enhances local anaesthetic action through peripheral analgesic mechanisms including hyperpolarisation-activated cation current blockade and vasoconstriction, thereby reducing local anaesthetic absorption [8-10]. Dexamethasone, a long-acting glucocorticoid, prolongs nerve block duration through anti-inflammatory mechanisms, inhibition of potassium channels on nociceptive C-fibres, and local vasoconstriction [11,12]. However, direct comparisons between these two adjuvants in supraclavicular brachial plexus blocks remain limited, particularly in the Indian population.

The present study was designed to compare the block characteristics, postoperative analgesia, and safety profile of dexmedetomidine (0.5 µg/kg) and dexamethasone (8 mg) as adjuvants to 0.5% bupivacaine in supraclavicular brachial plexus block for upper limb surgeries.

MATERIALS AND METHODS

This randomised, double-blind, prospective study was conducted at the Department of Anaesthesiology, Dhiraj Hospital, S.B.K.S. Medical Institute and Research Centre, Sumandeep Vidyapeeth, Vadodara, Gujarat, India, after obtaining approval from the Sumandeep Vidyapeeth Institutional Ethics Committee (SVIEC). The study was registered with the Clinical Trials Registry of India (CTRI/2025/08/092384). Written informed consent was obtained from all participants. The study was conducted in accordance with the Declaration of Helsinki.

Sixty ASA grade I and II patients aged 18-65 years, scheduled for elective upper limb surgeries under supraclavicular brachial plexus block, were enrolled. Patients with local site infection, hypersensitivity to study drugs, coagulation disorders, those on anticoagulants, pregnant or lactating females, patients with pre-existing nerve injury, and those requiring supplementation with other anaesthesia techniques were excluded.

Using computer-generated random numbers, patients were allocated into two groups of 30 each. Group D received 20 mL of 0.5% bupivacaine with dexmedetomidine 0.5 µg/kg, and Group DX received 20 mL of 0.5% bupivacaine with dexamethasone 8 mg. The study drugs were prepared by an anaesthesiologist not involved in the study, and both the operator and the observer were blinded to group allocation.

All blocks were performed using ultrasound guidance (linear probe, 6-13 MHz) with the patient in the supine position with head turned to the opposite side. Standard monitoring including electrocardiogram, non-invasive blood pressure, pulse oximetry, and respiratory rate was established. After skin preparation and local infiltration, the brachial plexus was identified in the supraclavicular fossa, and the study drug was deposited around the nerve trunks under real-time visualisation.

Outcome Measures: The primary outcomes were onset and duration of sensory and motor block. Sensory block was assessed by pinprick test every 2 minutes and motor block was assessed using the modified Bromage scale. Onset of sensory block was defined as time from injection to loss of pinprick sensation, and onset of motor block as time to inability to flex the elbow. Duration of analgesia was defined as time from onset of sensory block to first rescue analgesia request (VAS ≥4). Haemodynamic parameters (heart rate, systolic and diastolic blood pressure, mean arterial pressure, SpO2, respiratory rate) were recorded at baseline and at 0, 5, 10, 15, 30, 60, 90, 120, 150, 180 minutes and then 4, 6, 8, 10, 12, and 14 hours. Sedation was assessed using the Campbell Sedation Score. Complications including bradycardia, hypotension, nausea/vomiting, Horner's syndrome, and pneumothorax were noted.

Statistical Analysis: Sample size was calculated using the formula $n = Z^2P(1-P)/d^2$, yielding 30 per group. Data were analysed using SPSS version 26.0. Continuous variables were expressed as mean ± standard deviation and compared using unpaired Student's t-test. Categorical variables were expressed as frequency and percentage and compared using Chi-square test or Fisher's exact test. A p-value <0.05 was considered statistically significant.

RESULTS

All 60 patients completed the study. Both groups were comparable with respect to age, sex, weight, height, BMI, ASA grade, and duration of surgery (p>0.05) [Table/Fig-1].

[Table/Fig-1]: Demographic and baseline characteristics of study groups.

Parameter	Group D (n=30)	Group DX (n=30)	p-value
Age (years)	43.53±11.98	39.40±12.24	0.201
Sex (M/F)	10/20	11/19	0.787
Weight (kg)	68.56±9.59	64.66±11.17	0.149

ASA (I/II)	24/6	25/5	0.739
Duration of surgery (min)	98.40±35.21	95.67±33.48	0.760

Values expressed as Mean±SD or ratio; p>0.05 – not significant

The onset of sensory block was significantly faster in Group D (10.61±2.00 min) compared to Group DX (13.37±1.41 min) (p<0.001). Similarly, the onset of motor block was significantly faster in Group D (12.95±1.97 min) than Group DX (16.22±1.84 min) (p<0.001) [Table/Fig-2].

The duration of sensory block was significantly longer in Group DX (564.33±44.63 min) compared to Group D (534.97±38.30 min) (p=0.008). The duration of motor block was comparable between the groups (Group D: 477.37±39.94 min vs Group DX: 495.77±38.85 min, p=0.076). The duration of analgesia was significantly longer in Group DX (702.57±47.43 min) compared to Group D (600.83±52.92 min) (p<0.001) [Table/Fig-2].

[Table/Fig-2]: Comparison of block characteristics between the two groups.

Parameter	Group D (n=30)	Group DX (n=30)	p-value
Onset of sensory block (min)	10.61±2.00	13.37±1.41	<0.001*
Onset of motor block (min)	12.95±1.97	16.22±1.84	<0.001*
Duration of sensory block (min)	534.97±38.30	564.33±44.63	0.008*
Duration of motor block (min)	477.37±39.94	495.77±38.85	0.076
Duration of analgesia (min)	600.83±52.92	702.57±47.43	<0.001*

*Values expressed as Mean±SD; *p<0.05 statistically significant*

Haemodynamic parameters were comparable between the two groups at all time points (p>0.05). However, bradycardia was observed in 10 patients (33.3%) in Group D and none in Group DX (p=0.001). Hypotension was not observed in either group. Nausea and vomiting occurred in 3 patients (10%) in Group D and none in Group DX (p=0.237). No patient in either group developed Horner's syndrome, pneumothorax, respiratory depression, or neurological deficit [Table/Fig-3].

[Table/Fig-3]: Comparison of complications between the two groups.

Complication	Group D (n=30)	Group DX (n=30)	p-value
Bradycardia	10 (33.3%)	0 (0%)	0.001*
Hypotension	0 (0%)	0 (0%)	-
Nausea/Vomiting	3 (10%)	0 (0%)	0.237
Horner's syndrome	0 (0%)	0 (0%)	-
Pneumothorax	0 (0%)	0 (0%)	-

*Values expressed as n (%); *p<0.05 statistically significant*

Sedation scores at 30 and 60 minutes were significantly higher in Group D compared to Group DX (p<0.001). The mean Campbell Sedation Score at 30 minutes was 3.07±0.58 in Group D and 1.67±0.48 in Group DX.

DISCUSSION

The present study compared dexmedetomidine and dexamethasone as adjuvants to bupivacaine in supraclavicular brachial plexus block. The principal findings were that dexmedetomidine provided significantly faster onset of both sensory and motor block, whereas dexamethasone produced significantly longer duration of analgesia and sensory block with fewer side effects.

The faster onset observed with dexmedetomidine can be attributed to its alpha-2 adrenoreceptor agonist activity, which enhances local anaesthetic action through direct inhibition of compound action potentials in peripheral nerves and hyperpolarisation-activated cation current blockade [8,10]. Yoshitomi T et al., demonstrated that dexmedetomidine enhances the local anaesthetic action of lidocaine via alpha-2A adrenoreceptor mechanisms [13]. Our finding of faster sensory onset (10.61±2.00 vs

13.37±1.41 min) is consistent with Singh N et al., who reported faster onset of sensory block with dexmedetomidine compared to dexamethasone when used with ropivacaine in supraclavicular blocks [14].

The significantly longer duration of analgesia with dexamethasone (702.57±47.43 vs 600.83±52.92 min, $p<0.001$) is consistent with the meta-analysis by Albrecht E et al., which concluded that dexamethasone prolonged the duration of analgesia by approximately 148 minutes more than dexmedetomidine as a perineural adjunct [15]. Dexamethasone's prolonged action is mediated through inhibition of potassium channels on nociceptive C-fibres, suppression of inflammatory mediator release, and local vasoconstriction reducing anaesthetic absorption [11,12].

Venkatraman R et al., in their study comparing morphine, dexmedetomidine, and dexamethasone as adjuvants to ropivacaine in supraclavicular block, found that the dexamethasone group had the longest duration of postoperative analgesia [16]. Similarly, Hamada M et al., reported that dexamethasone provided longer sensory block duration and analgesia compared to dexmedetomidine in ultrasound-guided supraclavicular block [17]. These findings corroborate our results.

Lee MJ et al., compared dexamethasone 10 mg and dexmedetomidine 100 µg with ropivacaine in axillary brachial plexus block and found that both drugs were equally effective in extending block duration, with no significant difference between them [18]. The discordance with our study may be related to differences in drug doses, local anaesthetic used, and block approach.

Maagaard M et al., in their 2023 systematic review, reported that the combination of dexamethasone and dexmedetomidine provided similar analgesia duration as dexamethasone alone, suggesting that dexamethasone may be the more impactful adjuvant for prolonging analgesia [19]. Li M et al., in their 2022 meta-analysis also supported the use of both adjuvants, noting that dexamethasone tended to provide longer analgesia while dexmedetomidine offered faster onset [20].

The higher incidence of bradycardia (33.3%) in the dexmedetomidine group is a well-recognised side effect attributable to its sympatholytic properties. This finding aligns with Abdallah FW and Brull R, who reported reversible bradycardia in 7% of brachial plexus block patients receiving dexmedetomidine [21]. The higher sedation scores in Group D reflect the systemic sedative effect of dexmedetomidine absorbed from the perineural site. Dexamethasone, lacking such central effects, showed no significant sedation or haemodynamic perturbations.

LIMITATION(S)

The present study was conducted at a single centre with a relatively small sample size of 60 patients. The study evaluated only a single dose of each adjuvant; dose-response relationships were not explored. Long-term neurological outcomes beyond 24 hours were not assessed. The study population was predominantly female, which may limit generalisability. Future multi-centre studies with larger sample sizes and dose-finding designs are recommended.

CONCLUSION(S)

Dexmedetomidine (0.5 µg/kg) as an adjuvant to 0.5% bupivacaine in supraclavicular brachial plexus block provides significantly faster onset of sensory and motor block compared to dexamethasone (8 mg). However, dexamethasone offers significantly longer duration of postoperative analgesia and sensory block with a superior safety profile, including absence of bradycardia and lower sedation. The choice of adjuvant should be guided by clinical priorities: dexmedetomidine for rapid surgical onset and dexamethasone for prolonged postoperative pain relief.

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