



Original Research Article

A COMPARATIVE STUDY OF DEXMEDETOMIDINE AS AN ADJUVANT TO BUPIVACAINE WITH ONLY BUPIVACAINE IN SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK

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ABSTRACT

Background: Single-shot supraclavicular brachial plexus blocks with bupivacaine may provide reliable analgesia for upper-limb surgery, but their duration is limited and onset may be delayed. We aimed to compare the analgesic efficacy of dexmedetomidine as an adjuvant to bupivacaine versus bupivacaine alone with respect to onset and duration of sensory and motor block, sedation score and complications.

Materials and Methods: Sixty adult patients (ASA I/II) undergoing elective upper-limb surgery under supraclavicular brachial plexus block were randomly allocated to receive 0.25 % bupivacaine 40 mL with either normal saline 0.5 mL (Group B) or dexmedetomidine 50 µg (Group D). Onset of sensory and motor block, duration of blocks, sedation score and incidence of complications were recorded.

Results: The dexmedetomidine group demonstrated significantly shorter onset times, prolonged sensory and motor block durations and longer analgesia, higher sedation scores without significant respiratory depression or serious complications.

Conclusion: Dexmedetomidine (50 µg) added to bupivacaine significantly enhances the quality of supraclavicular brachial plexus block, improves analgesia and offers acceptable sedation with minimal side-effects. **Keywords:** dexmedetomidine, bupivacaine, supraclavicular brachial plexus block, analgesia.

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INTRODUCTION

Upper limb surgery increasingly relies on regional anaesthesia techniques such as the supraclavicular approach to the brachial plexus block, offering excellent analgesia, fewer systemic side-effects and faster recovery compared to general anaesthesia. The efficacy of a nerve block however depends largely on the onset time of sensory and motor blockade, the duration of the block, and the time to first rescue analgesic. Local anaesthetics such as bupivacaine are widely used for supraclavicular brachial plexus blocks, but their duration of action remains a

limitation in the context of postoperative pain management. In recent years there has been increasing interest in the use of adjuvants to prolong block duration, improve block quality and reduce analgesic requirements.

Dexmedetomidine is a selective α_2 -adrenoceptor agonist characterised by sedative, anxiolytic, sympatholytic and analgesic-potentiating properties. Its use as a perineural adjuvant in peripheral nerve blocks has been described and meta-analysed; for example, a meta-analysis found that perineural dexmedetomidine significantly prolonged sensory and motor block durations when added to local

anaesthetics in brachial plexus blocks.^[1] Mechanistically, dexmedetomidine is believed to act by hyperpolarising C- and A α /A β -fibres and reducing nerve action potential propagation, as well as via vasoconstriction that may retard local anaesthetic absorption. When added to local anaesthetics such as bupivacaine or ropivacaine, dexmedetomidine may yield earlier onset, prolonged duration, and improved postoperative analgesia.^[2] Several randomised controlled trials have specifically examined the addition of dexmedetomidine to bupivacaine or levobupivacaine in supraclavicular and other brachial plexus blocks. A study adding dexmedetomidine to bupivacaine for supraclavicular brachial plexus block reported significantly shortened onset times and prolonged sensory and motor block durations.^[3] Another trial using 1 μ g/kg dexmedetomidine with 0.25% levobupivacaine demonstrated shortened onset times of sensory and motor blockade and extended analgesia without significant side-effects.^[4] A more recent prospective, double-blinded RCT comparing two doses of dexmedetomidine (50 μ g and 100 μ g) with levobupivacaine in infraclavicular blocks confirmed a dose-dependent prolongation of block duration and analgesia with acceptable sedation scores.^[5]

Despite this growing evidence, the specific context of dexmedetomidine as an adjuvant to bupivacaine in supraclavicular brachial plexus block merits further investigation, especially with standardized volumes of bupivacaine, measurement of both sensory and motor block characteristics, sedation score, and monitoring for complications. For example, a recent randomised controlled trial in supraclavicular blocks compared 1 μ g/kg dexmedetomidine added to 20 mL of 0.5% bupivacaine versus bupivacaine alone and demonstrated superior onset and duration of block in the dexmedetomidine group.^[6] A systematic review and meta-analysis further suggested that while dexmedetomidine improves block duration, the risks of bradycardia, hypotension or sedation must be monitored carefully.^[7]

In addition to block characteristics, sedation score is an important parameter since dexmedetomidine also provides conscious sedation — which may be beneficial but also carries risks of over-sedation or haemodynamic changes. Studies have reported sedation scores in the range of Ramsay 2–3 when dexmedetomidine is used perineurally without clinically significant respiratory depression.^[8] Moreover, the safety profile of perineural dexmedetomidine appears favourable in most trials, but some bradycardia or hypotension has been reported, underscoring the need for vigilant monitoring.^[9]

Given the foregoing, the present study aims to compare the analgesic efficacy of dexmedetomidine as an adjuvant to bupivacaine with only bupivacaine in supraclavicular brachial plexus block with respect to onset and duration of sensory and motor block, sedation score and any complications. This

comparative evaluation will help inform clinical decision-making regarding adjuvant use in upper-limb regional anaesthesia and optimize both block quality and patient safety.^[10]

MATERIALS AND METHODS

This prospective, randomized comparative study was conducted on 60 adult patients of either sex belonging to ASA physical status I or II, scheduled for elective upper limb surgeries under supraclavicular brachial plexus block. After obtaining institutional ethical clearance and informed written consent, patients were randomly allocated into two equal groups of 30 each. Group B received 40 mL of 0.25 % bupivacaine with 0.5 mL of 0.9 % normal saline, whereas Group D received 40 mL of 0.25 % bupivacaine with 0.5 mL (50 μ g) of dexmedetomidine as adjuvant.

All patients underwent a detailed pre-anaesthetic check-up including medical history, general and systemic examination, and routine laboratory investigations such as haemoglobin, blood urea, serum creatinine, random blood sugar, ECG, and chest X-ray. Patients with known allergy to local anaesthetics, bleeding disorders, local infection, neurological deficits, or unwillingness to participate were excluded. Participants were kept nil per oral for six hours before surgery, and standard monitors (ECG, pulse oximetry, and non-invasive blood pressure) were applied intra-operatively. Baseline parameters were recorded before the block and monitored at regular intervals intra- and post-operatively.

The onset and duration of sensory and motor block were evaluated at one-minute intervals after completion of drug injection using a three-point scale. Sensory block was assessed by the pin-prick method over the distribution of the median, ulnar, radial, and musculocutaneous nerves, while motor block was assessed by evaluating thumb and elbow movements. Sedation was assessed using the Chenik sedation score, and pain was evaluated using the Visual Analogue Scale (VAS) during the postoperative period. The duration of analgesia was defined as the time from the end of injection to the first request for rescue analgesia (VAS $\geq$ 5), for which intravenous diclofenac sodium 1.5 mg/kg was administered.

Patients were observed for complications such as hypotension, bradycardia, respiratory depression, nausea, vomiting, hypersensitivity, or signs of local anaesthetic toxicity. Data were analysed using the independent Student's t-test, and results were expressed as mean $\pm$ SD. A p-value $<$ 0.05 was considered statistically significant, while p $<$ 0.001 was taken as highly significant.

RESULTS

In the present study comprising 60 patients undergoing various elective upper limb surgeries

under supraclavicular brachial plexus block, two groups were compared — Group B receiving 0.25 % bupivacaine alone and Group D receiving dexmedetomidine (50 µg) as an adjuvant to 0.25 % bupivacaine. The demographic data were statistically comparable between the groups as shown in [Table 1]. Both groups were similar in terms of mean age, body weight, gender distribution, and ASA physical status, indicating that the baseline characteristics were evenly matched. The mean age in Group B was 36.87 ± 10.4 years and in Group D 37.20 ± 9.8 years ($p = 0.89$). Similarly, the mean weight was 61.26 ± 8.1 kg in Group B and 60.78 ± 7.9 kg in Group D ($p = 0.83$). The comparable baseline parameters eliminated demographic bias, allowing a valid comparison of drug efficacy.

The onset of sensory and motor blockade is presented in [Table 2]. A significantly faster onset was observed in the dexmedetomidine group compared to bupivacaine alone. The mean onset of sensory block was 8.32 ± 1.61 minutes in Group B and 5.74 ± 1.27 minutes in Group D ($p < 0.001$), while the mean onset of motor block was 12.14 ± 2.01 minutes in Group B and 8.65 ± 1.83 minutes in Group D ($p < 0.001$). The addition of dexmedetomidine markedly hastened both sensory and motor onset, attributable to its synergistic α_2 -agonistic action that augments local anaesthetic conduction blockade and potentiates neural hyperpolarization.

[Table 3] illustrates the duration of sensory block, motor block, and postoperative analgesia. The duration of sensory block was significantly prolonged in the dexmedetomidine group (517.80 ± 56.4 minutes) compared to the bupivacaine group (319.47 ± 42.8 minutes, $p < 0.001$). Similarly, motor block lasted longer in Group D (451.13 ± 49.6 minutes) than in Group B (280.16 ± 38.9 minutes, $p < 0.001$). The total duration of analgesia was also markedly extended in Group D (611.27 ± 63.2 minutes) versus Group B (355.40 ± 41.3 minutes, $p < 0.001$). These findings demonstrate the analgesic-potentiating

effect of dexmedetomidine when used as a perineural adjuvant, leading to both longer sensory blockade and prolonged pain-free intervals, thereby minimizing postoperative analgesic requirement.

The sedation profile assessed using the Chenik sedation score is shown in [Table 4]. In Group B, most patients remained fully awake (score 0 = 73.3 %), while in Group D, a higher proportion achieved light to moderate sedation (score 1 = 56.7 % and score 2 = 20 %). The mean sedation score in Group D (0.97 ± 0.66) was significantly higher than in Group B (0.27 ± 0.45 , $p < 0.001$). Patients receiving dexmedetomidine exhibited calmness and comfort without respiratory depression, reflecting the desirable sedative property of α_2 -agonists. Controlled sedation during regional blocks contributes to enhanced patient satisfaction and intraoperative cooperation.

The incidence of complications is summarized in [Table 5]. Adverse events were minimal in both groups, confirming the safety of the technique. In Group D, transient bradycardia occurred in 6.7 % and mild hypotension in 3.3 %, both easily managed with standard interventions. Nausea and vomiting were reported in 6.7 % of Group B and 10 % of Group D patients, showing no statistical significance. No patient developed respiratory depression, hypersensitivity, or local anaesthetic toxicity in either group. Thus, dexmedetomidine as an adjuvant demonstrated an excellent safety profile with negligible complications, reinforcing its clinical applicability in peripheral nerve blocks.

Overall, the results affirm that dexmedetomidine, when combined with bupivacaine, significantly shortens the onset time, prolongs the duration of sensory and motor blockade, enhances postoperative analgesia, and provides mild sedation without major adverse effects. This combination therefore improves block quality and patient comfort, supporting its routine use in supraclavicular brachial plexus block for upper limb surgeries.

Table 1: Demographic Profile of Patients

Parameter	Group B (Mean $\pm$ SD)	Group D (Mean $\pm$ SD)	p value
Age (years)	36.87 ± 10.4	37.20 ± 9.8	0.89
Weight (kg)	61.26 ± 8.1	60.78 ± 7.9	0.83
Sex (M/F)	18/12	17/13	0.79
ASA Grade I/II	20/10	21/9	0.67

Table 2: Onset of Sensory and Motor Block

Parameter	Group B (Mean $\pm$ SD) min	Group D (Mean $\pm$ SD) min	p value
Onset of Sensory Block	8.32 ± 1.61	5.74 ± 1.27	< 0.001 (H.S.)
Onset of Motor Block	12.14 ± 2.01	8.65 ± 1.83	< 0.001 (H.S.)

Table 3: Duration of Sensory, Motor Block and Analgesia

Parameter	Group B (Mean $\pm$ SD) min	Group D (Mean $\pm$ SD) min	p value
Duration of Sensory Block	319.47 ± 42.8	517.80 ± 56.4	< 0.001 (H.S.)
Duration of Motor Block	280.16 ± 38.9	451.13 ± 49.6	< 0.001 (H.S.)
Duration of Analgesia	355.40 ± 41.3	611.27 ± 63.2	< 0.001 (H.S.)

Table 4: Comparison of Sedation Scores (Chenik Score)

Sedation Score	Group B (n = 30)	Group D (n = 30)
0 (Awake)	22 (73.3 %)	7 (23.3 %)
1 (Sleep comfortable, easily arousable)	8 (26.7 %)	17 (56.7 %)

2 (Deep sleep but arousable)	0	6 (20 %)
Mean $\pm$ SD	0.27 $\pm$ 0.45	0.97 $\pm$ 0.66
p value	< 0.001 (H.S.)	

Table 5: Incidence of Complications

Complication	Group B (n = 30)	Group D (n = 30)
Hypotension	0 (0 %)	1 (3.3 %)
Bradycardia	0 (0 %)	2 (6.7 %)
Nausea/Vomiting	2 (6.7 %)	3 (10 %)
Respiratory Depression	0 (0 %)	0 (0 %)
Local Anaesthetic Toxicity	0 (0 %)	0 (0 %)

DISCUSSION

In this study the addition of dexmedetomidine to bupivacaine in supraclavicular brachial plexus block resulted in marked improvements in block characteristics, consistent with emerging evidence on the role of perineural α_2 -adrenoceptor agonists. A meta-analysis of randomized clinical trials demonstrated that the addition of dexmedetomidine to local anaesthetics in brachial plexus blocks significantly prolongs both sensory and motor blockade, and extends the time to first rescue analgesia, albeit with a modest increase in risk of bradycardia and hypotension.^[11] More recent work has confirmed that when used perineurally rather than systemically, dexmedetomidine accelerates onset of sensory and motor blocks and prolongs duration of analgesia in supraclavicular approaches.^[12] In one randomized controlled trial comparing two doses of dexmedetomidine (50 μ g vs 100 μ g) added to levobupivacaine in infraclavicular blocks (a comparable setting) the higher dose produced significantly longer block duration but also increased sedation and haemodynamic changes, highlighting the need for dose-optimisation.^[13] Importantly, in a recent study using dexmedetomidine with bupivacaine specifically in supraclavicular block, investigators reported faster onset times and prolonged durations of sensory/motor block with stable haemodynamics and acceptable sedation scores.^[14] The mechanistic rationale is that dexmedetomidine may act by hyperpolarising nerve fibres and reducing C-fibres excitability, as well as via local vasoconstriction slowing anaesthetic absorption, thereby enhancing block efficacy.^[15] In our current work the results echo these findings: the adjuvant group demonstrated significantly shorter onset times, longer durations of sensory and motor block, extended analgesia, improved sedation profiles, and negligible complications compared to bupivacaine alone. The consistent demographic baseline between groups further strengthens the validity of these findings. Moreover, the absence of major adverse events supports the safety of low-dose dexmedetomidine when used adjunctively in a peripheral nerve block. These results support the proposition that perineural dexmedetomidine is a valuable adjuvant in supraclavicular brachial plexus block, enhancing anaesthetic quality and analgesic duration without compromising patient safety. Future studies might focus on refining optimal dosing,

delineating differential effects on sedation versus block quality, and assessing long-term outcomes including functional recovery and patient-reported satisfaction.

CONCLUSION

The study confirms that adding dexmedetomidine (50 μ g) to bupivacaine (0.25% 40 mL) for supraclavicular brachial plexus block significantly improves onset, extends duration of sensory and motor block, enhances postoperative analgesia and provides acceptable sedation with minimal complications. This adjuvant technique offers a simple, effective enhancement of block quality for upper-limb surgery. Clinical incorporation of dexmedetomidine as an adjunct merits strong consideration for routine use, while attention to dosing and monitoring remains important.

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