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Original Research Article

Efficacy of Dexmedetomidine as an Adjuvant in Brachial Plexus Block by Supraclavicular Approach with 0.25% Bupivacaine

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Abstract

Introduction: Regional anaesthesia is widely used for upper limb surgeries due to its ability to provide excellent intraoperative anaesthesia, superior postoperative analgesia, and faster recovery. Among brachial plexus blocks, the supraclavicular approach is preferred for its rapid onset and reliable dense block. Bupivacaine, though effective, has a delayed onset and limited analgesic duration. Dexmedetomidine, a selective α2-adrenergic agonist, has emerged as a promising adjuvant that can enhance block quality, prolong analgesia, and provide hemodynamic stability. This study aimed to evaluate the efficacy of dexmedetomidine as an adjuvant to 0.25% bupivacaine in supraclavicular brachial plexus block.

Materials and Methods: This prospective, randomized, comparative study was conducted at Mamata Medical College, Khammam, from July 2024 to July 2025, including 100 ASA I–II patients undergoing elective upper limb surgeries. Group B received 30 mL of 0.25% bupivacaine, and Group BD received 30 mL of 0.25% bupivacaine with dexmedetomidine 1 µg/kg. Onset and duration of sensory and motor block, duration of postoperative analgesia, rescue analgesic requirement, hemodynamic parameters, and adverse events were recorded. Data were analyzed using t-test and Chi-square test, with $p<0.05$ considered significant.

Results: Group BD demonstrated a significantly faster onset of sensory and motor block, prolonged block duration, and longer postoperative analgesia with fewer rescue analgesics ($p<0.001$). Hemodynamic parameters were stable with mild, clinically insignificant MAP reduction. Sedation was more frequent but well tolerated.

Conclusion: Dexmedetomidine significantly enhances block characteristics and postoperative analgesia without major adverse effects, making it an effective adjuvant to bupivacaine for supraclavicular brachial plexus block.

Keywords: Supraclavicular brachial plexus block, Dexmedetomidine, Postoperative analgesia.

Introduction

Regional anaesthesia has become an increasingly preferred technique for upper limb surgeries due to its ability to provide effective intraoperative anaesthesia, superior postoperative analgesia, early mobilization, and reduced requirement for systemic opioids [1,2]. Among the various approaches for brachial plexus block, the supraclavicular approach is considered highly reliable as it provides dense anaesthesia of the upper limb with rapid onset and high success rate [3,4]. Bupivacaine, a long-acting local anaesthetic, is frequently used for peripheral nerve blocks; however, its relatively slow onset and limited duration of postoperative analgesia have prompted the use of adjuvants to enhance block characteristics [5,6]. Dexmedetomidine, a highly selective alpha-2 adrenergic receptor agonist, has gained attention as an effective adjuvant to local anaesthetics in regional anaesthesia [7]. Its use has

been shown to shorten the onset time of sensory and motor blockade, prolong the duration of analgesia, and improve patient comfort without significant adverse effects [8]. The sedative, analgesic, and sympatholytic properties of dexmedetomidine make it particularly attractive for use in peripheral nerve blocks, where prolonged pain relief and hemodynamic stability are desirable [9,10]. Several studies have evaluated dexmedetomidine as an adjuvant in various approaches of brachial plexus block and have reported favourable outcomes [11-13]. However, there is still variability in reported results regarding its efficacy, onset and duration of block, and hemodynamic profile, especially when used with lower concentrations of local anaesthetic agents. Further research is needed to strengthen the evidence and establish optimal dosing and safety in clinical practice. Therefore, the present study was conducted to evaluate the efficacy of dexmedetomidine as an adjuvant to 0.25% bupivacaine in supraclavicular brachial plexus block with respect to onset and duration of sensory and motor block, duration of postoperative analgesia, hemodynamic stability, and incidence of adverse events.

Materials and Methods

This prospective, randomized, comparative study was conducted in the Department of Anaesthesiology at Mamata Medical College, Khammam, from July 2024 to July 2025. Ethical approval was obtained from the Institutional Ethics Committee prior to initiation of the study, and written informed consent was obtained from all participants. A total of 100 adult patients of either sex, aged between 18 and 60 years, belonging to the American Society of Anaesthesiologists (ASA) physical status I or II and scheduled for elective upper limb surgeries under brachial plexus block were enrolled.

Patients with a history of hypersensitivity to local anaesthetics, coagulopathy, infection at the injection site, pre-existing neurological deficits, severe cardiopulmonary disorders, baseline bradycardia (heart rate <50 beats per minute), or those receiving alpha-2 adrenergic agonists or antagonists were excluded from the study. Patients unwilling to participate were also excluded. Participants were randomly assigned into two equal groups of 50 each using a computer-generated randomization sequence. Group B received 30 mL of 0.25% bupivacaine, whereas Group BD received 30 mL of 0.25% bupivacaine with dexmedetomidine 1 µg/kg as an adjuvant. The supraclavicular brachial plexus block was performed under strict aseptic precautions using a peripheral nerve stimulator. After drug administration, the onset of sensory and motor blockade was assessed at regular intervals until complete block was achieved. Intraoperative hemodynamic parameters including heart rate and mean arterial pressure were monitored continuously.

The primary outcomes measured were the onset and duration of sensory and motor block. Secondary outcomes included the duration of postoperative analgesia, rescue analgesic requirement within the first 24 hours, intraoperative hemodynamic stability, and incidence of adverse events such as bradycardia, hypotension, sedation, nausea, and vomiting. Sensory block was assessed by the pinprick method, while motor block was evaluated using a modified Bromage scale. Hemodynamic parameters were recorded at baseline, at 10, 30, and 60 minutes after the block, and hourly thereafter until the end of surgery. All data were entered in Microsoft Excel and analyzed using IBM SPSS version 27. Quantitative variables were expressed as mean ± standard deviation and compared using the independent sample t-test. Categorical variables were expressed as frequency and percentage and compared using the Chi-square test. A p-value of less than 0.05 was considered statistically significant.

Results

Both groups were comparable with respect to demographic characteristics. There was no statistically significant difference between Group B and Group BD in terms of age, gender distribution, weight, ASA physical status, or duration of surgery, indicating that the two groups were homogeneous and comparable at baseline (Table 1).

Table 1: Demographic Characteristics

Parameter	Group B (n=50)	Group BD (n=50)	p-value
Age (years)	37.8 ± 10.2	38.6 ± 9.8	0.68
Gender (M/F)	32 / 18	30 / 20	0.68
Weight (kg)	64.3 ± 8.5	65.1 ± 9.2	0.64
ASA Grade I / II	28 / 22	30 / 20	0.69
Duration of Surgery (min)	72.5 ± 15.3	74.8 ± 16.0	0.52

The addition of dexmedetomidine significantly improved block characteristics. Group BD demonstrated a faster onset of both sensory (5.3 ± 0.9 min) and motor (7.1 ± 1.1 min) block when

compared to Group B (7.6 ± 1.2 min and 10.2 ± 1.4 min, respectively; $p < 0.001$).

Furthermore, the duration of sensory and motor block was markedly prolonged in Group BD (640.3 ± 56.2 min and 610.7 ± 50.1 min) compared to Group B (460.8 ± 48.6 min and 430.5 ± 42.3 min), with results being statistically significant ($p < 0.001$) (Table 2).

Table 2: Onset and Duration of Sensory and Motor Block

Parameter	Group B (n=50)	Group BD (n=50)	p-value
Onset of Sensory Block (min)	7.6 ± 1.2	5.3 ± 0.9	<0.001
Onset of Motor Block (min)	10.2 ± 1.4	7.1 ± 1.1	<0.001
Duration of Sensory Block (min)	460.8 ± 48.6	640.3 ± 56.2	<0.001
Duration of Motor Block (min)	430.5 ± 42.3	610.7 ± 50.1	<0.001

The duration of postoperative analgesia was significantly prolonged in Group BD (780.6 ± 72.8 min) compared to Group B (510.4 ± 60.5 min), resulting in fewer rescue analgesic requirements within the first 24 hours (1.2 ± 0.5 vs 2.6 ± 0.8, $p < 0.001$). This finding highlights the superior analgesic profile of dexmedetomidine when used as an adjuvant (Table 3).

Table 3: Duration of Analgesia and Rescue Analgesic Requirement

Parameter	Group B (n=50)	Group BD (n=50)	p-value
Duration of Analgesia (min)	510.4 ± 60.5	780.6 ± 72.8	<0.001
Number of Rescue Analgesics (24 h)	2.6 ± 0.8	1.2 ± 0.5	<0.001

Hemodynamic parameters were stable in both groups throughout the study period. While there was no significant difference at baseline and 10 minutes after block, a mild but statistically significant reduction in mean arterial pressure was noted in Group BD at 30 minutes ($p = 0.03$) and 60 minutes ($p = 0.04$) post-block.

These changes were clinically well tolerated and did not necessitate intervention (Table 4).

Table 4: Hemodynamic Parameters (Mean Arterial Pressure)

Time Interval	Group B (mmHg)	Group BD (mmHg)	p-value
Baseline	94.5 ± 6.8	95.1 ± 6.3	0.72
10 min after block	92.8 ± 6.1	91.2 ± 5.8	0.18
30 min after block	92.2 ± 5.9	89.5 ± 5.6	0.03
60 min after block	91.6 ± 5.7	88.9 ± 5.5	0.04

Adverse events were infrequent and comparable between groups. Bradycardia and hypotension occurred more often in Group BD, though the difference was not statistically significant. Sedation (RASS ≤ –2) was significantly higher in Group BD (8%, $p = 0.04$), but was clinically acceptable and did not require intervention. Nausea and vomiting were comparable between groups (Table 5).

Table 5: Adverse Events

Adverse Event	Group B (n=50)	Group BD (n=50)	p-value
Bradycardia	0 (0%)	3 (6%)	0.08
Hypotension	1 (2%)	2 (4%)	0.56
Nausea/Vomiting	4 (8%)	3 (6%)	0.69
Sedation (RASS ≤ –2)	0 (0%)	4 (8%)	0.04

Discussion

The present study demonstrated that adding dexmedetomidine to 0.25% bupivacaine in supraclavicular brachial plexus block significantly shortened the onset of sensory and motor blockade and markedly prolonged their duration compared to bupivacaine alone. Our finding of faster onset (sensory ~5.3 min vs. ~7.6 min; motor ~7.1 min vs. ~10.2 min) is consistent with several prior studies. Sane S et al. reported that the addition of dexmedetomidine to bupivacaine resulted in significantly reduced onset times for both sensory and motor block, comparable to our results [14]. Similarly, a meta-analysis by Ping et al., which pooled data from multiple brachial plexus block studies, reported a weighted mean difference in onset of sensory block of −3.34 minutes (95% CI −4.61 to −2.07) and motor block of −4.26 minutes (95% CI −5.64 to −2.89) with dexmedetomidine use [15].

Our study also observed a substantially longer duration of sensory (~640 min) and motor (~610 min) block in the dexmedetomidine group, corroborating findings from previous literature that

consistently report prolongation of block duration with dexmedetomidine as an adjuvant. The meta-analysis by Ping et al. demonstrated that dexmedetomidine prolonged sensory block duration by approximately 282 minutes on average [15]. Similarly, an RCT adding dexmedetomidine to ropivacaine for interscalene block reported median block durations of approximately 18 hours in the dexmedetomidine group compared to 14 hours in controls [16].

While differences in drug concentrations, block approach, and definitions of block duration exist across studies, the overall trend of significant prolongation remains consistent. The prolonged duration of postoperative analgesia (~780 min vs. ~510 min) and reduced rescue analgesic requirements observed in our study further emphasize the analgesic benefit of dexmedetomidine.

These findings are in agreement with the meta-analysis by Ping et al., which reported a weighted mean difference of 266 minutes in analgesia duration in favor of dexmedetomidine [15]. Sane S et al. also found fewer rescue analgesic requirements in patients receiving dexmedetomidine-augmented bupivacaine blocks [14].

With respect to hemodynamics, we observed mild but statistically significant decreases in mean arterial pressure at 30 and 60 minutes in the dexmedetomidine group. These changes were clinically well tolerated and did not necessitate major intervention. Similar hemodynamic effects have been reported in other studies, with mild bradycardia and hypotension being common but usually not clinically significant when patients are appropriately monitored. The meta-analysis by Ping et al. also reported increased odds of bradycardia and hypotension with perineural dexmedetomidine [15]. Adverse events in our study were minimal, with a significantly higher incidence of sedation (RASS ≤ -2) in the dexmedetomidine group (8%) but no major hemodynamic instability or respiratory compromise. This is consistent with previous reports indicating that sedation is one of the more frequent side effects of dexmedetomidine, though it is typically not harmful. For instance, in a study on perineural dexmedetomidine in axillary brachial plexus block, patients experienced deeper sedation without significant hemodynamic or respiratory complications [17].

Our study has certain limitations. Variability in the concentration of local anesthetic, patient population, and definition of block onset and duration across studies may limit direct comparison with previously published results. The use of 0.25% bupivacaine in our study, which is a lower concentration compared to some other trials, may restrict generalizability to settings where higher concentrations or alternative anesthetics are used. Additionally, adverse events were monitored only during the intraoperative and early postoperative period (24 h), and long-term safety outcomes such as delayed neurological effects were not assessed.

Conclusion

The addition of dexmedetomidine to 0.25% bupivacaine in supraclavicular brachial plexus block significantly shortened the onset of sensory and motor blockade, prolonged the duration of block and postoperative analgesia, and reduced rescue analgesic requirements without causing major hemodynamic instability or serious adverse events. These findings support the use of dexmedetomidine as an effective and safe adjuvant to bupivacaine for enhancing the quality and duration of supraclavicular brachial plexus block in upper limb surgeries.

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