Section: Anaesthesiology

Original Research Article

COMPARISON OF VARYING DOSES OF DEXMEDETOMIDINE AS AN ADJUVANT TO BUPIVACAINE IN ULTRASOUND GUIDED SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK

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ABSTRACT

Background: Ultrasound (USG)-guided supraclavicular brachial block (SCB) is widely used for upper limb surgeries due to its effectiveness and safety. Dexmedetomidine, a selective α_2-adrenergic agonist, is used as an adjuvant to Bupivacaine for enhancing the block quality and prolonging analgesia. **Materials and Methods:** This prospective randomised double-blinded study was conducted on 60 patients aged 18–60 years and scheduled for elective upper limb surgeries. They were randomly assigned into two equal groups. BD0.5 received 0.5 µg/kg and BD1 received 1 µg/kg dexmedetomidine, both added to 19 ml of 0.25% bupivacaine and were administered under USG guidance. Sensory block was evaluated using a 3-point pinprick scale, motor block by the Modified Bromage scale, and sedation by the Ramsay sedation score. Hemodynamic parameters were recorded at regular intervals. The time to first rescue analgesia with IV tramadol 50 mg was noted. **Result:** The BD1 group showed significantly faster onset of sensory block (6.40 ± 0.81 min) and motor block (11.67 ± 2.40 min) compared to BD0.5 (8.87 ± 1.01 min and 17.50 ± 2.54 min, respectively, $p < 0.0001$). The duration of sensory (872.00 ± 40.12 min) and motor block (773.00 ± 43.64 min) and time to first analgesic request (903.17 ± 39.01 min) were also longer in BD1 versus BD0.5 (743.00 ± 42.92 min, 664.00 ± 42.96 min, and 770.50 ± 48.00 min respectively; $p < 0.0001$). Sedation scores were higher in BD1 at 30 and 45 minutes (1.7 ± 0.47 and 2.0 vs 1.0 and 1.5 ± 0.51, $p < 0.0001$). Hemodynamic and respiratory variables remained stable. Bradycardia was seen in two BD1 patients ($p = 0.15$). **Conclusion:** Dexmedetomidine at 1 µg/kg as an adjuvant to bupivacaine significantly improves block characteristics and postoperative analgesia without major adverse effects, supporting its clinical utility in SCB.

INTRODUCTION

The effective management of pain is an important part of recent surgical practices. Anaesthesia procedures like nerve blocks play an important role in achieving this goal, especially for surgeries involving the upper. The supraclavicular block (SCB), focusing on the brachial plexus nerves located at the base of the neck, provides a reliable and safe anaesthesia technique and analgesia in the arm, forearm, wrist, and hand.[1] The SCB targets the brachial plexus by placing local anaesthetic close to the nerve bundle with the help of ultrasound (USG) guidance. This method efficiently anaesthetises the entire upper limb.[2] It is widely used for different types of upper limb surgeries, such as fracture fixation, joint-related procedures like arthroscopy, soft tissue repairs, and for providing relief from long-term pain conditions.[3]

Using USG guidance instead of traditional landmark-based methods offers several benefits. It allows the operator to see the nerves, nearby blood vessels, and other important structures, which helps reduce the chances of complications such as nerve damage, puncturing the wrong vessel, or causing a collapsed lung. The USG support also helps in guiding the needle accurately to the target area, making sure the anaesthetic spreads properly. As a result, the block

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sets in more quickly. Additionally, the precision of the delivery of the drug made under USG makes the nerve block more reliable and effective overall.[4]

Local anaesthetics, when used alone for supraclavicular brachial plexus blocks, offer effective intraoperative anaesthesia but are limited by a shorter duration of postoperative pain relief.[5] Bupivacaine, a commonly used agent for this block, is effective; however, a single-shot technique may not provide adequate coverage for extended postoperative pain. Although continuous catheter techniques can prolong analgesia, they are associated with increased risks of infection and added procedural complexity.[6] To enhance block quality and duration, various adjuvants such as opioids, clonidine, dexamethasone, midazolam, and fentanyl are often combined with local anaesthetics to produce a faster onset, denser block, and prolonged analgesic effect.[5]

A highly selective α-adrenergic agonist, dexmedetomidine has become well-known as a useful adjuvant for peripheral nerve blocks. Without resulting in serious complications, it has been demonstrated to shorten the onset time and considerably extend the duration of both sensory and motor blocks.[7] Randomised controlled trials have demonstrated that perineural injection at 0.5–1 µg/kg doses of dexmedetomidine can extend postoperative analgesia by approximately 5 to 7 hours when compared to bupivacaine alone, with only mild, manageable side effects such as bradycardia and sedation.[8] In contrast, other adjuvants like clonidine and midazolam are generally less effective than dexmedetomidine and have been associated with more serious adverse effects, including arterial hypotension, profound sedation, and potential neurotoxicity.[9]

Although dexmedetomidine is highly effective with a favourable safety profile, existing research on its efficacy across different dosing regimens remains limited. Therefore, the present study was undertaken to evaluate and compare the effects of varying doses of dexmedetomidine as an adjuvant to bupivacaine in patients undergoing elective upper limb surgeries under USG-guided SCB.

Objectives

The study's main goal is to determine how long pain relief lasts. Measuring hemodynamic stability, side effects, and the onset and duration of sensory and motor block are secondary goals.

MATERIALS AND METHODS

This prospective randomised double-blinded study was conducted on 60 patients posted for elective upper limb surgery under USG-guided SCB, at Mahatma Gandhi Memorial Government Hospital, Trichy, for 20 months.

Inclusion Criteria

Patients included were aged between 18 and 60 years, had a body mass index ranging from 17 to 35 kg/m², belonged to ASA physical status I or II, and were scheduled for elective upper limb surgeries.

Exclusion Criteria

Patients who refused the block, had a history of bleeding disorders, systemic or local infections, respiratory, hepatic, renal, or cardiac diseases, or had a known allergy to the study medications were not allowed to participate. Those with peripheral neuropathy, neurological deficits, psychiatric conditions, seizure disorders, substance abuse, chronic pain disorders, or who were pregnant or breastfeeding were also not included.

Sample size: The sample size was calculated using the following formula: $n = t2^* [p(1-p)]/[m2]$, in which $t = 1.96$, $p = 0.15$ and $m = 0.1$. Thus, providing $n = 24$, which is rounded off to 30 in each group.

Methods

A total of 60 patients were randomly divided into two groups of 30 each. Using computer-generated randomisation, patients were assigned to their respective groups. Group BD 0.5 received 19 ml of 0.25% bupivacaine with 0.5 µg/kg of dexmedetomidine diluted in 1 ml of distilled water, while Group BD 1 received the same volume of bupivacaine with 1 µg/kg of dexmedetomidine in 1 ml of distilled water. All patients were evaluated in the pre-anaesthetic clinic a day before surgery, with detailed assessment of cardiovascular, respiratory, and nervous systems, along with airway examination and baseline investigations. Prior to surgery, all patients were required to fast for eight hours. Two hours prior to the procedure, oral ranitidine 50 mg and metoclopramide 10 mg were administered as premedication.

The drugs were prepared by an independent observer, and both the patients and the administering anaesthetist were blinded to group allocation. Bupivacaine 0.5% (9.5 ml) was diluted with distilled water to make 19 ml of 0.25% solution, and dexmedetomidine was added to achieve a final volume of 20 ml. In the operating theatre, IV access was secured on the opposite limb, and crystalloid infusion was started; monitors (MINDRAY Imec 10) were connected to record baseline vitals.

Patients were placed in a supine position with their ipsilateral arm adducted and their head turned away from the side that needed to be blocked. A 22-G Teflon-coated needle was used to perform an USG-guided SCB while adhering to aseptic protocols. At regular intervals, sensory and motor blocks were evaluated using the modified Bromage scale and the pinprick method, respectively. The grades for both blocks ranged from 0 to 2. The period of time between a drug injection and total sensory or motor loss was known as the "onset of block" (Grade 2). Patients showing incomplete block after 30 minutes were excluded and managed under general anaesthesia. Vital parameters, including heart rate, blood pressure, oxygen saturation, respiratory rate, and Ramsay sedation score, were monitored at intervals up to 180 minutes. Sedation was graded from 1 to 6 based on the patient's responsiveness.

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After obtaining Grade 2 sensory and motor block, surgery began. Adverse effects, including bradycardia, hypotension, respiratory depression, nausea, and vomiting, were monitored in the patients. Intravenous atropine at a dose of 20 µg/kg was used to treat bradycardia, which is defined as a heart rate below 50 bpm. Patients were moved to the post-anesthesia care unit at the conclusion of the procedure, and the length of the surgery was noted. Intravenous tramadol 50 mg was given as rescue analgesia after the time it took to request analgesia was recorded.

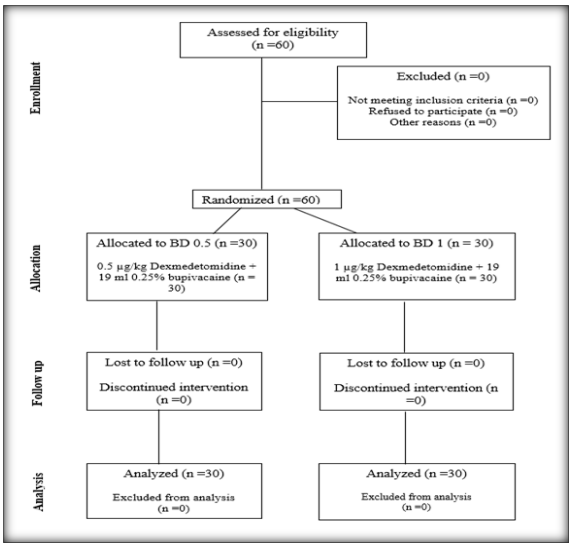

Figure 1: Consort Diagram

Statistical Analysis

IBM SPSS Statistics (version 25) was used to analyse the data. The mean and standard deviation were used to display quantitative variables. The Chi-square test was used to analyse categorical data. In a two-tailed test, significance was defined as $p < 0.05$.

Ethical Considerations

The Institutional Ethics Committee (IEC) granted approval for this study, and all patients signed written informed consent before taking part. The study adhered to ethical guidelines for clinical research.

RESULTS

The BD 0.5 and BD 1 groups did not differ significantly in baseline characteristics such as age, height, weight, BMI, and length of surgery ($p > 0.05$). The BD 0.5 group had a higher number of females compared to males (16 vs 14), whereas the BD 1 group had more males than females (21 vs 9). However, this difference was not significant ($p = 0.067$). The ASA physical status I and II were similar in both groups (20 vs 19 and 10 vs 11 for BD 0.5 and 1, $p = 0.787$).

The onset of sensory and motor block was faster in the BD 1 group (6.40 ± 0.81 min and 11.67 ± 2.40 min, respectively) compared to the BD 0.5 group (8.87 ± 1.01 min and 17.50 ± 2.54 min), with $p < 0.0001$. There was also a significant difference in the duration of sensory and motor block between the BD 1 group (872.00 ± 40.12 min and 773.00 ± 43.64 min) and the BD 0.5 group (743.00 ± 42.92 min and 664.00 ± 42.96 min) ($p<0.0001$). Similarly, the time to first analgesic requirement was extended in the BD 1 group (903.17 ± 39.01 min) versus the BD 0.5 group (770.50 ± 48.00 min), with a significant difference ($p<0.0001$).

Additionally, the BD 1 group had higher sedation scores at 30 and 45 minutes (1.7 ± 0.47 and 2) than the BD 0.5 group (1 and 1.5 ± 0.51), with $p < 0.0001$ throughout. In the BD 1 group, bradycardia was seen in two patients, but there was no significant difference ($p = 0.15$). (Table 1).

Table 1: Comparison of demographic data, block characteristics, analgesia duration, and sedation scores between groups

Parameters	Group		P-value
	BD 0.5	BD 1	
Age (years)	40.37 ± 10.52	41.97 ± 9.06	0.53
Height (m)	1.62 ± 0.06	1.63 ± 0.06	0.54
Weight (kg)	71.30 ± 9.66	69.47 ± 9.20	0.455
BMI (kg/m²)	27.16 ± 2.88	26.13 ± 2.62	0.152
Duration of Surgery (min)	125.50 ± 36.42	134.50 ± 32.12	0.314
Onset of Sensory Block (min)	8.87 ± 1.01	6.40 ± 0.81	<0.0001
Onset of Motor Block (min)	17.50 ± 2.54	11.67 ± 2.40	<0.0001
Duration of Sensory Block (min)	743.00 ± 42.92	872.00 ± 40.12	<0.0001
Duration of Motor Block (min)	664.00 ± 42.96	773.00 ± 43.64	<0.0001
Time to First Analgesic Requirement (min)	770.50 ± 48.00	903.17 ± 39.01	<0.0001
Sedation Score at 30 mins	1 ± 0	1.7 ± 0.47	<0.0001
Sedation Score at 45 mins	1.5 ± 0.51	2 ± 0	<0.0001

Preoperatively, the mean pulse rate (PR) was slightly lower in the BD 0.5 group (79.53 ± 10.22) than in the BD 1 group (82.20 ± 4.05), though not statistically significant ($p = 0.189$). Throughout most intervals, pulse rate differences between groups remained insignificant. However, at 30 and 45 minutes post-administration, significantly higher mean PR values were observed in the BD 0.5 group (86.73 ± 6.51 and 85.73 ± 5.48) compared to the BD 1 group (82.87 ± 5.37 and 82.27 ± 6.30), with p-values of 0.015 and 0.027, respectively (Figure 2).

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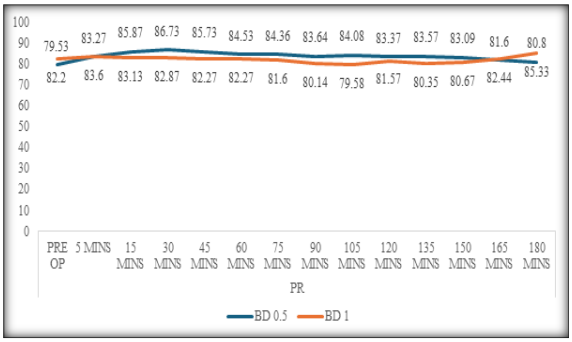

Figure 2: Comparing mean PR between groups

Preoperative systolic blood pressure (SBP) was nearly identical between the two groups (119.40 ± 10.33 vs. 119.20 ± 10.42; p = 0.941), and no significant differences were observed at any measured interval. Across all time points from 5 minutes up to 180 minutes, the mean SBP values remained similar with no significance (p > 0.05) (Figure 3).

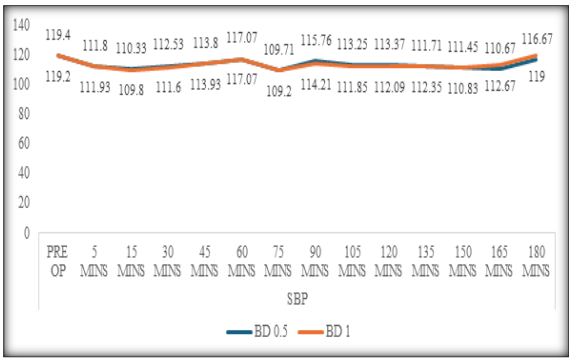

Figure 3: Comparing mean SBP between groups

The preoperative diastolic blood pressure (DBP) was nearly similar between the groups (75.73 ± 9.77 vs. 75.60 ± 10.01; p = 0.959), and similar findings were observed across all subsequent time points. No significant differences were found at any interval (p > 0.05) (Figure 4).

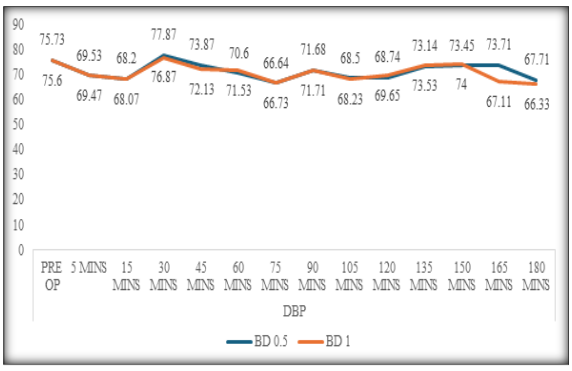

Figure 4: Comparing mean DBP between groups

Preoperative mean arterial pressure (MAP) was similar (BD 0.5: 89.93 ± 7.81; BD 1: 89.73 ± 6.44; p = 0.914). MAP remained nearly similar from 60 minutes to 180 minutes, and also showed no significant differences (p > 0.05) (Figure 5).

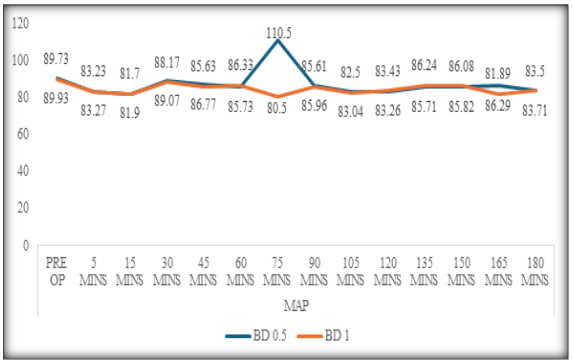

Figure 5: Comparing MAP between groups

Preoperative respiratory rate (RR) was the same in both groups (15.20 ± 1.00; p = 1.000). The mean RR remained similar between both groups at every time interval with no significant difference (p > 0.005) (Figure 6).

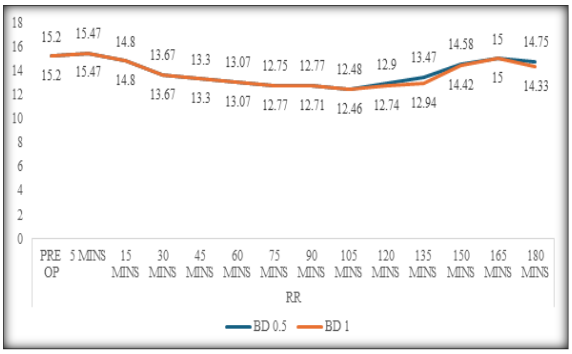

Figure 6: Comparing RR between groups

Preoperative SpO2 was the same in both groups (97.83 ± 1.02; p = 1.000). The mean SpO2 remained similar between both groups at every time interval with no significant difference (p > 0.005) (Figure 7).

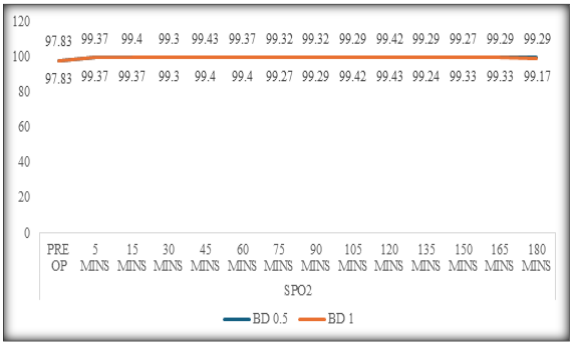

Figure 7: Comparing SpO2 between groups

DISCUSSION

Upper limb surgeries require effective regional anaesthesia, and the USG-guided SCB has become a preferred technique due to its precision, safety, and reliability. As an adjuvant to local anaesthetics in peripheral nerve blocks, dexmedetomidine has become more significant. The purpose of the current study was to evaluate the effectiveness of two distinct dexmedetomidine dosages (0.5 and 1 µg/kg) as

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adjuvants to 0.25% bupivacaine in SCB. Through the assessment of sedation, analgesia duration, and sensory and motor block characteristics, this study provides a comparison of dose-dependent effects.

In our study, the mean age was 40.37 ± 10.52 years in Group BD 0.5 and 41.97 ± 9.06 years in Group BD 1. The BD 0.5 group had a higher number of females, and the BD 1 group had more males (16 vs 21). However, the differences were not significant (p = 0.53 and 0.067). Similar to our study, Kabara et al. evaluated 60 patients into groups A and B, with each receiving dexmedetomidine 0.5 and 0.75 µg/kg, respectively. They reported a mean age of 38.10 ± 11.35 and 40.87 ± 8.52 years, and a higher proportion of males in groups A and B, with no significant difference.[10]

In our study, the mean weight was 71.30 ± 9.66 and 69.47 ± 9.20, with no significant difference (p < 0.455). The ASA physical status I was 20 vs 19, and II was 10 vs 11 among both groups (p = 0.787). In contrast, Koshyari et al. reported a mean weight of 57.85 ± 9.9 and 59.87 ± 9.3 kg. They also reported ASA grade I for 25 vs 35 and II for 22 vs 13 among both groups.[11]

In our study, the BD1 group showed a significantly faster onset of sensory (6.40 ± 0.81 min) and motor block (11.67 ± 2.40 min) compared to the BD0.5 group (8.87 ± 1.01 min and 17.50 ± 1.54 min, p < 0.001). These findings are consistent with those of Akshara et al., who examined 50 patients treated with 25 and 50 µg of dexmedetomidine and found that the D50 group experienced sensory and motor block earlier than the D25 group (11.47 ± 2.21 vs. 14.6 ± 2.42 and 18.92 ± 1.94 vs. 23.01 ± 3.00, p = 0.001).[12] Similarly, Saha et al. compared 5, 7.5 and 10µg of dexmedetomidine among 105 patients and reported a similar finding of shortening of mean sensory block and motor block with increase in the dose (sensory: 3.9, 3.3, and 2.9 min, and motor: 5.6, 5.3, and 4.8 min; P < 0.001).[13] These findings indicate that a higher dose of dexmedetomidine accelerated both sensory and motor block onset.

We found that the BD1 group's sensory and motor block durations were significantly longer (872 ± 40.12 minutes, motor: 773 ± 43.64 minutes) than the BD0.5 group's (743 ± 42.92 minutes, motor: 664 ± 42.96 minutes). Additionally, the time to first analgesic requirement (duration of analgesia) was longer in the BD1 group (903.17 ± 39.01 minutes) than in the BD0.5 group (770.50 ± 48.00 min). Further strengthening our findings, Bhiwal et al. also observed similar findings after evaluating about 68 patients who were split into 2 groups, with each receiving 50 and 25µg of dexmedetomidine. They reported a significant increase in the durations of sensory and motor blocks among the D50 compared to the D25 group (180 ± 10.94 vs 159.41 ± 6.715 min, and 154.41 ± 8.143 vs 141.325 ± 4.97 min, p < 0.001). The D50 group required a higher time for the first rescue dose (270.59 ±5 0.78 vs 172.50 ± 10.46 min, p < 0.001).[14]

Kumari et al. compared 1 and 2µg/kg of Dexmedetomidine among 50 patients and reported that group D2 had higher duration of sensory block (952.50 ± 29.15 vs 733.96 ± 29 min), motor block (1004.17 ± 37.41 vs 797.29 ± 28.63 min), and duration of analgesia (1070.62 ± 43.84 vs 870.83 ± 32.22 min) compared to D1 groups with a significant difference (p < 0.001).[15] These findings support a dose-dependent prolongation of block and analgesia.

In our study, the sedation scores were significantly higher in the BD 1 group at both 30 and 45 minutes (1.7 ± 0.47 and 2 vs 1 and 1.5 ± 0.51, p <0.0001). Only 2 patients in the BD1 group experienced bradycardia, which was not significant. No incidents of hypotension, respiratory depression, nausea, vomiting, or pruritus were noted in either group. Similar outcomes were noted by Chandni Sinha et al., who compared 1 and 2µg/kg doses of dexmedetomidine added to levobupivacaine. They found that while 1µg/kg provided adequate analgesia, it resulted in less sedation and fewer side effects than the higher dose.[16] Similarly, Nallam et al. compared 1µg/kg and 2µg/kg of dexmedetomidine and reported a significant increase in analgesic effect, and complications like bradycardia and hypotension at higher doses.[17]

Our study supports these results and demonstrates that 1µg/kg is effective with few side effects. The onset and duration of sensory and motor blocks are improved, postoperative analgesia is prolonged, and fewer adverse effects are experienced when the dose of dexmedetomidine is increased from 0.5 to 1µg/kg as an adjuvant to 0.25% bupivacaine. More research with bigger sample sizes and comparisons between various surgical populations may aid in the development of standardised dosage recommendations.

Limitations

This study was limited by its single-center design and small sample size, which could have an impact on the generalisability of the results. Furthermore, no long-term monitoring of late-onset complications was done.

CONCLUSION

The addition of 1 µg/kg dexmedetomidine to 0.25% bupivacaine increases the onset and duration of both sensory and motor blocks, extends the duration of analgesia, and increases sedation levels compared to a lower dose of 0.5 µg/kg. While there was a high sedation in the BD1 group, it remained within safe limits, with minimal adverse events. Hemodynamic stability was maintained in both groups. These results support the use of 1 µg/kg dexmedetomidine as an effective and safe adjuvant in SCB. To create standardised dosage guidelines and assess long-term safety across various patient populations, larger, multicenter trials with longer follow-up periods are advised in the future.

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