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DEXMEDETOMIDINE AN ADJUVANT TO LEVOBUPIVACAINE IN SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK: A PROSPECTIVE RANDOMIZED CONTROL STUDY

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ABSTRACT
Various α2-adrenergic agonists and other adjuvants are used with local anesthetics to prolong the duration of regional anesthesia. This study evaluated the effect of adding dexmedetomidine to 0.5% levobupivacaine for ultrasound-guided supraclavicular brachial plexus block, focusing on the duration of sensory and motor blockade and postoperative analgesia. Materials and methodology: Sixty patients scheduled for elective forearm and hand surgery were randomly allocated into two equal groups (n=30 each). All patients received an ultrasound-guided supraclavicular brachial plexus block. Group L received 20 mL of 0.5% levobupivacaine with 1 mL of isotonic saline, whereas Group LD received 20 mL of 0.5% levobupivacaine with 1 mL containing 100 µg of dexmedetomidine. The durations of sensory and motor blockade and the time to first rescue analgesic requirement were recorded and compared between the groups. Results: The durations of sensory and motor blockade were significantly longer in Group LD than in Group L ($P<0.01$). The duration of postoperative analgesia, assessed by the time to first rescue analgesic requirement, was also significantly longer in Group LD compared with Group L ($P<0.05$). Conclusion: The addition of 100 µg dexmedetomidine to 0.5% levobupivacaine for ultrasound-guided supraclavicular brachial plexus block significantly prolongs sensory and motor blockade and extends the duration of postoperative analgesia in patients undergoing elective forearm and hand surgery

KEYWORDS: Supraclavicular, brachial plexus, regional, anaesthesia, levobupivacaine, dexmedetomidine.

INTRODUCTION
Supraclavicular brachial plexus block is an established regional anesthesia technique for surgical procedures involving the forearm and hand. The technique provides effective anesthesia and postoperative analgesia while reducing the need for systemic analgesics and their associated adverse effects. [1,2] With the increasing use of ultrasound guidance, accurate identification of the brachial plexus and deposition of local anesthetic around the neural structures has become more precise, potentially improving the quality and reliability of the block.[3]
Levobupivacaine, the S-enantiomer of bupivacaine, is a long-acting amide local anesthetic with a favorable safety profile and is widely used for peripheral nerve blocks. Despite its relatively prolonged duration of action, the duration of sensory and motor blockade and postoperative analgesia may not always be sufficient for procedures associated with significant postoperative pain.[4] Consequently, various adjuvants have been investigated to enhance the quality and duration of regional anesthesia while avoiding excessive doses of local anesthetics.[5]
Dexmedetomidine is a highly selective α2-adrenergic receptor agonist that has been investigated as an adjuvant to local anesthetics in peripheral nerve blocks. Its analgesic and sympatholytic properties may enhance the effects of local anesthetics and prolong neural blockade. Several studies have reported that perineural dexmedetomidine can increase the duration of sensory and motor blockade and delay the requirement for postoperative rescue analgesia. However, differences in local anesthetic agents, dexmedetomidine doses, block techniques, and patient populations have resulted in variation in the reported magnitude of benefit.[6-8]
Therefore, the present prospective randomized controlled study was undertaken to evaluate the effect of adding dexmedetomidine to 0.5% levobupivacaine in ultrasound-guided supraclavicular brachial plexus block. The primary objective was to compare the duration of sensory and motor blockade between patients receiving levobupivacaine alone and those receiving levobupivacaine with dexmedetomidine. The study also assessed the duration of postoperative analgesia, measured by the time to first rescue analgesic requirement.

MATERIALS AND METHODOLOGY
This prospective, randomized, controlled study was conducted in 60 patients scheduled for elective forearm and hand surgery under ultrasound-guided supraclavicular brachial plexus block. Patients aged 20 years and above, irrespective of gender, and classified as American Society of Anesthesiologists (ASA) physical status I or II were included in the study.

Patients with bleeding disorders, known allergy to any of the study drugs, significant comorbid illness, multiple injuries, or those unwilling to undergo regional anesthesia were excluded. Written informed consent was obtained from all participants before enrolment in the study.

The sample size was calculated based on the difference in duration of postoperative analgesia reported in a previous study, where the mean duration was 997 ± 154.23 minutes in the dexmedetomidine group and 801.13 ± 200.08 minutes in the control group.[9] Assuming a two-sided α of 0.05 and 80% power, the estimated sample size was 14 patients per group. Considering potential dropouts and to provide adequate power for assessment of the secondary outcomes, 30 patients were recruited in each group, resulting in a total sample size of 60 patients.

The patients were randomly allocated into two equal groups of 30 patients each using computer-generated randomization. Patients in Group L received 20 mL of 0.5% levobupivacaine with 1 mL of isotonic saline, whereas patients in Group LD received 20 mL of 0.5% levobupivacaine with 1 mL containing 100 µg of dexmedetomidine. All patients received an ultrasound-guided supraclavicular brachial plexus block using the respective study solution. The block was performed by the person who is trained under USG guided supraclavicaular block with an experience of performing atleast 50 independent block.

Assessment of sensory and motor blockade:

Sensory blockade was assessed using the pinprick method in the distributions of the median, radial, ulnar, and musculocutaneous nerves. The onset of sensory blockade was considered to have occurred when the patient reported a dull sensation to pinprick in the distribution of at least two of these four nerves. Complete sensory blockade was defined as complete absence of sensation to pinprick in all four nerve territories. Sensory blockade was graded on a three-point scale, with Grade 0 indicating a sharp pinprick sensation, Grade 1 indicating analgesia with perception of a dull sensation, and Grade 2 indicating anesthesia with complete absence of sensation.

Motor blockade was evaluated using the modified Bromage scale for the upper extremity. Grade 0 represented normal motor function with full flexion and extension of the elbow, wrist, and fingers. Grade 1 indicated reduced motor strength with movement restricted to the fingers, whereas Grade 2 represented complete motor blockade with inability to move the fingers. Sensory and motor blockade were assessed at 3-minute intervals for the first 30 minutes following administration of the study solution and subsequently at 30-minute intervals until complete resolution of the block.

The duration of sensory blockade was defined as the interval from completion of administration of the local anesthetic solution until complete recovery of sensation in all assessed nerve territories. Similarly, complete motor blockade was defined as the absence of voluntary finger movement (Grade 2), and the duration of motor blockade was calculated from completion of local anesthetic administration until recovery of complete motor function of the hand and forearm. The duration of postoperative analgesia was assessed by recording the time to first requirement for rescue analgesia. Pain intensity was evaluated using the Visual Analog Scale (VAS), scored from 0 to 10, with higher scores indicating greater pain intensity. Patients with VAS score of 5 and above were supplemented with rescue analgesia using intravenous Inj Paracetamol 1gm.

Heart rate, systolic arterial blood pressure, diastolic arterial blood pressure, and peripheral oxygen saturation (SpO_2) were monitored intraoperatively at 5-minute intervals and postoperatively at 15-minute intervals. All observations were recorded systematically and compared between the two study groups.

Statistical evaluation was performed using SPSS software, version 16.0 (SPSS Inc., Illinois, USA; 2008). Categorical data were summarized as frequencies and proportions and assessed using Pearson's chi-square test. Continuous data were evaluated for distributional characteristics; variables showing an approximately normal distribution were compared between the two groups using the independent t test, whereas variables with a non-normal distribution were assessed using the Mann–Whitney U test. All analyses were conducted using two-sided tests, with statistical significance established at a p value <0.05.

RESULTS

A total of 87 patients were screened and out of them 20 patients were not eligible for the study as they were not fitting into the inclusion criteria. In remaining patients 7 patients denied to provide the consent for the study. The two groups were comparable with respect to baseline demographic characteristics. There were no statistically significant differences between Group-L and Group-LD in terms of age (42.56 ± 10.00 vs. 41.34 ± 11.90 years, p=0.669), height (175.34 ± 9.00 vs. 172.45 ± 10.08 cm, p=0.246), or weight (76.34 ± 9.00 vs. 75.60 ± 10.48 kg, p=0.770), as assessed using a two-tailed independent-samples t test (Table 1).

Table 1. Comparison of demographic characteristics between the study groups

Variable	Group-L (n=30) X±SD	Group-LD (n=30) X±SD	t value	p value
Age (years)	42.56 ± 10.00	41.34 ± 11.90	0.430	0.669
Height (cm)	175.34 ± 9.00	172.45 ± 10.08	1.171	0.246
Weight (kg)	76.34 ± 9.00	75.60 ± 10.48	0.293	0.770

Table 2. Comparison of haemodynamic parameters between Group-L and Group-LD

Time	SBP Group-L (Mean ± SD)	SBP Group-LD (Mean ± SD)	p value	DBP Group-L (Mean ± SD)	DBP Group-LD (Mean ± SD)	p value	HR Group-L (Mean ± SD)	HR Group-LD (Mean ± SD)	p value
Baseline	128±10.5	124±8.7	>0.05	84±7.2	86±7.9	>0.05	88±3.2	86±9.5	>0.05
30 min	126±8.7	124±7.4	>0.05	78±9.2	81±2	>0.05	83±5.3	68±7.2	<0.05
45 min	132±6.5	129±7.4	>0.05	83±3.2	81±9.8	>0.05	80±7.2	65±2.9	<0.05
60 min	127±3.9	110±2.1	<0.05	79±5.9	68±4.3	<0.05*	83±1.2	70±8.9	<0.05
90 min	132±8.9	106±7.8	<0.05	88±7.3	70±3.8	<0.05*	79±2	69±7.2	<0.05
120 min	121±7.7	102±6.5	<0.05	83±6.5	71±3.2	<0.05*	90±3.1	71±9.8	<0.05

** Mann–Whitney U test; P<0.05 was considered statistically significant.*

As shown in table 2, the baseline haemodynamic parameters were comparable between the two groups. SBP and DBP were significantly lower in Group-LD compared with Group-L at 60, 90, and 120 minutes after administration of the block (P<0.05). Heart rate was also significantly lower in Group-LD than in Group-L at 30, 45, 60, 90, and 120 minutes (P<0.05), whereas the baseline heart rate did not differ significantly between the groups (P>0.05).

Table 3: The duration of sensory block, motor block and postoperative analgesia in two study groups

Duration of	Group L (n=30) (X±SD)	Group LD (n=30) (X±SD)
Sensory block	480±76.3	790±53.3
Motor block	513±59.3	760±23.9
Postoperative analgesia	710±11.3	912±22.8

The duration of sensory blockade was significantly greater in Group LD than in Group L, with mean durations of 790 ± 53.3 and 480 ± 76.3 minutes, respectively (p<0.05; Mann–Whitney U test). Similarly, patients in Group LD demonstrated a significantly prolonged motor blockade compared with Group L (760 ± 23.9 vs. 513 ± 59.3 minutes; p <0.05; Mann–Whitney U test). The duration of postoperative analgesia was also significantly longer in Group LD than in Group L, with mean durations of 912 ± 22.8 and 710 ± 11.3 minutes, respectively (p<0.05; Mann–Whitney U test) (Table 3). These findings indicate that the addition of dexmedetomidine to levobupivacaine prolonged both sensory and motor blockade and extended the duration of postoperative analgesia. None of the patients had intraoperative complications related to the regional block in either group.

DISCUSSION

The present prospective randomized controlled study evaluated the effect of adding an adjuvant Inj Dexmedetomedine to Levobupivacaine during ultrasound-guided supraclavicular brachial plexus block in patients undergoing elective forearm and hand surgery. The demographic characteristics of the participants were comparable between the two groups. There were no statistically significant differences in age, height, or weight, indicating satisfactory baseline comparability. The principal findings were that the two study groups were comparable with respect to baseline demographic characteristics, while the group receiving the adjuvant demonstrated prolonged sensory and motor blockade and a longer duration of postoperative analgesia. The haemodynamic observations showed that baseline parameters were comparable between the groups, whereas differences in systolic blood pressure, diastolic blood pressure, and heart rate became apparent at selected postoperative time points.

A major finding of the present study was the prolongation of sensory blockade in the adjuvant group. The mean duration of sensory block was 790 ± 53.3 minutes in Group LD compared with 480 ± 76.3 minutes in Group L, with the difference reaching statistical significance. This represents a substantial prolongation of sensory blockade and suggests that the addition of the study adjuvant modified the duration of neural blockade produced by levobupivacaine. Similar finding was seen in the previous study conducted by Biswas et al where the duration of sensory block was 997+/- 154.23 min. [9] A small difference was observed may be due to larger quantity used in the study conducted by Biswas et al. The prolonged sensory blockade may be particularly relevant in the postoperative period because sustained sensory analgesia can reduce the early requirement for rescue analgesics and provide a smoother transition from regional anesthesia to systemic postoperative analgesia.

Motor blockade was similarly prolonged in Group LD. The mean duration of motor blockade was 760 ± 23.9 minutes compared with 513 ± 59.3 minutes in Group L, and this difference was statistically significant. The parallel prolongation of sensory and motor blockade suggests that the observed effect was not restricted to sensory fibres. Similar prolongation of motor blockade was seen in the previous study conducted by Singh et al and Agarwal et al. [10,11]

However, prolonged motor blockade should also be considered when interpreting the clinical implications of the intervention, particularly in ambulatory surgery, where early recovery of limb function may be desirable.
The duration of postoperative analgesia was another important outcome. Patients in Group LD had a mean analgesic duration of 912 ± 22.8 minutes compared with 710 ± 11.3 minutes in Group L, demonstrating a statistically significant prolongation. Our findings are in consistants with the study conducted by Biswas et al.[9] The prolonged interval before the first requirement for rescue analgesia may therefore represent an important benefit of the intervention in patients undergoing upper-limb surgery.
The haemodynamic findings demonstrated that the two groups had comparable baseline systolic blood pressure, diastolic blood pressure, and heart rate. During the subsequent observation period, systolic and diastolic blood pressures were significantly lower in Group LD at 60, 90, and 120 minutes. Heart rate was also significantly lower in Group LD at 30, 45, 60, 90, and 120 minutes, while the baseline heart rate remained comparable. Although we did not measure the blood dexmeditomedine levels due to lack of facility, based on the previous studies this drug may be the cause for bradycardia and hypotension. The reduction in arterial blood pressure and heart rate associated with dexmedetomidine can be attributed primarily to its sympatholytic action. By activating central α2-adrenergic receptors, dexmedetomidine suppresses sympathetic nervous system activity. Its stimulation of presynaptic α2 receptors also reduces norepinephrine release from sympathetic nerve terminals, contributing to decreased sympathetic tone and consequent reductions in heart rate and blood pressure. [12,13]
No major adverse events were observed during the study. There were no cases of pneumothorax, local anesthetic systemic toxicity, allergic reactions to the study medications, or inadvertent intravascular drug administration. Furthermore, none of the patients required conversion from regional anesthesia to general anesthesia because of an inadequate or failed block. This may be due to the block was performed using ultrasound by an expert who has experience.

Limitation:
Although the study was conducted using a randomized design, blinding was not implemented, which may have introduced the possibility of observer or performance bias. Blinding of the participants and investigators could have strengthened the methodological rigor of the study. In addition, sedation was not systematically assessed or documented during either the intraoperative or postoperative period, and details regarding the sedative agents administered were not recorded. These factors limit the assessment of the overall clinical effects of the intervention. Future well-designed, adequately powered multicentric randomized controlled trials incorporating appropriate blinding, standardized assessment of sedation, and comprehensive documentation of perioperative medications may provide more robust evidence.

CONCLUSION
The addition of dexmedetomidine to 0.5% levobupivacaine in ultrasound-guided supraclavicular brachial plexus block significantly prolonged the duration of sensory and motor blockade and extended the duration of postoperative analgesia compared with levobupivacaine alone.

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