ORIGINAL RESEARCH

Role of dexmedetomidine as an adjuvant with Levobupivacaine in supraclavicular approach to brachial plexus block

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ABSTRACT

Aim: Investigation of the potential benefits of dexmedetomidine as an adjunct to Levobupivacaine in the supraclavicular approach to brachial plexus block.

Material and Methods: This prospective, randomized, double-blind, placebo-controlled trial included a sample of 50 patients from the American Society of Anesthesiologists physical status I and II categories. These patients were between the ages of 18 and 60 and were scheduled to undergo upper limb surgery. The patients received a supraclavicular brachial plexus block as part of the study. In this study, a total of 50 participants were divided into two groups. Group I, consisting of 25 participants, received a solution containing 30 ml of levobupivacaine with an additional 1 ml of isotonic sodium chloride solution. On the other hand, Group II, also consisting of 25 participants, received a solution containing 30 ml of levobupivacaine along with 1 ml (100 µg) of dexmedetomidine.

Results: The average time at which sensory and motor blocks began in Group I was 9.41±1.29 and 14.88±1.85 minutes, respectively. In Group II, the corresponding times were 4.01±1.05 and 4.74±1.29 minutes. The systolic blood pressure (SBP) and diastolic blood pressure (DBP) values observed in Group II were found to be significantly lower compared to those in Group I during the intraoperative period ($P < 0.001$). In Group II, a total of 20 patients experienced hypotension and 21 patients experienced bradycardia, both of which were observed as adverse effects.

Conclusion: We concluded that the inclusion of dexmedetomidine in levobupivacaine for supraclavicular brachial plexus block results in a reduction in the time required for the sensory and motor blocks to take effect, as well as an extension of their duration.

Keywords: Dexmedetomidine, Levobupivacaine, Supraclavicular, Brachial plexus block.

Introduction

Regional anesthesia is the preferred method for surgical procedures involving the upper and lower limbs due to its superior postoperative outcomes. Extensive research has been undertaken over an extended period of time to ascertain the optimal local anesthetic (LA) medication. An optimal pharmaceutical substance should possess a rapid initiation of sensory effects, distinct termination characteristics, wherein the cessation of motor blockade occurs prior to the cessation of sensory blockade. This would facilitate early mobilization and movement while maintaining extended pain relief. Various combinations of local anesthetics (LAs) and adjuvants, including tramadol [1,2], sufentanyl [2], clonidine [2], and fentanyl [3], have been utilized in the pursuit of an optimal agent, which has yet to be identified. At present, levobupivacaine, which is the S(−)-enantiomer of bupivacaine, is being preferred as a local anesthetic for regional block due to its favorable clinical characteristics and reduced risk of cardiotoxicity compared to racemic bupivacaine [4,5]. In contemporary medical practice, the utilization of dexmedetomidine, an agonist of the alpha-2 receptor, has become more prevalent. Its applications include regional anesthesia and intravenous anesthesia (specifically Bier's block), the reduction of the pressor response, intravenous sedation and analgesia for mechanically ventilated patients in Intensive Care Units, as well as for nonintubated patients undergoing surgical and other procedures.[6-8]The description of its application in peripheral nerve blocks has only been provided in recent times.[9,10] The objective of this study was to investigate the impact of incorporating dexmedetomidine into levobupivacaine for supraclavicular brachial plexus block. Specifically,

the study aimed to assess the potential effects of this combination on sensory and motor blockade, as well as its influence on the duration of analgesia (DOA).

Material and Methods

Following the authorization of the Hospital Ethics Committee, written informed consent was obtained from all patients involved. This prospective, randomized, double-blind, placebo-controlled trial included a sample of 50 patients from the American Society of Anesthesiologists physical status I and II categories. These patients were between the ages of 18 and 60 and were scheduled to undergo upper limb surgery. The patients received a supraclavicular brachial plexus block as part of the study. The study excluded individuals who had prior nerve deformity or brachial plexus injury, severe liver or kidney disease, opposite side pneumothorax or collapsed lung, were scheduled for bilateral upper limb surgeries, had hypersensitivity to amide local anesthetics, had local infection, had coagulopathy, or were uncooperative or unwilling to participate. A total of 25 patients were enrolled in each group to enhance the validity of the study findings. The patients were assigned to two groups, each consisting of 25 individuals, using a computer-generated randomization number. This allocation was performed by distributing 50 coded slips. In this study, a total of 50 participants were divided into two groups. Group I, consisting of 25 participants, received a solution containing 30 ml of levobupivacaine with an additional 1 ml of isotonic sodium chloride solution. On the other hand, Group II, also consisting of 25 participants, received a solution containing 30 ml of levobupivacaine along with 1 ml (100 µg) of dexmedetomidine. he patients were transferred to the preoperative room, during which the basal heart rate (HR), noninvasive arterial systolic blood pressure (SBP), diastolic blood pressure (DBP), and peripheral oxygen saturation (SpO2) were documented. A 20-gauge intravenous cannula was inserted into the nonoperating arm, and the administration of lactated Ringer's solution was initiated at a rate of 5 milliliters per kilogram per hour. The patients were positioned supine with the arm to be anesthetized adducted, and the head extended and rotated away from the side to be blocked, in order to administer the supraclavicular brachial plexus block and the block was given under ultrasound guidance. The assessment of sensory block involved evaluating the absence of sensation to pinprick in the midline using a 22-gauge blunt hypodermic needle at one-minute intervals. The Hollmen scale was utilized for this purpose, which categorizes the sensation as follows: 1 - normal pinprick sensation, 2 - pinprick felt as sharp but less intense compared to the corresponding area in the opposite limb, 3 - pinprick recognized as touch with a blunt object, and 4 - no perception of pinprick. The utilization of a sensory block with a magnitude of 3 was deemed as a suitable criterion for concluding the surgical procedure. The initiation of sensory block was defined as the duration between the administration of the drug and the attainment of a Hollmen sensory scale score of 2. The duration of the sensory block was defined as the period of time that transpired from the initiation of the block to the point at which the sensory block regressed and reached a scale of ≤ 2. The assessment of motor block was conducted utilizing the Hollmen scale, which consists of four categories: 1 representing normal muscle action, 2 indicating slightly weak muscle action, 3 denoting very weak muscular action, and 4 signifying complete loss of muscle action. The experiment was conducted at one-minute intervals until reaching scale 2. The surgical procedure was concluded when a motor block of level 3 was reached. The initiation of motor block was defined as the duration between drug administration and the attainment of a Hollmen motor scale score of 2. The duration of motor block was defined as the time interval between the administration of the block and the subsequent regression of motor scale and lower degree. In the event that any patient exhibited sparing of dermatomes in the surgical region, the administration of midazolam (0.05 mg/kg) and ketamine (0.5 mg/kg) was used as a supplementary measure. General anesthesia was administered as a supplement in patients who had a lesser degree of block or were uncooperative. The evaluation of postoperative pain was conducted using the visual analog scale (VAS) at specific time intervals, namely 2 hours, 4 hours, 6 hours, 8 hours, 10 hours, 12 hours, 18 hours, and 24 hours following the surgical procedure. Rescue analgesia in the form of intravenous injection of diclofenac sodium 75 mg was administered whenever the Visual Analog Scale (VAS) score reached a value of 4 or higher. The time at which the initial dose of diclofenac sodium was administered following the surgical procedure was recorded.

The Visual Analog Scale (VAS) was utilized to assess pain levels, with a score of 0 indicating the absence of pain, scores ranging from 1 to 3 indicating mild pain, scores ranging from 4 to 7 indicating moderate pain, and scores ranging from 8 to 10 indicating severe pain. Heart rate (HR), systolic blood pressure (SBP), and diastolic blood pressure (DBP) were measured at various time intervals: 0, 3, 6, 9, 15, 20, 25, 30, 45, 60, 75, 90, and 120 minutes. The assessment of sedation score was conducted in accordance with the Ramsay sedation scale, which utilizes a numerical scale ranging from 1 to 6. The numerical scale used to assess a patient's level of consciousness is as follows: 1 indicates a state of anxiety, agitation, and restlessness; 2 indicates a cooperative and oriented state of tranquility; 3 indicates a state where the patient only responds to commands; 4 indicates a brisk response to a light glabellar tap or loud noise; 5 indicates a sluggish response to a light glabellar tap or loud noise; and 6 indicates a complete lack of response. The adverse effects observed in the study

included hypotension, which was defined as a 20% decrease relative to the baseline blood pressure, bradycardia, which was defined as a 20% decrease relative to the baseline heart rate, as well as symptoms of nausea, vomiting, and hypoxemia, indicated by a peripheral oxygen saturation (SpO2) level below 90%. The process of deciphering the groups was conducted at the conclusion of the study, subsequently followed by the statistical examination of the findings. Following the conclusion of the study, the obtained data was subjected to statistical analysis. The Chi-square test was employed for nonparametric data, while the Student unpaired t-test was utilized for parametric data, enabling comparison between different groups. The statistical analysis was conducted using SPSS 25.0 software (SPSS Inc., Chicago). A significance level of $P < 0.05$ was deemed to indicate statistical significance, while a significance level of $P < 0.001$ was considered to indicate a high degree of statistical significance.

Results

The demographic data exhibited comparability between the two groups, as shown in Table 1. The average time at which sensory and motor blocks began in Group I was 9.41±1.29 and 14.88±1.85 minutes, respectively. In Group II, the corresponding times were 4.01±1.05 and 4.74±1.29 minutes. The average duration time for the sensory and motor components of Group I was found to be 7.88±1.74 and 9.41± 1.31 hours, respectively. In contrast, Group II exhibited corresponding values of 16.11 ± 1.74 and 17.48± 1.74 hours. The statistical analysis revealed a highly significant difference ($P < 0.001$) as indicated in Table 2 and Table 3. The average duration of anesthesia (DOA) for Group I was 426.55±5.81 minutes, whereas for Group II patients, it was 979.63±7.16 minutes, as shown in Table 3. The duration of DOA was found to be significantly greater in Group II compared to Group I, with a statistically significant difference ($P < 0.001$). The systolic blood pressure (SBP) and diastolic blood pressure (DBP) values observed in Group II were found to be significantly lower compared to those in Group I during the intraoperative period ($P < 0.001$) [Table 4]. In Group II, a total of 20 patients experienced hypotension and 21 patients experienced bradycardia, both of which were observed as adverse effects. The systolic blood pressure (SBP) did not decrease by more than 20% from its initial value. One patient in Group II exhibited a decrease in pulse rate exceeding 20% from the baseline measurement. The average Ramsay sedation score in Group II was 3.14±0.84, while in Group I it was 1.23±0.74. No instances of side effects such as nausea, vomiting, hypoxemia, pruritis, or urinary retention were observed in either of the groups, as indicated in Table 5.

Table 1: Demographic parameters in group I and group II

	Group I	Group II	p-value
Age In Year	39.04 ± 5.81	38.36 ± 5.74	>0.05
Gender			
Male	20(80 %)	18 (72%)	>0.05
Female	5(20%)	7 (28%)	
ASA Grade			
I	15 (60 %)	13 (56.67 %)	
II	10 (40%)	12 (43.33%)	>0.05

Table 2: Comparison of time of onset of complete sensory and motor block

Onset time	Group I	Group II	p-value
Sensory block (min)	9.41±1.29	4.01± 1.05	< 0.05
Motor block (min)	14.88± 1.85	4.74 ±1.29	< 0.05

Table 3: Comparison of time of duration of block, analgesia and level of sedation

	Group I	Group II	p-value
Sensory Block (H)	7.88 ± 1.74	16.11 ± 1.74	<0.001
Motor Block (H)	9.41 ± 1.31	17.48± 1.74 h	<0.001
Analgesia (MIN)	426.55±5.81	979.63±7.16	<0.001
Sedation Score (1-4)	1.23±0.74	3.14±0.84	

Table 4: Comparison of Mean Systolic Bp between group I and group II

	GROUP I	GROUP II	p-value
0 min	135.47 ± 2.43	133.40±6.30	>0.05
5 min	131.4±5.63	129.01±4.66	>0.05
10 min	128.27 ± 6.65	112.24±3.47	<0.05
15 min	123.77 ± 6.59	103.47 ± 6.20	<0.05
20 min	121.50 ± 4.42	105.80 ± 6.62	<0.05

25 min	119.40 ± 4.33	107.10± 6.18	<0.05
30 min	117.44 ± 4.66	105.17 ±2.42	<0.05
45 min	124.57 ± 3.13	103.87±3.31	<0.05
60 min	127.50 ± 2.42	103.73 ± 7.71	<0.05
90 min	119.40 ± 6.37	105.01± 6.28	<0.05
120 min	123.44 ± 4.66	107.17 ±2.43	<0.05
150 min	120.57±10.03	110.87±12.12	<0.05

Table 5: Incidence of Adverse effects

	Group I=25	**Group II=25**	**P value**
Hematoma	0	0	0.24
Hypotension	0	20	0.001
Nausea and vomiting	0	0	0.35
LA toxicity	0	0	0.54
Postoperative paresthesias	0	0	0.41
Sedation	0	20	0.001
Bradycardia	0	21	0.001

Discussion

The addition of dexmedetomidine as a supplementary medication to levobupivacaine has demonstrated notable advantages. Specifically, it has been found to considerably decrease the time it takes for sensory and motor block to take effect, reduce the duration of motor block offset, extend the period of postoperative pain relief, result in significantly lower postoperative pain scores as measured by the Visual Analog Scale (VAS), and yield comparable levels of overall satisfaction among patients. In essence, α-2 agonists elicit analgesic and sedative effects through the inhibition of substance P release in the nociceptive pathway at the dorsal root neuron level, as well as the activation of α-2 adrenoceptors in the locus coeruleus. Dexmedetomidine is the d-isomer of medetomidine and functions as a pharmacologically active compound. It exhibits a high degree of specificity and selectivity as an α2 adrenoceptor agonist. In comparison to clonidine, dexmedetomidine demonstrates a significantly higher α2:α1 binding selectivity ratio of 1620:1, thereby reducing the occurrence of undesirable side effects associated with α1 receptors.[11-14] Research has indicated that the activation of α2 adrenoceptors in the central nervous system prior to synaptic transmission hinders the release of norepinephrine, thereby interrupting the transmission of pain signals. Additionally, the activation of these adrenoceptors after synaptic transmission inhibits sympathetic activity, resulting in a reduction in heart rate and blood pressure.The user has provided a numerical range, specifically [15,16]. The present study demonstrated a significant reduction in the onset time of sensory and motor blockade ($P < 0.001$) with the administration of dexmedetomidine in conjunction with levobupivacaine. This finding aligns with the research conducted by Esmaoglu et al. (10), which similarly determined that the onset time for sensory and motor block was significantly shorter in the group administered with levobupivacaine and dexmedetomidine compared to the group administered with levobupivacaine alone. This disparity was found to be statistically significant. The findings of our study were inconsistent with the research conducted by Kaygusuz et al. [17], as they reported a decrease in the time it took for sensory block to occur, while no decrease was observed in the time it took for motor block to occur. This phenomenon may be attributed to the utilization of a reduced dosage of dexmedetomidine in the aforementioned studies. he study found that the duration of sensory block and motor block was significantly longer in patients of Group II compared to Group I ($P < 0.001$). The prolonged duration of motor block observed in this study may be attributed to the direct inhibition of excitatory amino acid release from spinal interneurons, which is consistent with findings reported by Agarwal et al. [18]. The duration of action (DOA) in Group II was observed to be significantly extended in comparison to Group I. This observation aligns with the findings reported by Esmaoglu et al. [10] and Agarwal et al. [18], who similarly concluded that the addition of 100 µg of dexmedetomidine to 0.5% levobupivacaine in axillary brachial plexus block resulted in a prolonged DOA.

The C4 dermatome was found to be unaffected in all patients from both groups. Both groups exhibited statistical similarity in terms of the dermatomal spread of the anesthetic. Cox et al.[19] and Vainionpää et al. [20] demonstrated comparable findings. Within Group II, a total of 20 patients experienced hypotension, while 21 patients exhibited bradycardia as adverse effects. The systolic blood pressure (SBP) did not decrease below 20% of the initial baseline value, thus no intervention or treatment was administered. In one patient from Group II who exhibited a positive response to atropine, there was a decrease in pulse rate exceeding 20% from the baseline measurement. The reduction in blood pressure can be attributed to the suppression of central sympathetic outflow. Dexmedetomidine additionally activates the

presynaptic alpha-2 receptors, resulting in a reduction in the release of norepinephrine and subsequent decreases in both blood pressure and heart rate. The occurrence of intraoperative complications in both groups in our study did not demonstrate statistical significance. None of the groups experienced any instances of respiratory depression throughout the duration of the study. Agarwal et al. [18] similarly demonstrated comparable findings in their study. It was observed that within Group II, there was a single patient who required supplementation and conversion to general anesthesia. Similarly, within Group I, two patients necessitated supplementation and conversion to general anesthesia.

Conclusion

We concluded that the inclusion of dexmedetomidine in levobupivacaine for supraclavicular brachial plexus block results in a reduction in the time required for the sensory and motor blocks to take effect, as well as an extension of their duration. The considerably extended duration of action eliminates the necessity for supplementary analgesic medications. The potential utilization of conscious sedation as an adjuvant for nerve blocks is supported by its additional benefits, including hemodynamic stability and minimal occurrence of side effects.

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