Section: Anaesthesiology

Original Research Article

COMPARISON OF THE EFFECTS OF BUPRENORPHINE AND DEXMEDETOMIDINE AS ADJUVANTS TO ROPIVACAINE IN ULTRASOUND-GUIDED SUPRACLAVICULAR BLOCK FOR ELECTIVE UPPER LIMB SURGERIES

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Abstract

Background: Peripheral nerve blockade is a crucial anaesthesia technique that provides profound analgesia, stable hemodynamics and improved patient response. The brachial plexus block is the most commonly used method for upper extremity surgeries. The study aimed to compare and evaluate the effects of buprenorphine and dexmedetomidine as an adjuvant to 0.5% ropivacaine in the ultrasound-guided supraclavicular block for elective upper limb surgeries. **Materials and Methods:** This prospective randomized double-blinded comparative study was conducted at Government Vellore Medical College from May 2018 to July 2019 on patients undergoing elective upper limb Surgery. Fifty patients were randomly allocated into two groups (Group RB and Group RD of 25 patients in each group. Group RB received 25 ml of 0.5% ropivacaine (maximum of 3mg/kg) with 1 ml (0.3mg) of Buprenorphine. Group RD received 25 ml of 0.5% ropivacaine (maximum of 3mg/kg) with 1 ml (50 µg) Dexmedetomidine. **Results:** There was no statistically significant difference between the two groups in age, gender and weight. There was no significant difference between the two groups in the onset time for the sensory block, onset time of the motor block and duration of the sensory block. There is a significant difference between the two groups in the duration of motor block and duration of analgesia. 3 out of 25 patients in the Buprenorphine group had an incidence of post-op Vomiting and no side effects were found in the Dexmedetomidine group. **Conclusion:** Dexmedetomidine (50 micrograms) enhances motor blockade and analgesia in ultrasound-guided supraclavicular brachial plexus block without side effects compared to Buprenorphine.

INTRODUCTION

Pain is defined as the distressing sensory stimulus or emotional experience associated with tissue damage which presents significant challenges in the context of surgery both physiologically and psychologically.[1] Anaesthesia has evolved over decades, introducing new techniques and drugs. These innovations aim to provide anaesthesia and analgesia with minimal complications.

Peripheral nerve blockade has emerged as an indispensable component of anaesthesia care. This technique entails administering local anaesthetics around specific nerves or nerve plexuses, effectively rendering targeted dermatomes insensitive to noxious surgical stimuli and pain. Peripheral nerve blocks offer a multitude of advantages over general anaesthesia including the provision of ideal operating conditions with complete analgesia and dense motor blockade, maintenance of stable intraoperative hemodynamics, an alert and responsive patient, extended postoperative pain relief, avoidance of airway instrumentation, reduction in the use of multiple medications (polypharmacy) associated

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with general anaesthesia, early patient ambulation, fewer postoperative side effects, cost-effectiveness and a reduction in theatre pollution.[2-4]

For upper extremity surgeries, the brachial plexus block is the most commonly employed method with various approaches available including the interscalene, supraclavicular, axillary and infraclavicular approaches.[5] The supraclavicular approach stands out as an easy and highly effective method. It is the most efficient upper extremity block performed at the division level of the plexus with minimal or no sparing of dermatomes. The historical anatomical approach of supraclavicular brachial plexus block using paresthesia as a guide is a blind technique. It is associated with the potential for nerve injury, damage to surrounding vascular structures, pleural complications and a high failure rate.[6,7] To address these concerns nerve stimulators were introduced allowing for better nerve localisation. However, even with the use of nerve stimulators there remained a risk of injury to surrounding structures and the pleura, potentially leading to pneumothorax.

To mitigate these risks associated with blind techniques, ultrasound-guided techniques have been employed. This approach provides real-time visualisation of nerve plexuses, vascular structures and the pleura, enhancing the safety and accuracy of the procedure. Local anaesthetics such as Ropivacaine belonging to the amino amide group have been utilised for brachial plexus blocks. Ropivacaine offers the advantage of prolonged action similar to bupivacaine but without the cardiotoxicity associated with the latter. To further extend the duration of action, several techniques have been explored including increasing the volume of the administered drug (with the caveat of potential toxicity), continuous drug infusion through catheters (requiring skill and increased cost) and the addition of adjuvants like Clonidine, Dexmedetomidine, Dexamethasone, opioids and Vasopressors.[8] These strategies collectively contribute to the ongoing refinement of anaesthesia practices, optimising patient comfort, safety and outcomes in the surgical setting.

Dexmedetomidine, a highly selective α2 adrenergic receptor agonist with eight times greater affinity for α2 receptors than α1 receptors is frequently used as an adjuvant to local anaesthesia. Its primary role is to extend nerve block duration thus enhancing anaesthesia's effectiveness.[9] Conversely buprenorphine, a lipophilic opioid, exhibits a strong affinity for μ receptors and boasts an extended duration of action while causing fewer side effects. It is also known for its cost-effectiveness.[10] However, despite extensive research in the existing literature only limited data is available comparing the effects of Dexmedetomidine and Buprenorphine when used as adjuvants to ropivacaine in peripheral nerve blocks. Therefore, the study aimed to compare and evaluate the effects of buprenorphine and dexmedetomidine as an adjuvant to 0.5% ropivacaine in the ultrasound-guided supraclavicular block for elective upper limb surgeries.

MATERIALS AND METHODS

This prospective randomized double-blinded comparative study was conducted at Government Vellore Medical College, Vellore from May 2018 to July 2019 on patients undergoing elective upper limb Surgery. Ethical approval of the study protocol was obtained from the Ethical Committee at the institution before the study was undertaken. Written and informed consent was obtained from each patient in the prescribed format before performing any study-related procedures.

Inclusion Criteria

ASA physical status I & II undergoing elective upper limb surgeries, patients aged between 18 and 60 years old, and weight above 40 kg were included.

Exclusion Criteria

Patient refusal, allergy to local anaesthetics and opioids, local infection at the site of block, pregnant women, severe cardiopulmonary disease, patients with neurological deficit in the operating arm, bleeding disorders/patients on anticoagulants, ASA III-IV, and patients who needed or converted to general anaesthesia after unsuccessful block or block failure were excluded.

Each patient was randomly allocated into two groups (Group RB and Group RD of 25 patients in each group. Both groups received an equal volume of the drug (0.5% Ropivacaine 25 ml + 1 ml adjuvant, a total of 26 ml). Group RB received 25 ml of 0.5% ropivacaine (maximum of 3mg/kg) with 1 ml (0.3mg) of Buprenorphine. Group RD received 25 ml of 0.5% ropivacaine (maximum of 3mg/kg) with 1 ml (50 μg) Dexmedetomidine.

The materials required for the procedure include a sterile tray, sterile swab, sterile towel, sponge-holding forceps and drugs such as 0.5% Ropivacaine, Inj. Buprenorphine and Inj. Dexmedetomidine. Additionally, a sterile needle for insertion, a high-frequency ultrasound probe with a sterile cover, equipment and drugs for resuscitation and conversion to general anaesthesia in case the block procedure fails.

Pre-Operative Preparation

Basic investigations recommended for ASA physical status I and II patients like haemoglobin, random blood sugar, blood urea, serum creatinine, urine for albumin and sugar, chest x-ray and electrocardiogram were taken and reviewed. All the patients were pre-medicated with the drug Inj. Ranitidine 50 mg and Inj. Ondansetron 8 mg before the surgery. On arrival of patients to the operating room monitors like pulse oximeter, non-invasive blood pressure and ECG were connected and the patient's baseline values were recorded. An 18G intravenous cannula was inserted in the contralateral forearm and an IV infusion started. All emergency drugs and intubation kits were kept ready.

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Supraclavicular Block- Procedure

Patients were asked to lie supine with their head turned to the contralateral side, their ipsilateral arm adducted and their shoulder kept down with a flexed elbow. After complete sterile preparation, the brachial plexus was visualised with a sterile covered 8 -13 MHz linear high-frequency ultrasound transducer placed in the sagittal plane in the supraclavicular fossa behind the middle third of the clavicle. The brachial plexus was found to appear as three hypoechoic circles with hyperechoic outer rings or as a cluster of grapes located superolateral to the subclavian artery between the anterior scalene and middle scalene muscle. The predicted volume of 26 ml of prepared drug solution was administered around the bunches of brachial plexus after negative aspiration to avoid accidental intravascular needle puncture.

The "Onset of Sensory Blockade" was monitored which signifies the duration between the administration of local anaesthetic and the complete loss of sensation to pain, evaluated using a pinprick test with a three-point scale. This scale ranges from Grade 0 for normal sensation to Grade 2 for a complete loss of sensation to touch and pain. Similarly, the "Onset of Motor Blockade" was recorded using the Modified Bromage Scale, categorising motor function from Grade 0 for normal function to Grade 2 for the complete motor block. The "Duration of Sensory Blockade" was defined as the time from complete sensory block to restoring normal sensation. Correspondingly, the "Duration of Motor Blockade" denoted the period between complete motor block and full motor recovery. Lastly, "Duration of Analgesia" was documented as the time elapsed from complete sensory block to a VAS score of ≥ 4 or when the patient requested analgesia.

Heart rate and blood pressure were recorded before the procedure and immediately after the supraclavicular block, then at 5-minute intervals for the first 60 minutes, and later at 15-minute intervals till completion of the surgery. The last reading was taken 10 minutes after the procedure. Postoperative BP and Heart rate were measured every two hours until 24 hours. All patients were monitored for complications (if any) during the intraoperative and postoperative periods (24 hours). The observations and particulars of each patient were recorded in the pro- forma enclosed.

Statistical Analysis

All the data were entered into MS Excel and all continuous variables were expressed as Mean and Standard Deviation. All categorical variables were expressed as percentages and proportions. The unpaired t-test assesses normally distributed continuous variables and the Mann-Whitney U test was used for continuous variables that did not follow a normal distribution. A p-value (< 0.05) indicates a statistically significant between the groups.

RESULTS

The mean age in years was 36.56±11.45 in group RB and 43.12±14.10 in group RD with a p-value of 0.077. The male-to-female ratio in group RB was 80/20 and in group RD it was 80/20 with a p-value of 1.000. The median range of weight in kilograms was 65 [58, 70] (Kg) in group RB and 60 [57.50, 66] (Kg) in group RD with a p-value of 0.355. Hence the two groups are comparable in age, sex ratio and weight. There was no statistically significant difference between the two groups in age, gender, and weight (Table 1).

The median onset time for the sensory block is 7 (6,10) [minutes] in group RB and 7 (5, 8.50) [minutes] in group RD with a p-value of 0.452. The Median onset time of motor block is 11 [9,15] (minutes) in group RB and 10 [10, 15] (min) in group RD with a p-value of 0.556 [Table 2]. The mean duration of sensory block is 681.52 ± 132.06 (minutes) in group RB and 752.72 ± 124.32 (minutes) in group RD with a p-value of 0.055. There was no significant difference between the two groups in the onset time for the sensory block, onset time of the motor block and duration of the sensory block. The mean duration of the motor block is 630.52±131.35 (minutes) in group RB and 705.00 ± 120.26 (minutes) in group RD with a p-value of 0.042. The mean time for the duration of analgesia is 703.12 ± 124.74 (minutes) in group RB and 776.48 ± 130.83 (min) in group RD with a p-value of 0.048. There is a significant difference between the two groups in the duration of motor block and duration of analgesia (Table 2).

It was found that 3 out of 25 patients in the Buprenorphine group had an incidence of post-op Vomiting, and no side effects were found in the Dexmedetomidine group.

Table 1: Age, gender, and weight between groups

Parameter		Group		Unpaired t-test
		Ropivacaine plus buprenorphine (N=25)	Ropivacaine plus dexmedetomidine (N=25)	
Age (Mean± SD)		36.56 ± 11.45	43.12 ± 14.10	0.077
Gender	Male	20 (80%)	20 (80%)	1
	Female	5 (20%)	5 (20%)	
Weight (kg)		65 (58, 70)	60 (57.50, 66)	0.355

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Table 2: Comparison of sensory block, motor block and analgesia between groups

Parameter	Group		Mann Whitney U test t-test
	Ropivacaine plus buprenorphine (N=25)	Ropivacaine plus Dexmedetomidine (N=25)	
Onset of sensory block (minutes) [Median (IQR)]	7 (6, 10)	7 (5, 8.50)	0.452
Onset of motor block [Median (IQR)]	11 (9, 15)	10 (10, 15)	0.556
Duration of sensory block (Mean ± SD)	681.52 ± 132.06	752.72 ± 124.32	0.055
Duration of motor block (Mean ± SD)	630.52 ± 131.35	705 ± 120.26	0.042
Duration of analgesia (Mean ± SD)	703.12 ± 124.74	776.48 ± 130.83	0.048

DISCUSSION

Peripheral nerve blocks are widely used in upper limb surgeries for muscle relaxation, stable intraoperative haemodynamics, pain control, post-operative analgesia, early recovery, and reduced side effects. The ultrasound-guided technique improves success rates, reduces local anaesthetic dosage, and eliminates complications. However the advantages of local anaesthetics are limited by their brief duration of action, potentially causing block resolution before post-operative pain. Adjuvants like opioids and α2 adrenergic agonists have been tried to prolong the effects. Ropivacaine is a long-acting local anaesthetic drug similar to Bupivacaine with reduced CNS and cardiac toxicity and similar efficacy in peripheral nerve blocks.

Gaurav Kuthiala et al. concluded that the efficacy and effects of ropivacaine are similar to that of bupivacaine and its congener levobupivacaine for peripheral nerve blocks and Shailendra Modak et al. concluded that ropivacaine 0.5% could be safely used as a good alternative to bupivacaine 0.5% in a supraclavicular block.[11,12] Also Stephen M. Klein et al. concluded that increasing the concentration of ropivacaine from 0.5% to 0.75% failed to improve the onset or duration effects of the block.[13] Thus with all these advantages over bupivacaine we decided to use 25 ml Ropivacaine 0.5 % (125 mg) for patients above 40 kg, considering a maximum dose of 3 mg/kg. Our study shows no significant difference in age, gender and weight between the groups.

In the study done by Neena Jain et al., the mean onset time for sensory block in the buprenorphine group was around 8.60 ± 2.82 min and the mean onset time of motor block in buprenorphine was around 11.13 ± 1.89 min. They concluded that onset was significantly faster in the Buprenorphine group than in the control group.[14] In the study by Jithendra Chinnappa et al. with dexmedetomidine as an adjuvant, the sensory block onset time was 9.5 ± 5.8, and the mean motor block onset time was 15.6 ± 6.3. They concluded that the Dexmedetomidine group's sensory and motor block onset was significantly faster.15 In our study, the median onset time for the sensory block is 7 (6,10) [minutes] in group Ropivacaine plus Buprenorphine group (RB) and 7 (5, 8.50) [minutes] in group Ropivacaine with Dexmedetomidine (RD) with a p-value of 0.452. The Median onset time of motor block is 11,[9,15] (min) in group RB and 10,[10,15] (min) in group RD with a p-value of 0.556. The two groups had no significant difference in the sensory and motor block onset time. In the study done by Neena Jain et al. with buprenorphine, the mean duration of motor and sensory block was significantly longer in Buprenorphine Group B (451.8 ± 57.18 min) and (525.8 ± 50 min) respectively, than in the control Group C (320.5 ± 43.62 min) and (373 ± 53.78 min) respectively (P < 0.05).14 Also in the study done by Jithendra Chinnappa et al. with dexmedetomidine as an adjuvant, the duration of sensory and motor block in the dexmedetomidine group was around 630.6 ± 208.2 and 545.9 ± 224.0 minutes which is greater than the control group.15 In our study, the mean duration of sensory block is 681.52 ± 132.06 (minutes) in group Ropivacaine plus buprenorphine and 752.72 ± 124.32 (minutes) in group Ropivacaine with dexmedetomidine with a p-value of 0.055 and it was concluded that there was no significant difference among two groups (P>0.05). Also, the mean duration of motor block is 630.52 ± 131.35 (minutes)in group Ropivacaine plus buprenorphine and 705.00 ± 120.26 (minutes) in group Ropivacaine plus dexmedetomidine with a p-value of 0.042 thus having a significant difference among two groups (P < 0.05).

In the study done by Neena Jain et al. with buprenorphine, the mean duration of analgesia was 868.2 ± 77.78 min and in the study done by Jithendra Chinnappa et al. with dexmedetomidine, the duration of analgesia was 805.7 ± 205.9 min.14,15 In our study, the mean time for the duration of analgesia is 703.12 ± 124.74 (min) in group Ropivacaine plus Buprenorphine and 776.48 ± 130.83 (min) in group Ropivacaine plus Dexmedetomidine with a p-value of 0.048 thus having a significant difference among two groups (P < 0.05). 3 out of 25 patients in the Buprenorphine group had an incidence of post-op Vomiting and no side effects were found in the Dexmedetomidine group.

CONCLUSION

The addition of Dexmedetomidine (50 micrograms) to local anaesthetic Ropivacaine in ultrasound-guided supraclavicular brachial plexus block shows prolongation of the duration of motor blockade and duration of analgesia when compared to

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Buprenorphine (300 micrograms) with Ropivacaine without any side effects.

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