ORIGINAL ARTICLE

EFFECT OF PERINEURAL ADMINISTRATION OF DEXMEDETOMIDINE WITH BUPIVACAINE VERSUS BUPIVACAINE ALONE IN ULTRASOUND GUIDED SUPRACLAVICULAR BLOCK FOR UPPER EXTREMITY ORTHOPAEDIC OPERATIONS

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Background: During procedures on the upper limbs, the brachial plexus block is usually advised. To increase the length of the block, many medicines have been utilized as adjuvants. The purpose of this study was to compare the effects of dexmedetomidine plus bupivacaine against bupivacaine alone on the onset and duration of the sensory and motor block and the duration of analgesia in the supraclavicular block during upper extremity orthopaedic surgery. **Methods:** Sixty individuals qualified for orthopaedic operations on the upper extremities, ranging in age from 20 to 60 years, participated in this prospective, randomized investigation. The modified Bromage scale and the pinprick method were used to assess the sensory and motor block. Using a visual analogue pain scale, the postoperative pain was evaluated at 0, 6, 12 and 24 hours after surgery. **Results:** In patients receiving only bupivacaine, the mean onset time of sensory and motor block was 32.84 minutes and 26.67 minutes respectively; while in those receiving bupivacaine along with dexmedetomidine, it was 23.38 minutes and 14.81 minutes (p<0.005). In the intervention group (bupivacaine and dexmedetomidine), the period between the first request for analgesia and the duration period of sensory and motor block were both longer (p<0.005). The intervention group experienced less postoperative discomfort for 24 hours (p<0.05). **Conclusion:** Dexmedetomidine added to bupivacaine perineurally prolonged both numbness and immobility while shortening the time it took for sensory and motor blocks to begin. Moreover, dexmedetomidine considerably decreased postoperative pain when combined with bupivacaine for supraclavicular blocks.

Keywords: Perineural administration; Dexmedetomidine; Bupivacaine; Supraclavicular block

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INTRODUCTION

The distal upper extremity surgical procedure makes extensive and efficient use of the supraclavicular block.[1] When doing distal limb surgery under general anaesthesia or by itself, this approach has extremely few problems. Nonetheless, a variety of studies have been published regarding the efficacy of this technique in upper limb surgery. Yet no specific pharmacological combination has been thought of yet to be used for the supraclavicular block.[1] Epinephrine, alpha 2-agonists, corticosteroids, bicarbonate, and opioids all have been used to prolong local anaesthetic effects in the supraclavicular block. Although epinephrine is the most widely used adjunct of all with multiple benefits such as the reduction of local anaesthetic toxicity by reducing its absorption, and prolongation of anaesthesia, it can cause sympathetic discharge resulting in tachycardia and hypertension, thus, limiting its use in ischemic heart disease patients.[2] Pneumothorax, Horner's syndrome, phrenic nerve block and neuropathy are some of the complications of supraclavicular brachial plexus block.[3]

Bupivacaine is a potent drug of the amide group of local anaesthetics widely used for regional and local anaesthesia since 1957.[4] Using adjuncts in local anaesthesia can cause a reduction of the total dose of local anaesthetic drugs for nerve block thus reducing their side effects, and the benefits of added drugs can be increased. Drugs that have been used as adjuvants include magnesium, dexamethasone[4], midazolam[5] and alpha-2 receptor-stimulating drugs which have been proven to have excellent analgesia and anaesthesia with hemodynamic stability and sedative effects.

Dexmedetomidine had been recently tested alongside bupivacaine in peripheral nerve blocks. It is linked to clonidine and is a functional D-isomer of medetomidine.[6,7] Its 2:1 ratio makes it a selective

alpha-2 agonist, and cytochrome P450 and liver glucuronidation are both involved in the drug's metabolism.[8,9]

Dexmedetomidine with bupivacaine was compared to other medicines such as levobupivacaine and clonidine with bupivacaine in a brachial plexus block for upper extremity surgery by Singh *et al*. and Tripathi *et al* respectively.[10,11] They concluded that dexmedetomidine lengthens analgesia, improves the block's effect, prolongs their endurance and minimizes the start of sensory and motor blocks without the incidence of unwanted systemic complications. 25 studies on the effectiveness and safety of dexmedetomidine were examined in two meta-analyses of randomized controlled trials. The study comes to the conclusion that more research should concentrate on the efficiency and safety of dexmedetomidine delivery perineurally.[12–19]

Our study evaluated the impact of perineural dexmedetomidine combined with bupivacaine versus bupivacaine alone on the duration of the sensory and motor block, the pain score, and the hemodynamic changes after supraclavicular block in upper limb orthopaedic surgery. The pinprick method, the Bromage scale, and the visual analogue scale were used to measure sensory and motor block quality and postoperative pain respectively. Dexmedetomidine's impact on hemodynamics, complications, and the first analgesic request time was among the secondary outcomes

MATERIAL AND METHODS

The Ethical Review Committee approved this randomized, prospective trial dated 20 September 2022; Reference number MSF (H)/308/3/1/Trg. In this study, 60 patients with American Society of Anaesthesiologists (ASA) grades I and II between the ages of 20 and 60 years participated. Patients, who were on the elective list for upper extremity orthopaedic surgery, were divided into two groups (intervention and control groups) by lottery method. Those who met the following criteria were excluded: patients with a history of renal, respiratory, cardiovascular, or hepatic disease; pregnant women; diabetics; those with neurological or neuromuscular disorders; those who had a contraindication for supraclavicular block, such as coagulopathy or those who had a local infection; and psychiatric patients who refused to consent or expressed displeasure with the procedure. Before taking part in the trial, each patient signed an informed consent form. The primary anaesthesiologist was blinded to the group of patients. Patients were explained the Visual analogue score (VAS) thoroughly by an anaesthesiologist a day before the surgery (0 means no pain,1–4 is for mild pain, 5–8 for moderate pain and 9 to 10 means severe pain).

Patients in the dexmedetomidine group (intervention group) got 39 ml of bupivacaine (0.25%) plus 0.75 microgram/kg dexmedetomidine (40 ml total). Patients in the control group got a total volume of 40 ml consisting of 39 ml of 0.25% bupivacaine and 1 ml of normal saline. Patients were kept nil per oral (N.P.O) for eight hours prior to surgery.

In the operating room, patients were connected to monitoring devices such as a standard pulse oximeter, a non-invasive blood pressure monitor and an electrocardiogram. Heart rate, blood pressure, and oxygen saturation were measured at baseline. After putting an 18-gauge intravenous catheter into the nonoperative arm prior to performing a supraclavicular block, all patients were premedicated with 0.04 mg/kg of midazolam and given 5 L/min of oxygen via nasal cannula. They were positioned supine, and their heads were turned 45 degrees to the contralateral side. The arm was abducted at 90 degrees. Before carrying out the procedure, all aseptic measures were taken. The supraclavicular plexus site was established using a nerve stimulator, a 22-gauge, 55-mm-long stimulating needle and an ultrasonic device (Stimuplex; Draminiski, Poland). When the distal limb responded satisfactorily to the output current of 0.5 mA, it was determined that the needle's position was appropriate.

The local anaesthetic was administered under ultrasound guidance. Sensory blocking of each nerve in sensory dermatomes associated with sensory areas was assessed using the pinprick method and scored as 0 = no sensation, 1 =dull sensation, and 2=intense pain. The motor blockage was graded using a modified Bromage scale as follows: 3 indicates elbow flexion against gravity's force, 2 indicates wrist flexion against gravity's force, 1 indicates finger movement, and 0 indicates no motion. The time between the administration of local anaesthetic and the loss of sensation to a pinprick test was used to determine the onset of sensory block. The time between the injection and the second Bromage was used to calculate the onset of motor block. The sensory level and motor blockages were evaluated every 3 minutes for the first 30 minutes following a complete dose of the local anaesthetic agent. When it was judged that the block was sufficient, surgery was permitted.

All vital data, including heart rate, blood pressure, respiratory rate and oxygen saturation were recorded on the checklist every five minutes for the first thirty minutes and then every ten minutes for the remainder of the procedure. Following surgery, sensory and motor blockade, as well as vital signs, were immediately measured in the recovery room.

Patients' perceptions of postoperative pain were assessed using the Visual analogue scale which was explained to them as a scale ranging from 0 to 10

for pain intensity (0= no pain, and 10= for worst pain imaginable). At six, twelve, and twenty-four hours after surgery, the level of pain was measured and documented in the recovery area. Analgesic medication was given when the VAS score exceeded 4. The time between the administration of the local anaesthetic and the administration of the first analgesic determined the duration of analgesia. Adverse symptoms such as hypotension (a 20% reduction from baseline), bradycardia (heart rate equal to or less than 50/min), nausea and vomiting were tracked and documented for each patient in the questionnaire.

Based on the 2016 study by Tripathi *et al.*[11] and 95% confidence interval (p=0.05), the sample size was estimated to be 30 patients per group. Data was analyzed using SPSS software version 23. In this study, frequencies were calculated for qualitative characteristics such as gender, age of the patients and the type of upper extremity orthopaedic surgeries they underwent. The chi-square test was applied to the categorical data. In addition, an independent samples T-test was employed to compare quantitative factors between the two groups. p value <0.05 was considered statistically significant. ANOVA test was performed to compare the average pain scores at the end of surgery and at 6-, 12- and 24-hours following surgery.

RESULTS

Out of the 60 patients, 30 were males and 30 were females. 16:14 patients had soft tissue: bony tissue surgery in group Bupivacaine alone (group A) while 14:16 patients had soft tissue: bony tissue surgery in group Bupivacaine with Dexmedetomidine (group B). The mean age of the patients in group A was 42.26± 11.05 and in group B was 42.40± 10.97 (p-value 0.724). Table-1.

The intervention group (bupivacaine with dexmedetomidine) had a shorter upper extremity sensory block start time, i.e., 23.38±2.37 minutes than the control group (bupivacaine alone) which is 32.84±3.25 minutes. The control group had a longer upper extremity motor block start time, i.e., 26.67±1.62 minutes than the intervention group which is 14.81±1.16 minutes. The intervention group had 487.83±42.88 of upper extremity sensory block, while the control group had 353.26±37.95. The intervention group had longer analgesia than the control group, which was statistically significant (p-value <0.05). In the intervention group, the motor block lasted for 504.66±40.47 minutes compared to 349.33±49.67 minutes in the control group. The intervention group requested analgesia at 450.06±25.77 minutes while the control group asked at 313.70±44.91 minutes. The control group had more initial analgesic requests than the intervention group (p-value <0.05). Table-2 and 3.

After surgery and at 6, 12 and 24 hours after surgery, the control group had mean Visual analogue scale VAS pain scores of 0.30±0.44, 2.06±0.17, 3.13±0.22 and 5.86±0.54 while the intervention group had 0.11±0.25, 1.11±0.21, 3.00±0.00 and 5.20±0.44 mean scores showing statistically significant differences at 6 and 12 and 24 hours after surgery indicating that there was no difference in pain score at the end of surgery between the two groups but as the time progressed, patients in the Dexmedetomidine with Bupivacaine group experienced lesser pain and discomfort as compared to patients who received Bupivacaine only (p-value <0.05). Figure 1 and Table 3.

Overall, a total of 2 patients in the intervention group had bradycardia. 1 control patient and 2 intervention patients had hypotension. 1 control patient and 1 intervention patient experienced nausea and vomiting. Figure 2 and Table-4.

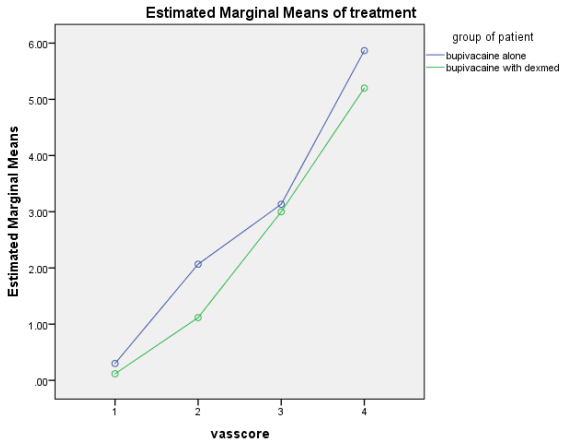

Figure-1: Plotting VAS scores measured at 0, 6, 12 and 24 hours after surgery between the control and intervention groups of patients.

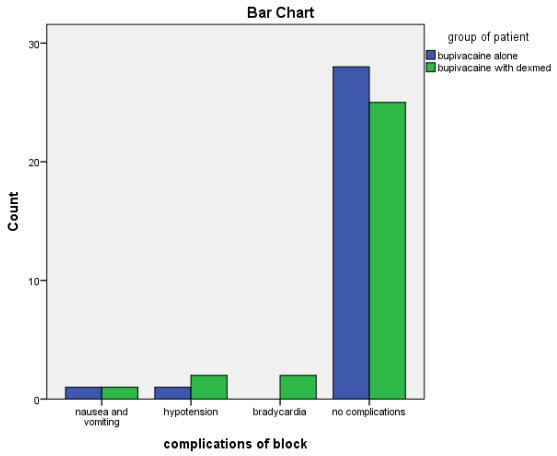

Figure-2: Complications of the block

Table-1: Mean±SD of Demographic characteristics of patients (n=60)

Demographics	Mean±SD Group A (n=30)	Mean±SD Group B (n=30)	*p*-value
Age (years)	42.26± 11.05	42.40± 10.97	0.724
Gender: (Male: Female)	15:15	15:15	0.602
Kind of surgery: (Soft tissue: bony tissue)	16:14	14:16	0.398

Table-2: Comparison of block characteristics in both groups (n=60)

Block characteristics	Mean±SD Group A (n=30)	Mean±SD Group B (n=30)	*p*-value
Time of sensory block onset (minutes)	32.84±3.25	23.38±2.37	0.141
Time of motor block onset (minutes)	26.67±1.62	14.81±1.16	0.138
Time of sensory block duration (minutes)	353.26± 37.95	487.83± 42.88	**0.025**
Time of motor block duration (minutes)	349.33± 49.67	504.66± 40.47	0.494
Analgesia duration (minutes)	313.70±44.91	450.06±25.77	**0.000**

Table-3: Comparison of Postoperative pain characteristics in both groups (n=60)

Post-operative pain and analgesia characteristics	Mean±SD Group A (n=30)	Mean±SD Group B (n=30)	*p*-value
VAS pain score at the end of surgery	4.466± 0.50	4.933± 0.25	0.055
VAS pain score at 6 hours after surgery	2.433± 0.62	1.933± 0.52	**0.000**
VAS pain score at 12 hours after surgery	2.433± 0.62	2.433± 0.62	**0.002**
VAS pain score at 24 hours after surgery	2.966± 0.18	2.833± 0.37	**0.000**

Table-5: Comparison of complications in both groups (n=60)

Complications	Group A n=30 (%)	Group B n=30 (%)	*p*-value
Nausea and vomiting	1 (3.3%)	1 (3.3%)	0.475
Bradycardia	0	2 (6.6%)	
Hypotension	1 (3.3%)	2 (6.6%)	
No complications	28	25	

DISCUSSION

Quick onset, sustained analgesia, and motor block without adverse consequences characterized the optimal local block. As a result, numerous different medicines have been introduced as adjuvants to topical anaesthetics. Alpha 2 agonists such as clonidine have been used alongside ropivacaine in axillary blocks.[12] In recent research, dexmedetomidine injection has been characterized as an effective method for extending the duration of a block. However, it raised the risk of bradycardia, hypotension, and sedation.[8,19]

Presynaptic alpha receptor activation in the brain and spinal cord limits the release of norepinephrine and pain signals. The impact of dexmedetomidine on the locus coeruleus induces spontaneous sleep in the patient.[17,18] Without nerve injury, dexmedetomidine has been employed.

In a 2012 study by Gandhi *et al*. comprising 70 patients, the bupivacaine group experienced sensory and motor block beginning more quickly than the bupivacaine with dexmedetomidine group. However, the dexmedetomidine group experienced a longer-lasting sensory and motor blockage. The dexmedetomidine intervention group's analgesia lasted longer than that of the control group.[20] Our study conclusions were found to be similar to the above-mentioned research.

According to a meta-analysis conducted by Abdallah and Brull in 2013 and two studies conducted in 2014 and 2015 by Agarwal *et al*. and Bharti *et al*. respectively, the addition of dexmedetomidine to additional medications prolongs postoperative analgesia and motor and sensory block of the brachial plexus along with a statistically significant reduction in the sensory and motor block's onset time.[14,21,22] Secondly, Bharti *et al*. study concluded pain scores were significantly higher in the control group at 8 and 10 hours compared to the dexmedetomidine group.[22] The findings of these investigations align with those of our own study's conclusion. However, the dose of dexmedetomidine used in the two investigations was not the same.[21,22]

Kathuria *et al*. found in independent investigations that the combination of dexmedetomidine and ropivacaine accelerated the onset and extended the duration of motor and sensory block in comparison to ropivacaine alone.[23] However, in our study, we used bupivacaine instead of ropivacaine both of which belong to the amide local anaesthetics.

Our investigation showed that dexmedetomidine decreased the start time of sensory and motor blockades while increasing their length and decreasing post-operative discomfort mirroring the results of those of prior research.[21–28] Hypotension and bradycardia are, however, the most prevalent adverse effects associated with alpha 2-agonists. In our study, a low dose of dexmedetomidine was likely responsible for the occurrence of bradycardia in two of the thirty intervention group participants. In both groups, a total of three patients had hypotension.

CONCLUSION

The time period of sensory and motor blocks' onset was significantly lessened by the combination of dexmedetomidine and bupivacaine in the supraclavicular block. It lengthened sensory and motor blocks' duration without causing significant side effects like bradycardia and hypotension. Also, in the dexmedetomidine and bupivacaine group, dexmedetomidine significantly decreased postoperative pain.

The lack of serum dexmedetomidine dose measurement during surgery was a limitation of our study that made assessing this medication's systemic effects after local absorption unpredictable. We suggest more exploratory studies that will evaluate patients receiving intravenous dexmedetomidine which will overcome this limitation.

Conflict of interest:

There is no conflict of interest among authors.

AUTHORS' CONTRIBUTION

MK: Conception of study Experimentation/ Study conduction. MK, AH: Analysis, interpretation, discussion. MK, FF: Manuscript writing. AAT, SA, MSF, SF: Critical review, proofreading.

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