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A study to compare the Ultrasound-guided Supraclavicular Brachial plexus nerve block using bupivacaine with dexmedetomidine and only bupivacaine for upper limb surgeries: A prospective randomized control trial

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Abstract

Background and Objectives: Adjuncts to local anaesthetics for brachial plexus block enhances the quality and duration of analgesia. The purpose of this study was to compare the effects of dexmedetomidine, when added as adjuvant to bupivacaine, in respect to onset, duration of sensory and motor block along with duration of analgesia.
Materials and Methods: After informed consent, 60 ASA I and II patients scheduled for elective/emergency upper limb surgeries under supraclavicular brachial plexus block (under ultrasound guidance) was randomized were divided into two equal groups-Group A & B. Group A-received bupivacaine 28 ml (0.25%) & dexmedetomidine 1µg/kg, and Group B-received bupivacaine 28 ml (0.25%) & 2ml normal saline. Onset and duration of sensory and motor block, duration of analgesia were studied in both the groups.
Results: Both groups were comparable with regard to age, sex distribution & duration of surgery. There was no statistically significant difference. Onset of sensory and motor blockade was 9.2±1.6min and12.8±1.6mins, respectively in group A, while it was 17.7±2.6min and 23.5±1.7min respectively in Group B, which (p value<0.001) is statistically significant. Duration of sensory block and motor block was 648±49.1min 600.2±45.9min, respectively, in group A, while it was 250.5±26.8min and 206.0±19.0min respectively, in group B, which (p value<0.001) is statistically significant. The duration of analgesia in group A was 720.8±44.2 min, while in group B, it was 268.9± 23.1min which (p value<0.001), is also significant. There were no adverse events noted in either group. All patients were haemodynamically stable.
Conclusion: Dexmedetomidine when added to bupivacaine in supraclavicular brachial plexus block had faster onset, greater duration of sensory and motor block and also longer the duration of analgesia, than in bupivacaine alone.

Keywords: bupivacaine, dexmedetomidine and upper limb surgeries

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Introduction

Peripheral nerve blocks not only provide intraoperative anaesthesia but also extend analgesia in the postoperative period without any systemic side effects [1]. Supraclavicular block is widely employed regional nerve block for operation on elbow, forearm, and hand. Blockade occurs at the distal trunk-proximal division level. At this point brachial plexus is compact and small volume of solution produces rapid onset of reliable blocked of brachial plexus. Brachial plexus block remains the practical alternative to general anaesthesia for surgery on upper limb. It provides superior quality of analgesia avoids the common side effects of general anaesthesia such as postoperative nausea and vomiting. Useful in cardiovascular disease, respiratory disease, morbid obesity and in those with potential airway difficulties [1].

Supraclavicular brachial plexus block via Winne's approach is very popular mode of anaesthesia for various upper limb surgeries [2]. This approach is attractive due to its effectiveness in terms of cost and performance.

Local anaesthetic, Bupivacaine is the commonest agent used for spinal anaesthesia, but its relatively short duration of action may lead to early analgesic intervention in the postoperative period. There has always been a search for adjuvants to the regional block with drugs that prolongs the duration of analgesia with lesser adverse effects. Many drugs have been tried like opioids, clonidine, hyaluronidase, dexamethasone, midazolam, etc.

α_2 adrenergic receptor agonists have been tried either alone or in combination with another drug to prolong anaesthesia in various methods of anaesthetic administration like epidural, intrathecal and regional nerve blocks. Dexmedetomidine is a α_2 AR receptor agonist with evidence of an increased ratio of $\alpha_{2:}\alpha_1$ activity of 1620:1 as compared to 220:1 when contrasted against clonidine [3, 4]. The mechanism by which α_2 AR receptor agonist produces analgesia and sedation is by reducing release of nor epinephrine, leading α_2 agonist receptor independent inhibitory effects on nerve fibre action potentials. Dexmedetomidine possess analgesic properties and many other advantageous influences, but also lacks respiratory depression that may make it a useful and safe adjunct in many diverse clinical applications [4, 5]. Dexmedetomidine have enabled and overall improved blocked quality when added to local anaesthetics in a peripheral nerve block model, it shortens the onset time of both sensory and motor block prolongs the duration of postoperative analgesia.

The first Supraclavicular brachial plexus block was performed by Kulenkampff in 1912 [6]. The classical approach using paraesthesia technique may be associated with higher failure rate and injury to nerves and vascular structures. To avoid some this problems use of peripheral nerve stimulator was started which allowed better localization of nerves/plexus. However, this technique may not be fool proof with persistent risk of injury to surrounding structures especially vascular structures, nerves and pleura leading to pneumothorax [7].

Dynamic visualization of the relevant anatomical structures and needle along with observation of local anaesthetic spread in real time are arguably the biggest advantages of ultrasound-guided regional anaesthesia (UGRA). Where in ultrasound probes with suitable frequencies have been successfully tried.

Objectives

To compare Ultrasound guided supraclavicular brachial plexus nerve block using 0.25% bupivacaine with dexmedetomidine and only 0.25% bupivacaine for upper limb surgeries.

Materials and Methods

The randomized control trail was conducted on sixty patients aged 20-60 years undergoing upper limb surgery for elective and emergency surgery during a 12-month period conducted by the Department of Anaesthesiology, Noble Hospital, Pune.

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Inclusion criteria

1. Patients of either sex, aged between 20-60 years.
2. Patients with American society of Anaesthesiologists grade I and grade II physical status.
3. Elective and emergency upper limb surgeries.

Exclusion criteria

1. Patients on adrenoreceptor agonist and antagonist therapy.
2. Known hypersensitivity to local anaesthetics.
3. Uncontrolled diabetes mellitus.
4. Pregnant woman, breast feeding mothers.
5. Pre-existing peripheral neuropathy.
6. Patients with bleeding disorders.
7. ASA III and above.
8. Drug addicts.
9. Patients with systemic disease like liver disease and renal disease.

The patients were randomly divided in to two groups of 30 patients each:-
Group A: To receive supraclavicular brachial plexus block with Bupivacaine 0.25%-28ml and Dexmedetomidine 1µg/kg.
Group B: To receive supraclavicular brachial plexus block with Bupivacaine 0.25%-28ml and 2ml Normal saline.

After obtaining the consent of the 60 study subjects A pre-anaesthetic check-up was done for all patients which included a detailed history, general physical and systemic examination. Basic investigations was done (Hb%, complete blood counts, bleeding time, Clotting time, PT, INR, random blood sugar, serum urea, serum creatinine, CXR, ECG. Patients kept nil per oral overnight (6hours prior to surgery).
On arrival in the operating room, baseline heart rate, ECG recording, blood pressure and oxygen saturation was recorded. An intravenous line secured, in the unaffected limb and IV fluids started. All the patients received brachial plexus block through the supraclavicular approach under ultrasound guidance. Patients assessed intra and postoperatively.

Sensory block will be assessed by pinprick test using 3-point scale

0	Normal sensation
1	Loss of sensation of pinprick (analgesia)
2	Loss of sensation of touch (anaesthesia)

Motor blockade will be done using Bromage three-point score

1	Normal sensation
2	Decreased motor strength with ability to move fingers only
3	Complete motor block with inability to move fingers

Sensory and motor blocks evaluated every 3 minutes until 30 minutes after injection.
Onset time of sensory block defined as the time interval between the end of total local anaesthetic administration and complete sensory block. Duration of sensory block was defined as the time interval between end of local anaesthetic administration and complete resolution of anaesthesia on all nerves.
Onset of motor block defined as the time interval between the end of local anaesthetic administration and complete motor block. Duration of motor block is defined as time interval between end of local

anaesthetic administration and complete resolution of motor block.
Heart rate, ECG changes, systolic blood pressure (SBP), diastolic blood pressure (DBP) and saturation of oxygen (SpO_2) were recorded at 0 minutes, 5 minutes, 10 minutes, 15 minutes, 30 minutes, 45 minutes, 60 minutes, 90 minutes and 120 minutes. Adverse events like hypotension and bradycardia was monitored. Duration of motor and sensory blockade after surgery were recorded.
Rescue analgesia diclofenac sodium 75mg IV (infusion) was given when patient visual analogue score ≥4.
0-No pain
10-Worst possible pain.

Statistical analysis was carried out with the help of SPSS (version 20) for Windows package (SPSS Science, Chicago, IL, USA). The description of the data was done in the form of mean +/- SD for quantitative data while in the form of % proportion for qualitative (categorical) data. *P*-values of < 0.05 was considered significant. For quantitative data Student's t-test was used to test statistical significance of difference between two independent group means. Chi square test (or Fisher's exact test in case of small frequencies in cell) was used to examine the associations between qualitative/quantitative variables.

Results

A total of 60 study subjects with 30 subjects in each group.

Table 1: Social Profile of the study subjects

		Group A [Dexmedetomidine & Bupivacaine] (n=30)]	Group B [Bupivacaine (n=30)]	Inter-Group Comparison (P-value) Group A v/s Group B
Age Group (years)	<25	4 (13.3)	3 (10.0)	0.784 (NS)
	25 – 34	17 (56.7)	18 (60.0)	
	35 – 44	4 (13.3)	6 (20.0)	
	>=45	5 (16.7)	3 (10.0)	
Gender	Male	26 (86.7)	26 (86.7)	0.999 (NS)
	Female	4 (13.3)	4 (13.3)	
Weight	Mean ± SD	66.6 ± 10.0	66.1 ± 11.5	0.866 (NS)

The age distribution did not differ significantly across two intervention groups (p-value>0.05 for comparing Dexmedetomidine v/s Bupivacaine).The mean ± SD of age in Group A and Group B was 32.7 ± 8.8 and 32.1 ± 7.9 respectively. The sex distribution did not differ significantly across three study groups (p-value>0.05 for comparing Dexmedetomidine v/s Bupivacaine).Males were in large majority in both the study groups (86.7% each in Group A and Group B). The average weight of the cases studied did not differ significantly across two intervention groups (p-value>0.05 for comparing Dexmedetomidine v/s Bupivacaine).

Table 2: The distribution type of bony/soft tissue surgery across two intervention groups

		Group A [Dexmedetomidine & Bupivacaine] (n=30)]	Group B [Bupivacaine (n=30)]	Inter-Group Comparison (P-value) Group A v/s Group B
Surgery type	Debridement	6 (20.0)	8 (26.7)	0.586 (NS)
	K Wiring	7 (23.3)	9 (30.0)	
	ORIF	17 (56.7)	13(43.3)	

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Type of Surgery	Elective	23 (76.7)	22 (73.3)	0.999 (NS)
	Emergency	7 (23.3)	8 (26.7)	
Duration of Surgery	Mean ± SD	141.8 ± 42.7	126.5 ± 33.7	0.128 (NS)

The distribution of type of bony/soft tissue surgery did no differ significantly across two intervention groups (p-value>0.05 for comparing Dexmedetomidine v/s Bupivacaine). In Dexmedetomidine group 6 (20.0%) cases had Debridement surgery, 7 cases (23.3%) had K-wiring surgery and 17 cases (56.7%) had ORIF (Open Reduction & Internal Fixation) surgery. In Bupivacaine group 8 (26.7%) cases had Debridement surgery, 9 cases (30.0%) had K Wiring surgery and 13 cases (43.3%) had ORIF surgery. The distribution of type of surgery did not differ significantly across two intervention groups (p-value>0.05 for comparing Dexmedetomidine v/s Bupivacaine). The average duration of surgery did not differ significantly between Dexmedetomidine and Bupivacaine Groups (p-value >0.05).

Table 3: The comparison of onset and duration of sensory and motor blockade across two intervention groups

		Group A [Dexmedetomidine & Bupivacaine] (n=30)]	**Group B [Bupivacaine (n=30)]**	**Inter-Group Comparison (P-value) Group A v/s Group B**
Onset (Mins)	Sensory Blockade	9.2 ± 1.6	17.7 ± 2.6	0.001***
	Motor Blockade	12.8 ± 1.6	23.5 ± 1.7	0.001***
Duration (Mins)	Sensory Blockade	648.7 ± 49.1	250.5 ± 26.8	0.001***
	Motor Blockade	600.2 ± 45.9	206.0 ± 19.0	0.001***

The average sensory blockade onset time is significantly higher in Group B compared to Group A (p-value <0.001). The average motor blockade onset time is significantly higher in Group B compared to Group A (p-value <0.001).
The average sensory blockade duration is significantly higher in Group A compared to Group B (p-value <0.001). The average motor blockade duration is significantly higher in Group A compared to Group B (p-value <0.001).

Table 4: The comparison of Heart Rate across two intervention groups

Heart Rate (Per Min)	**Group A [Dexmedetomidine & Bupivacaine] (n=30)]**	**Group B [Bupivacaine (n=30)]**	**Inter-Group Comparison (P-value) Group A v/s Group B**
0-Min (Baseline)	84.3 ± 5.5	84.4 ± 5.1	0.981(NS)
5-Min	80.2 ± 5.7	83.6 ± 6.4	0.031*
10-Min	78.3 ± 5.2	81.9 ± 5.8	0.014*
15-Min	75.4 ± 5.2	80.9 ± 6.3	0.001***
30-Min	72.9 ± 5.1	80.6 ± 5.9	0.001***
45-Min	71.6 ± 5.9	79.9 ± 5.5	0.001***
60-Min	71.4 ± 4.7	78.0 ± 4.9	0.001***
90-Min	71.2 ± 5.2	77.9 ± 4.8	0.001***
120-Min	70.4 ± 5.0	76.5 ± 4.6	0.001***
Mean % Change at 120Min compared to 0-Min (Baseline)	16.5%	9.0%	0.001***

The average Heart rate at 0-Min (Baseline) did not differ significantly across two study groups (p-value>0.05). The average Heart rate at 5-Min, 10-Min, 15-Min, 30-Min, 45-Min, 60-Min, 90-Min and

120-Min is significantly higher in Group B compared to Group A (p-value<0.05 for all). The average % change (drop) in Heart rate at 120-Min compared to Heart rate at 0-Min (Baseline) is significantly higher in Group A compared to Group B (p-value<0.001).

Table 5: The comparison of Mean blood pressure across two intervention groups

Mean Blood Pressure (mmHg)	Group A [Dexmedetomidine & Bupivacaine] (n=30)]	Group B [Bupivacaine (n=30)]	Inter-Group Comparison (P-value) Group A v/s Group B
0-Min (Baseline)	88.6 ± 4.2	87.6 ± 4.4	0.371(NS)
5-Min	84.9 ± 3.3	85.8 ± 4.6	0.442(NS)
10-Min	83.0 ± 4.0	84.5 ± 4.1	0.159(NS)
15-Min	81.8 ± 3.3	83.2 ± 3.5	0.139(NS)
30-Min	80.7 ± 2.7	81.7 ± 2.6	0.147(NS)
45-Min	80.2 ± 2.1	80.9 ± 1.5	0.124(NS)
60-Min	81.6 ± 2.9	82.3 ± 2.4	0.363(NS)
90-Min	82.4 ± 2.1	83.3 ± 2.6	0.146(NS)
120-Min	83.2 ± 1.0	83.0 ± 2.5	0.742(NS)
Mean % Change at 120-Min compared to 0-Min (Baseline)	5.9%	5.1%	0.425(NS)

The average mean blood pressure at 0-Min (Baseline), 5-Min, 10-Min, 15-Min, 30-Min, 45-Min, 60-Min, 90-Min and 120-Min did not differ significantly across two study groups (p-value>0.05 for all). The average % change (drop) in Mean blood pressure at 120-Min compared to Mean blood pressure at 0-Min (Baseline) did not differ significantly across two study groups (p-value>0.05).

Table 6: The comparison of time to rescue analgesia across two intervention groups

Time (Mins)	Group A [Dexmedetomidine & Bupivacaine] (n=30)]	Group B [Bupivacaine (n=30)]	Inter-Group Comparison (P-value) Group A v/s Group B
Time to Rescue Analgesia	720.8 ± 44.2	268.9 ± 23.1	0.001***

The average time required to rescue analgesia is significantly higher in Group A compared to Group B (p-value <0.001).

Table 7: The comparison of Ramsay Sedation score across two intervention groups

Sedation Score	Group A [Dexmedetomidine & Bupivacaine] (n=30)]	Group B [Bupivacaine (n=30)]	Inter-Group Comparison (P-value) Group A v/s Group B
Mean ± SD	2.47 ± 0.51	2.07 ± 0.25	0.001***

The average sedation score is significantly higher in Group A compared to Group B (p-value <0.001).

Discussion

The Prospective randomized, control trial, we compared dexmedetomidine as adjuvant to bupivacaine, & bupivacaine alone in supraclavicular brachial plexus block, and that there is onset of sensory & motor blockade faster in dexmedetomidine group.

In present study onset of sensory block significantly (17.7±2.6 mins) higher in Group B compared to Group A (9.2±1.6mins).

(Table-3) p-value-<0.001.

The results are in accordance with those by Khade *et al*. [9], who used 50µg of dexmedetomidine to bupivacaine 0.5%, 20ml in brachial plexus block, and showed that dexmedetomidine shortens onset time. (7.42±1.39mins)

Results agree with the studies by Agarwal *et al*. [8], who used standard dose of 100µg dexmedetomidine with higher concentrations of 0.325% bupivacaine, showed onset time of 19.04±3.195mins & 13.20±1.848 mins respectively. However, they had employed peripheral nerve stimulator to locate the plexus as against ultrasound guidance in present study.

Similar observation were made by Kavitha Jinlil *et al*. [10], who compared effects of 1µg/kg dexmedetomidine with clonidine as an adjuvant to 0.25% ropivacaine for ultrasound guided supraclavicular block. And found that dexmedetomidine, shortens the onset of time (9.7 mins).

It is well understood that Dexmedetomidine in smaller dose of 50 µg with 0.5% ropivacaine also shortens sensory block onset time as proved by Suneet Kathuria *et al*. [11]. Study by Das *et al*. [12] has shown that 100µg of dexmedetomidine to30 ml of 0.5% ropivacaine significantly shortens onset of sensory block.

In present study onset time for motor block for dexmedetomidine group was also faster (12.8±1.6mins) as compared to bupivacaine group (23.5±1.7mins). p value<0.001.

The results are in accordance with those by Khade *et al*. [9] (2013), who used 50µgs of dexmedetomidine to bupivacaine 0.5%, 20ml in brachial plexus block, and showed that dexmedetomidine shortens onset time, motor block(15.1±2.6mins). Results agree with the studies by Agarwal *et al*. [8] who used standard dose of 100µgs dexmedetomidine with higher concentrations of 0.325% bupivacaine, showed onset time of 19.04±3.195mins & 13.20±1.848mins respectively. However, they had employed peripheral nerve stimulator to locate the plexus as against ultrasound guidance in present study.

Dexmedetomidine in doses of 50µgs is also known to shorten onset time of motor block (13.40±3.77mins) with ropivacaine (200mgs) 40ml induced axillary brachial plexus block, as suggested by Dar F.A *et al*. [13]

In Mirkheshti *et al*., study [14] (2014) ultrasound guided brachial plexus block, with 100µgs of dexmedetomidine and 1.5% lignocaine shown that dexmedetomidine better effect on motor onset. (11.68±4.3mins). Suneet Kathuria *et al*., [15] (2015)-shown that 50µg of dexmedetomidine with 0.5% ropivacaine in brachial plexus block, shortened the motor onset(18.75±6.37mins),because of dexmedetomidine.

Similar results are reported by Agarwal *et al*. [9] (2014), who got 755.6±126.8mins of sensory block with dexmedetomidine against 234.8±47.9mins with bupivacaine. Duration of motor blockade is 470.4±60.2mins.

Duration of sensory-motor blockade gets prolonged (722.15±78.27mins & 600.6±54.46mins) even with 50 ug Dexmedetomidine & Bupivacaine (Khade *et al*. [9]. Apart from prolonged duration, sedative effects are also noted with 100 ug Dexmedetomidine & 0.325% bupivacaine, in study by Agarwal S *et al*. [8]. Gandhi R *et al*. [16] shown that 0.25% bupivacaine 38ml with 30µg of dexmedetomidine, duration of sensory block (732.4±48.9mins) and motor blockade (660.2±60.4mins).

The time for first analgesia was considered as duration of analgesia. In present study, the average time required to rescue analgesia is significantly higher in dexmedetomidine group (720.8±44.2mins) compared to bupivacaine alone group (268.9±23.1mins). p value<0.001.

Esmaoglu *et al*. [7] added 1µg/kg dexmedetomidine to levobupivacaine for axillary plexus block and showed that dexmedetomidine prolongs both sensory and motor block & duration of post-operative analgesia. Results are in accordance with those by Gandhi R *et al*. [16] who showed greater post-operative analgesia with 0.25% bupivacaine 38ml, &30µg of dexmedetomidine in brachial plexus block. Time to rescue analgesia gets prolonged with 1ug/kg Dexmedetomidine & 0.25% bupivacaine as shown by Swami S.S *et al*. [17].

In concurrent studies, dexmedetomidine in dose of 100µg increases duration of analgesia with lignocaine (Mirkheshti *et al*.) [14] & with ropivacaine (Das A *et al*.) [12] found that requirement of rescue analgesia time is less for dexmedetomidine.

From above all study concluded that dexmedetomidine, in lower range from 30µg to 1µg/kg body weight,

increased the time of rescue analgesia, with all different local anaesthetics, in different doses. The average Ramsay sedation score is significantly higher in dexmedetomidine group compared to bupivacaine group (2.08 mean score) with p valve<0.001.
Khade *et al*. [9] concluded 50µg of dexmedetomidine, in brachial plexus block with bupivacaine, reduced intraoperative requirement of sedatives. Young Suk *et al*. [18] shown that 1µg/kg of dexmedetomidine with 0.5% of ropivacaine, under ultrasound guided supraclavicular block decreased BIS significantly until 30 mins after block(69.2±13.7mins), but remained relatively constant to 60 mins (63.8±15.3 mins).

Conclusion

It may be concluded from present study that by adding dexmedetomidine(1µg/kg), as an adjuvant to bupivacaine (0.25%), in supraclavicular brachial plexus block (under ultrasound guidance), can shorten onset of sensory and motor blockade, improves quality of block by increasing sensory and motor blockade duration and also increases the interval of first rescue analgesic use.

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