Comparative study of dexmedetomidine as an adjuvant to 0.5% isobaric ropivacaine in ultrasound guided supraclavicular brachial plexus block - A randomized, double blind controlled trial

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ABSTRACT

Context: Ultrasound-guided supraclavicular block (SCPB) offers improved safety and accuracy, reduces the amount of LA needed for block, quick to perform and a safe alternative to GA.

Aims: To study the effect of dexmedetomidine as an adjuvant to ropivacaine in ultrasound-guided SCBPB.

Setting and design: After ethical approval, a randomized, controlled double blinded study was done on 80 patients of either sex, ASA-I &II, 20-50 years age and 50-80kg weight undergoing elective orthopaedic upper limb surgery.

Methods and Material: Patients were randomly divided in two groups by chit-in-box method. Each group given 14ml 0.75% ropivacaine with either 7ml NS (Group R) or 1µg/kg dexmedetomidine in 7ml NS (Group RD) and assessed for onset and duration of sensory and motor block, duration of analgesia, sedation score, quality of anaesthesia, haemodynamic parameters and any adverse effects.

Statistical analysis: SPSS version 17.0 was used and variables were analyzed by unpaired student ‘t’ test and Chi-square test. P value ≤0.05 was considered statistically significant.

Results: Mean sensory onset (5.40±1.21min in RD group vs. 10.10±1.42min in R group) and motor onset (25.05±1.75min in RD group vs. 28.35±3.41min in R group) were significantly faster and mean duration of analgesia (724.10±52.90min in RD group vs. 263.75±53.52min in R group) and sensory and motor duration were significantly longer in group RD.

Conclusion: Addition of dexmedetomidine to ropivacaine has faster onset and longer duration of both sensory and motor block, longer duration of analgesia and better quality of anaesthesia with better haemodynamic stability and without any adverse effects.

Keywords: Ropivacaine, Dexmedetomidine, Ultrasound, Supraclavicular block.
Key Message:
Dexmedetomidine as an adjuvant to isobaric 0.5% ropivacaine in ultrasound-guided supraclavicular block significantly improves the quality of anaesthesia as well as provides early onset and prolonged duration of postoperative analgesia even with low volume and doses of local anaesthetic without causing any significant adverse effect.

Text:

INTRODUCTION

Effective pain management in orthopedic surgeries relieves suffering and leads to earlier mobilization, fewer pulmonary and cardiac complications, a reduced risk of deep vein thrombosis, faster recovery with less likelihood of the development of neuropathic pain, shortened hospital stay and increased patient satisfaction. The supraclavicular brachial plexus block (SCBPB) is often called as "spinal anaesthesia of the upper extremity" because of its ubiquitous application for upper extremity surgery. It is a safe alternative\(^{[1]}\) to general anesthesia (GA) using advanced techniques like ultrasound, newer local anesthetics (LA) and newer adjuvant drugs for successful conduct of block.

The classical approach using paresthesia technique and peripheral nerve stimulator techniques are blind procedures and may be associated with higher failure rate and injury to the surrounding vascular structures, nerves and pleura leading to pneumothorax\(^{[2]}\) and diaphragmatic paralysis.\(^{[3]}\) Ultrasound is a non-invasive technique which can show the relationship of nerves to surrounding structures in the living subject without morbidity. Ultrasound-guided SCBPB is quick to perform\(^{[4]}\) offers improved safety, fewer respiratory complications\(^{[5]}\) and with accuracy in identifying the position of the structures and nerves to be blocked. Needle placement and spread of the injected LA guided by ultrasound reduces the amount of LA needed for successful peripheral nerve block.\(^{[6]}\)

Due to unique pharmacologic properties and fewer side effects, ropivacaine is being preferred by anesthesiologists nowadays. Ropivacaine is a long acting amide with a safer cardiac profile.\(^{[7]}\) Its lower lipid solubility causes greater sensory and motor differential blockade.\(^{[8]}\) Addition of various adjuncts to LA increases the efficacy and duration of block while minimizes the systemic adverse effects along with a reduction in total dose of LA. Adjuncts like epinephrine,\(^{[9]}\) bicarbonate, opioids, Clonidine,\(^{[10]}\) neostigmine, dexamethasone\(^{[11]}\) and tramadol have been used.

Dexmedetomidine is a newer adjunct with no neurological deficit reported\(^{[12]}\) so far. In addition, use of dexmedetomidine decreases inflammation around peripheral nerves, thereby decreasing the potential for peripheral nerve injury.\(^{[13]}\) The action of dexmedetomidine is most probably peripheral than centrally mediated.\(^{[14]}\) The combination of dexmedetomidine and ropivacaine has been associated with significant prolongation of the duration of sensory blockade and post-operative pain relief.\(^{[14-17]}\) Hence, this study was planned as SCBPB with ultrasound-guided technique using a linear probe with aim to evaluate the effect of adding dexmedetomidine to isobaric 0.5% ropivacaine.

SUBJECTS AND MATERIALS

After approval from institutional ethical committee (Approval No.F.1/Acad/MC/JU/15/16573, Dated: 22/09/2015) and proper written informed consent from participants, a prospective, double blinded, randomized, controlled study was done on 80 patients of either sex, ASA-I&II, 20-50 year age and 50-80 kg weight undergoing elective orthopaedic upper limb surgery. Patient having infection at injection site, convulsion history, allergy to study drug, any acute or chronic illness and neuropathy were excluded.

By using chit in box method, patients were randomly allocated into two groups (40 patient in each): Group R- 0.75% isobaric Ropivacaine 14 ml (105 mg) plus 7 ml of 0.9% Normal Saline (NS) and Group RD- 0.75% isobaric Ropivacaine 14 ml (105 mg) plus Dexmedetomidine 1µg/kg in 7ml NS. (Total Volume = 21ml in each group).

As patient enters the operative room, fasting status, consent and pre-anaesthetic checkup (PAC) were confirmed. After reassuring the patient, standard monitoring were applied. Base line ECG, heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), respiratory rate (RR), oxygen saturation (SPO\(_2\)) and five point sedation score\(^{[18]}\) were recorded. IV line secured using 18 G cannula and inj. Ringer Lactate started. No premedication was used in our study.

After proper explanation of technique and positioning, 2 ml of 2% lidocaine infiltrated under aseptic precautions, supraclavicular brachial plexus was located using ultrasound (sonosite FUJIFILM M-Turbo) with high frequency linear
probe. Transducer is placed transverse on neck, just superior to the clavicle at midpoint in supine position. SCBPB was given by injecting 21ml of study drug mixture (prepared by other anesthesiologist) within the nerve sheath using 5cm long 22G needle after blood negative aspiration. Time of injection given was noted soon after the needle is out of the injection site. A brief massage at one minute at the injection site performed to facilitate even drug distribution. Surgery was started 30 min after giving block. Haemodynamic parameters and sedation score were documented every 5 min for first 30 min and thereafter every 15 min till the completion of surgery. Assessment of onset and duration of sensory and motor block, duration of analgesia, quality of anaesthesia and sedation score was done as following.

The sensory block was assessed every 2 minutes by pin prick with 25 gauge hypodermic needle in the territories of median, ulnar, radial and musculocutaneous nerves using a 3-point scale: Grade 0 - sharp pain on pin prick (normal sensation), Grade 1- loss of sensation of pinprick (analgesia) and Grade 2- loss of sensation of touch (anaesthesia).The onset of sensory block defined as the time interval between the end of total local anesthetic (LA) administration and disappearance of sharp pain by pin prick test (grade 1 sensory block) in skin dermatome C4-T2. Duration of sensory block defined as the time taken from the administration of LA to the return of touch sensation (complete recovery of anaesthesia) in the territories of all nerves.

The motor block was evaluated every 2 minutes by thumb opposition (median nerve), thumb adduction (ulnar nerve), thumb opposition (median nerve) and flexion at the elbow (musculocutaneous nerve) on a 3-point scale for motor function: Grade 0- Normal motor function, Grade 1- reduced motor strength but able to move fingers, and Grade 2- complete motor block (paralysis). Onset of motor block defined as the time interval between the local anesthetic (LA) administration and the grade 1 motor block. Duration of motor Block defined as the time interval between the local anesthetic (LA) administration and the recovery of complete motor function of the hand and forearm (return to grade 0 motor block).

Five point sedation score\[18\] described as score 1- awake and alert, score 2- sedated, responding to verbal stimulus, score 3- sedated, responding to mild physical stimulus, score 4- sedated, responding to moderate or severe physical stimulus and score 5- not arousable.

Surgery was started after assessing block at 30 min if sensory block grade≥1 and motor block grade≥1 were achieved. Block not achieving above mentioned level were considered as failure of block/Inadequate block and such cases were managed by providing general anaesthesia (GA) and were excluded from the study. When grade1 sensory block with grade2 motor block is achieved, the case was handed over to surgeon for operative procedure and monitoring was continued in intraoperative period. Onset, duration and highest grade of sensory and motor block were recorded. The time of starting of surgery (incision), completion of surgery (skin closure) and duration were noted. Blood loss assessment was done and fluid administered as per the loss.

Quality of anesthesia grading\[14\] done at the end of the operation as: Excellent (4) -no complaint from the patient, Good (3)-minor complaint with no need for supplemental analgesics, Moderate (2)-complaint that required supplemental analgesics and Unsuccessful (1)-patient required general anesthesia.

Postoperatively Visual Analog Score (VAS), motor and sensory block grade, haemodynamic parameters and five point sedation score were recorded at 0 hr, 2 hr, 4 hr, 6 hr, 8 hr, 10 hr, 12 hr, 14 hr, 18 hr and 24 hr. Post-operative analgesia was assessed by using Visual Analog scale (VAS). Duration of analgesia is defined as the time from commencement of block to the time when patient first demands rescue analgesia (VAS ≥ 4). Injection of rescue analgesic (inj. Diclofenac sodium 75 mg IM) terminates the study. Time of return of complete motor power (grade0 motor block) and time of return of touch sensation (grade0 sensory block) were recorded to assess the total duration of motor and sensory block respectively.

All patients monitored for any adverse perioperative events comprising of hypotension (>20% fall in mean arterial pressure), bradycardia (heart rate <50 beats/min), hypoxemia (spo2 <92%), nausea, vomiting, respiratory depression and complications like pneumothorax, haematoma, local anaesthetic toxicity and post-block neuropathy. Bradycardia was managed with inj. Atropine 0.6mg IV stat. Hypotension was managed with inj. Mephentermine 6mg IV boluses. Hypoxemia was managed with oxygen supplementation by oxygen face mask at the rate of 5 l/min. Duration of surgery was defined as time taken from skin incision to skin closure.

**SAMPLE SIZE AND STATISTICAL ANALYSIS**

The sample size taken for each group was 40 in this study, which gave the power of 80% and 95% confidence interval to detect a difference between means of 4.08min with a significance level (alpha error) of 0.05 (two tailed). Statistical analysis
was performed with Statistical Package of Social Science (SPSS) software version 17.0 developed by IBM Corporation for windows. Variables were analyzed using unpaired student ‘t’ test and Chi-square test. The P value <0.05 was considered as statistically significant.

RESULTS

Patients were labeled as a case of group R & RD with their respective dosages. Demographic variables, baseline haemodynamic parameters and preoperative sedation score were comparable in both groups. (Table I-Demographic and baseline variables).

Mean onset time of sensory and motor block was significantly less (P<0.0001) in group RD compared to group R. Maximum grade achieved for sensory and motor block were comparable in both groups (1.97±0.15 in group RD vs. 2.00±0.00 in group R).

Postoperatively time taken in achieving VAS score 4 was significantly longer in group RD compared to group R. Rescue analgesia was given soon after achieving VAS score 4. Mean duration of analgesia and mean duration of sensory and motor block were significantly longer (P<0.0001) in group RD compared to group R. Mean quality of anaesthesia grade was significantly higher (P<0.0001) in group RD compared to group R. (Table II- Characterstics of blockade)

Intraoperative Mean HR from 0 to 105min was significantly less in group RD compared to group R but only one patient in group RD had bradycardia that too recovered only by awakening. (Figure-1)

Intraoperative Mean SBP and Mean MAP from 0 to 105min were significantly less in group RD compared to group R but no incidence of hypotension while Mean DBP was comparable in both the groups. (Figure-2 and Figure-3)

The mean sedation score in Group RD was significantly high at time from 5 min intraoperatively till 2 hrs postoperatively as compared to group R. The difference in sedation score was statistically significant (p < 0.0001) with a maximum sedation score being 2.80±0.46 in group RD at 30 min intraoperatively. (Figure-4)

DISCUSSION

Dexmedetomidine, an alpha 2 agonist, has been used with las in regional blocks and IV regional anaesthesia and has been found to significantly reduce the onset time and prolong the duration of sensory block and analgesia[14-17]. In this prospective, we have compared the effect of 1µg/kg dexmedetomidine and placebo as an adjuvant to 21 ml of 0.50% ropivacaine in ultrasound-guided SCBPB in terms of the onset time and duration of sensory and motor block, duration of analgesia as well as quality of anaesthesia.

The demographic profile (Table I-Demographic and baseline variables)) between two groups was statistically insignificant (P > 0.05) of our patients was quite similar with other research investigations[14,15] and provided us the uniform platform to evenly compare the results obtained. The mean duration of surgery and indications of surgical procedures were almost similar in both groups and had no statistical significance.

In our study, addition of dexmedetomidine to ropivacaine 0.5% significantly shortened the onset time of sensory and motor block and significantly extended the duration of sensory and motor blocks and the duration of analgesia (Table II- Characteristics of blockade) in accordance with a previous study done under ultrasound guidance by Kathuria et al[14] but here we achieved far better results by using only 21ml drug volume compared to 30ml of study drug volume used by them.

The onset time of sensory block (5.40±1.21 min in RD group vs. 10.10±1.42 min in R group) was significantly earlier in group RD and it was even earlier then the studies of Kathuria et al[14] and Gurajala et al[16] probably due to definition of onset of sensory block taken in my study as loss of pin-prick sensation instead of taking loss of touch sensation. However Das et al[15] found comparable onset time of sensory block but they used peripheral nerve stimulator technique.
The onset time of motor block (25.05±1.75 min in RD group vs. 28.35±3.41 min in R group) was significantly earlier in group RD in accordance with the study of Gurajala et al.[16] but Kathuria et al.[14] and Das et al.[15] found much earlier onset of motor block. However, they used more doses (150 mg ropivacaine) of study drugs in compare to our study (105 mg ropivacaine).

The duration of sensory block (673.07±48.99 min in RD group vs. 218.25±48.29 min in R group) and duration of motor block (623.33±50.74 min in RD group vs. 172.25±48.91 min in R group) were significantly longer in group RD likewise previous studies of Gurajala et al.[16] Kathuria et al.[14] and Das et al.[15] Prolongation of the sensory blockade by Dexmedetomidine is likely elicited by prolonged hyperpolarization of the unmyelinated C fibers (sensory), and to a lesser extent the A fibers (motor function).[17,20]

The duration of analgesia (724.10±52.90 min in RD group vs. 263.75±53.52 min in R group) was significantly longer in group RD in accordance with previous studies of Gurajala et al.,[16] Kathuria et al.[14] and Das et al.[15] The analgesic effect of the α2-agonists is mediated through stimulation of the α2c and α2a receptor in the dorsal horn, thus directly suppressing pain transmission by reducing the release of pro-nociceptive transmitters, substance P and glutamate, and hyperpolarization of interneurons.[19] However, the central effects of dexmedetomidine also seem to play some role in prolongation of sensory and motor block duration.[14]

The quality of anaesthesia (score 3.90±0.37 in RD group vs. 3.20±0.45 in R group) was significantly better with a higher mean sedation score in group RD in accordance with previous study of Kathuria et al.[14] The α2-agonists produce their sedative-hypnotic effect by an action on α2 receptors in the locus coeruleus and by an analgesic action at α2 receptors within the locus coeruleus and within the spinal cord.[21] Only one patient in group RD had bradycardia but just by awakening the patient heart rate became normal. No haemodynamic or any other complication occurred in any patient of any groups.

There were some limitations of our study that we didn’t make any hypothesis regarding mechanism of action of dexmedetomidine whether it works peripherally or centrally. We conclude that addition dexmedetomidine to 0.5% isobaric ropivacaine with a total drug mixture volume of 21ml and with ultrasound guidance, have faster onset and longer duration of both sensory and motor block, longer duration of analgesia and better quality of anaesthesia with better haemodynamic stability and without any adverse effects.

REFERENCES


**TABLES:**

**Table-I: Demographic and baseline variables**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group R</th>
<th>Group RD</th>
<th>P value</th>
<th>Significance</th>
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<tr>
<td>Age (years)</td>
<td>33.27±10.81</td>
<td>29.30±8.63</td>
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<tr>
<td>Sex (M + F)</td>
<td>33+7</td>
<td>34+6</td>
<td>0.76</td>
<td>NS</td>
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<tr>
<td>ASA Grade I+II</td>
<td>37+3</td>
<td>38+2</td>
<td>0.64</td>
<td>NS</td>
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<tr>
<td>Weight (Kg)</td>
<td>59.59±6.27</td>
<td>55.49±5.31</td>
<td>0.11</td>
<td>NS</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>169.82±6.71</td>
<td>167.85±6.29</td>
<td>0.178</td>
<td>NS</td>
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<tr>
<td>Base line HR</td>
<td>82.57±13.46</td>
<td>82.87±12.84</td>
<td>&gt;0.999</td>
<td>NS</td>
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<tr>
<td>Base line SBP</td>
<td>123.55±9.61</td>
<td>122.37±11.86</td>
<td>0.627</td>
<td>NS</td>
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<tr>
<td>Base line DBP</td>
<td>77.50±8.30</td>
<td>76.50±7.67</td>
<td>0.577</td>
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<td>Base line Sedation score</td>
<td>1.00±0.00</td>
<td>1.00±0.00</td>
<td>NA</td>
<td>NS</td>
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</tbody>
</table>

*values are displayed as MEAN±SD

**Table-II: characteristics of blockade**

<table>
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<tr>
<th>Variables</th>
<th>Group R</th>
<th>Group RD</th>
<th>P value</th>
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</thead>
<tbody>
<tr>
<td>Onset of Sensory Block</td>
<td>10.10±1.42</td>
<td>5.40±1.21</td>
<td>&lt;0.0001</td>
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<td>Onset of Motor block</td>
<td>28.35±3.41</td>
<td>25.05±1.75</td>
<td>&lt;0.0001</td>
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<tr>
<td>Quality of Anaesthesia</td>
<td>3.20±0.45</td>
<td>3.90±0.37</td>
<td>&lt;0.0001</td>
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<tr>
<td>Duration of analgesia</td>
<td>263.75±53.52</td>
<td>724.10±52.90</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Duration of Sensory block</td>
<td>218.25±48.29</td>
<td>673.07±48.99</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Duration of Motor block</td>
<td>172.25±48.91</td>
<td>623.33±50.74</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

*values are displayed as MEAN±SD
FIGURE LEGENDS:

**Fig. 1 Mean Heart Rate in intraoperative and postoperative period**

Figure 1: Mean Heart Rate in intraoperative and postoperative period

**Fig. 2- Mean systolic and diastolic BP**

Figure-2: Systolic and Diastolic Blood Pressure- intraoperative and postoperative
Figure 3: Mean Arterial Pressure - intraoperative and postoperative

Figure 4: Mean Sedation Score - intraoperative and postoperative