Original Article

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# Effects of Perineural Dexmedetomidine Added to 0.75% Ropivacaine in Peripheral Nerve Stimulator Guided Supraclavicular Brachial Plexus Block - A Prospective Randomized Double-Blind Study

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## Abstract

**Background:** Regional anaesthesia for the upper limb is being widely used as it not only evades the necessity of general anaesthesia but also provides an excellent postoperative period devoid of nausea, vomiting, and early postoperative pain. The objective is to study the effects of perineural dexmedetomidine 75$\mu$g added to 0.75% ropivacaine in supraclavicular brachial plexus block (SCB). The primary objective was analgesia duration. Secondary objectives include various block (sensory and motor) characteristics, sedation, adverse effects if any. **Subjects and Methods:** Eightyfour patients undergoing forearm and wrist surgeries under peripheral nerve stimulator (PNS) guided SCB were randomized into two groups of 42 each. Group R received 24mL 0.75% ropivacaine + 1 mL normal saline (NS), and Group D received 24 mL 0.75% ropivacaine + 75$\mu$g dexmedetomidine in 1ml NS. Analgesia duration (the time when the first rescue analgesia was given), sensory and motor block characteristics, sedation and side effects in both groups were analysed using appropriate statistical tests. **Results :** Analgesia duration was significantly increased in group D (780 $\pm$ 101.59 min) compared to Group R (475.25 $\pm$ 81.42 min), P 0.000. The sensory and motor block duration was significantly increased in the group D (606.37 $\pm$ 74.33 min and 516$\pm$ 49.70 min) compared to group R (411.87 $\pm$ 62.90 min and 365.75 $\pm$ 51.74 min), P 0.000. **Conclusion**: Perineural dexmedetomidine with ropivacaine in SCB prolongs the analgesia duration, increase the sensory and motor block duration devoid of any significant side effects.

**Keywords:** Dexmedetomidine, Ropivacaine, Supraclavicular Brachial Plexus Block

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## Introduction

Regional anaesthesia techniques for forearm and wrist, especially supraclavicular brachial plexus block (SCB) are being widely used as it not only avoids the need for general anaesthesia (GA) but also provides an excellent postoperative period devoid of nausea, vomiting and worst early postoperative pain. Local anesthetic agents used for brachial plexus blocks have their limitation of shorter block duration and thereby not prolonging analgesia in the early postoperative period. Increasing the local anesthetic drug volume to prolong the analgesic duration may result in local anesthetic systemic toxicity (LAST). Ropivacaine, a long-acting amide local anesthetic drug, produce differential sensory blockade with dose-related motor block and a more secure cardiac profile.[1–4]Ropivacaine produced a prompt return of hand strength with less paraesthesia of fingers compared to bupivacaine. To prolong the block duration and to provide better analgesia within the early postoperative period, adjuvants like opioid analgesics,[5]benzodiazepine midazolam,[6]magnesium sulfate,[7]$\alpha$2-adrenoceptor agonist clonidine,[8] dexamethasone,[9]were used. Dexmedetomidine, an $\alpha$2 receptor agonist is more potent and highly selective than clonidine.[10]Human study shows, dexmedetomidine extends the block duration and provides excellent analgesia in the postoperative period in various regional blocks when used as an adjuvant.[11]Different doses of dexmedetomidine were studied with different local anesthetic drugs in brachial plexus block for their adjuvant effects.[12] We aim to study the effects of perineural dexmedetomidine 75$\mu$g with 0.75% ropivacaine

using peripheral nerve stimulator (PNS) guided SCB. To find the analgesia duration (a time when first rescue analgesia was given) was our primary objective. To study the block characteristics, sedation and side effects were our secondary objectives.

## Subjects and Methods

Our randomized double-blind study was done in a teaching hospital from July 2019 to June 2020.

The inclusion criteria were patients of 18 to 70 years of age, of either gender, weighing 60 to 80 kg belonging to the American Society of Anesthesiologists (ASA) I and II, coming for elective forearm and wrist surgeries by SCB. Patient's refusal for block, patients with bleeding disorders and those taking medications such as anticoagulant drugs, sedatives, antipsychotics, vasodilators, negative chronotropic drugs, patients with severe respiratory disease, neurological deficits of brachial plexus, severe ventricular dysfunction, advanced heart block, cardiac arrhythmias, infection at the injection site, altered sensorium and pregnant women were taken as exclusion criteria.

After getting ethical committee approval from our institution and the patient's informed consent, eighty-four patients were chosen for the study. They were split up into two groups of 42 patients each by chit in the box method.

**Group R:** 24mL 0.75% ropivacaine + 1 ml NS, making a total volume 25ml.

**Group D:** 24 mL 0.75% ropivacaine + 75$\mu$g dexmedetomidine in 1ml NS, making a total volume of 25ml.

Study solutions were prepared by one anesthesiologist and given over to another anesthesiologist who was unaware of the nature of the medicate arrangement. The attending anaesthesiologist performed the block and recorded the data.

All the study patients in both the groups were given tablet alprazolam 0.5mg night before surgery as anxiolytic and 150 mg of tablet ranitidine on the previous night as well as on the morning of surgery as premedication. On receiving the patients in the operation room, intravenous access was secured, standard monitors were attached and baseline vital parameters were recorded. Before performing the block, patients were given intravascular midazolam 1 mg. Under aseptic precautions, the supraclavicular block was done using a peripheral nerve stimulator (B Braun Stimuplex® HNS 12 Nerve Stimulator, 22gauge 50mm long needle) by the classical approach. On obtaining wrist flexion and extension of the fingers, the stimulating current strength was reduced to 0.3 to 0.5 mA. On confirming the presence of a motor response, the study drug was given 5ml incrementally.

Sensory block assessment was done using a 23gauge hypodermic needle by pricking the dermatomal areas innervated by the four major nerves of the upper limb (median, ulnar, radial and musculocutaneous nerves) and evaluated by Hollmen scale. Score 1= if patent appreciates pinprick. Score 2= if the patient feels sharp-pointed sensation, but less intense than the opposite side upper limb. Score 3= if the patient feels a blunt object touching. Score 4= if the patient doesn't perceive pinprick.[13] By keeping the time of giving the study drug as time zero, sensory onset time was taken as the time to reach hollmen score 2. The time is taken to accomplish score 1 (i.e., complete resolution of sensation to pre block level) was considered as sensory block duration.

Motor block assessment was done by the modified Bromage scale for upper extremities. Grade 0 being the ability of the patient to raise the extended arm to 90° for 2 seconds; grade 1 being the ability of the patient to flex the elbow and to move fingers but unable to raise his/her extended arm; grade 2 being patient unable to flex his/her elbow but ability to move fingers; grade 3 being patient unable to move his/her arm, elbow and fingers.[14] Keeping the time of injection of the drug as time zero, the onset of motor block was time to reach grade 2. The duration of motor block was time to reach grade 0.

For patients with inadequate sensory and motor block 30 minutes after SCB, GA was given and excluded from our study. Intraoperative sedation was recorded using the Ramsay sedation scale.[15] Intraoperative vitals were noted every 5 min during the first 15 min, then every 15 min intraoperatively and postoperatively till complete recovery of the block. Hypotension (>20% fall in systolic blood pressure (SBP) from baseline value) was treated by incremental doses of injection ephedrine 6mg intravenously. Bradycardia (heart rate <50 beats per minute) if occurs was managed initially by waking up the patient who is sedated. If the heart rate doesn't rise on waking the patient, injection atropine 0.6mg was given intravenously. Complications, if any were recorded and treated appropriately by the attending anaesthesiologist. Visual analog scale (VAS),[16] a ten (10) point scale (score 0 = no pain and 10 = worst pain)was used for assessing pain. Analgesia duration was characterized as the time patient himself first requests for analgesic injection for pain (VAS >3). Injection tramadol 100 mg in 100 ml intravascular infusion was rescued analgesic used. Intravenous infusion of paracetamol 1 g was given 8th hourly for the first 24 hours.

### Sample size

By considering a 30% increase in the duration of analgesia as clinically relevant, assuming an $\alpha$- error of 0.05, power of 80% and a dropout rate of 10%, the sample size of our study was calculated to be 42 and included in the study. However, 2 cases in each group had a patchy or inadequate nerve block, and hence given GA and excluded from the study. Thus, final data analysis was carried out on data obtained from 80 patients (Group R= 40 patients, Group D = 40 patients).

### Statistical analysis

Continuous data were presented as mean ± SD and analyzed by Student's unpaired t-test and categorical variables were presented as number (%) and compared by Chi-square test using Statistical Package for Social Science Version 17. P < 0.05 was taken as statistically significant. Microsoft Office was used for drawing graphs and tables.

## Results

Groups R and D had comparable demographic profiles (age, gender, ASA grade, weight, height) [Table 1]. Group D (780 ± 101.590 min) had increased analgesia duration compared to Group R (475.25 ± 81.43 min), (P 0.000) [Table 2]. In Group D, the onset of both sensory and motor block was faster (7.35 ± 1.86 min and 11.40 ± 2.11 min) compared to slower onset in group R (12.35 ± 6.20 min and 15.83 ±2.37 min) (P 0.000) [Table 2]. Group D (606.37 ± 74.33 min and 516± 49.70 min) had increased sensory and motor block duration in contrast to group R (411.87 ± 62.90 min and 365.75 ± 51.74 min) (P 0.000) [Table 2]. Three patients in group D and none in group R had bradycardia (P 0.0114) [Table 3]. Horner's syndrome was noted in both groups (group R=6, group D= 5). (P 0.2915) [Table 3]. Group D patients had higher sedation scores compared to group R [Figure 1].

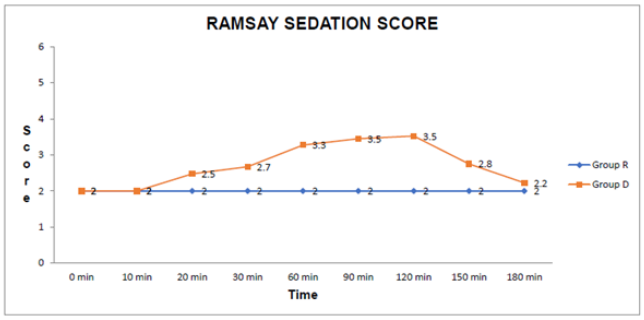


**Figure 1: Intraoperative sedation score**

## Discussion

In our study, we performed supraclavicular brachial plexus block by PNS guided technique with 24 ml 0.75% ropivacaine and 1ml NS in Group R and 24 ml 0.75% ropivacaine with 75 $\mu$g of dexmedetomidine in 1ml making a total volume of 25ml in group D, compared to 30 ml by Madhusudhana et al.[17] and Rashmi et al.[18] Thus, in our study we kept the total dose of ropivacaine below the maximum recommended dose which can be used safely. The analgesia produced by $\alpha$2-adrenergic receptor agonists is multifactorial.[19] Dexmedetomidine maintains the nerve in a hyperpolarized state and preventing subsequent firing,[20] thereby exerting its analgesic effect through the perineural mechanism. Perineural block using ropivacaine 0.75% with 20$\mu$g dexmedetomidine prolonged the sensory block duration by 60% when compared with a plain local anesthetic.[21] This peripheral nerve block duration prolongation is due to perineural action and not due to systemically absorbed dexmedetomidine because systemic dexmedetomidine prolonged the duration of block by only 10%, as reported by Brummett et al.[22] In an animal study, perineural dexmedetomidine did not affect myelin and nerve axon after twenty-four hours and fourteen days.[23] In humans, neuraxial dexmedetomidine was safely used up to 2 $\mu$g/kg.[24] Keplinger et al., reported that about 1/3$^{rd}$ of their patients had intense sedation and post block neuropathy with 150$\mu$g dexmedetomidine.[25] In our study, we safely used a lower dose of 75$\mu$g of dexmedetomidine.

In our study, there was a quicker onset and longer duration of both sensory block and motor block by adding 75 $\mu$g dexmedetomidine to 0.75% ropivacaine, which concurs with Kathuria et al.[26] The duration of analgesia (the time when the first rescue analgesic was given ) in group D was significantly longer than the duration in group R, as seen in a study by Bharti et al.[27] The occurrence of sedation with perineural dexmedetomidine could be due to its partial perivascular uptake and its effect on the central nervous system. In our present study, patients in group D had higher sedation scores than patients in group R. More sedation was noted in group D from 20 minutes to 150 minutes after the block was given. In group D most of the patients sedation scores were 3/6 or 4/6, whereas in group R it was 2/6. Although group D patients had higher sedation scores, none of them had airway compromise needing airway assistance. Hypotension and bradycardia are known to occur with $\alpha$2-agonists such as dexmedetomidine. Esmaoglu et al.,[28] noted bradycardia in 7 out of 30 patients, who received 100 $\mu$g dexmedetomidine with 0.5% levobupivacaine. In our present study in group D, none had hypotension, although 3 patients had bradycardia which was managed by awakening patients. This lesser incidence of bradycardia in our study may be due to a lesser dose of dexmedetomidine used. Horner's syndrome was reported in patients in both groups. (group R-6, group D - 5). Complications like vascular puncture, phrenic nerve palsy, LAST and post block neuropathy were not seen in any groups.

The non-availability of ultrasound equipment in our department during the study period was our limitations. Future studies can be done by combining peripheral nerve stimulator with ultrasound guidance for SCB. This would help to reduce the volume of 0.75% ropivacaine used and thereby can be safely used even in patients weighing less than 60 kg without crossing the maximum recommended dose (3 mg/kg) of ropivacaine. Future trials can explore the maximum safe dose

**Table 1: Demographic profile**

| Parameters | Group R (n=40) | Group D (n=40) | p-value |
|---|---|---|---|
| Age (years) | 44.43±10.85 | 42.20±10.85 | 0.382 |
| Weight (kg) | 66.55±7.69 | 69.08±5.33 | 0.076 |
| Height (cm) | 161.25±11.54 | 162.08±8.13 | 0.647 |
| Gender (M/F) | 21/19 | 19/21 | 0.653 |
| ASA grade (I/II) | 22/18 | 24/16 | 0.651 |

n - Number of patients, Group R - Ropivacaine + Normal Saline, Group D - Ropivacaine+ Dexmedetomidine, ASA=American Society of Anaesthesiologists

**Table 2: Block characteristics**

| Parameters | Group R (n=40) | Group D (n=40) | p value |
|---|---|---|---|
| Onset of sensory block (min) | 12.35±6.20 | 7.35±1.86 | 0.000* |
| Onset of motor block (min) | 15.83±2.37 | 11.40±2.11 | 0.000* |
| Duration of sensory block (min) | 411.87±62.90 | 606.37±74.33 | 0.000* |
| Duration of motor block (min) | 365.75±51.74 | 516±49.70 | 0.000* |
| Duration of analgesia (min) | 475.25±81.43 | 780±101.59 | 0.000* |

n-Number of patients, Group R - Ropivacaine + Normal Saline, Group D - Ropivacaine + Dexmedetomidine

**Table 3: Comparison of side effects or complications [n (%)]**

| Symptoms | Group R (n %) | Group D (n %) | p-value |
|---|---|---|---|
| Bradycardia | 0 (0%) | 3 (7.5%) | 0.0114 |
| Hypotension | 0 | 0 | - |
| Vomiting | 0 | 0 | - |
| Horner's syndrome | 6 (15%) | 5 (12.5%) | 0.2915 |
| Vascular puncture | 0 | 0 | - |
| Pneumothorax | 0 | 0 | - |
| Post block neuropathy | 0 | 0 | - |

n=Number of patients, Group R=Ropivacaine + Normal Saline, D=Ropivacaine + Dexmedetomidine

of dexmedetomidine which can be added to 0.75% ropivacaine by combining peripheral nerve stimulator with ultrasound guidance for supraclavicular brachial plexus block.

## Conclusion

Dexmedetomidine 75$\mu$g with 0.75% ropivacaine perineurally in PNS guided SCB significantly increased duration of sensory block, motor block and analgesia, thereby ensuring relatively pain-free early postoperative period, which allows early ambulation without any potential side effects.

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