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**Review Article**

# Effect of dexmedetomidine as an adjuvant to 0.75% ropivacaine in ultrasound guided supraclavicular brachial plexus block for elective upper limb surgeries: A prospective randomized double blind study

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**Abstract: Background and Objectives:** Ropivacaine is one of the most widely used amide local anesthetic as it is less cardiotoxic, less toxic to central nervous system than bupivacaine. Dexmedetomidine is an alpha 2 agonist has been used as an adjuvant to ropivacaine in very few studies and has been shown to prolong the duration of sensory and motor block and postoperative analgesia. The aim of our study was to evaluate the effects of dexmedetomidine as an adjuvant to ropivacaine (0.75%) in supraclavicular brachial plexus block in terms of onset, duration of sensory and motor block, duration of analgesia and quality of block. **Methods**: Sixty ASA grade I and II patients of either sex were randomly divided into two groups, Group A and B. Group A received 20 ml of 0.75% of ropivacaine along with intravenous infusion of 50µg dexmedetomedine and Group B received 20 ml of 0.75% ropivacaine with 50µg dexmedetomedine. **Results**: Onset of sensory and motor block was earlier in group B than in group A although it was not statistically significant (p>0.05). Duration of analgesia was prolonged in group B (954+-275.41 min) compared to group A (642+-141.96 min; P<0.001). Duration of sensory and motor block was longer in group B (610.30+- 163.392 min and 570.660+-143.609 min) than those in group A (540.16+-120.619 min and 501.29+-120.739 min; P <0.05). **Conclusion**: Dexmedetomidine as an adjuvant to 0.75% ropivacaine in supraclavicular brachial plexus block prolongs duration of analgesia, shorten onset of sensory and motor block and prolongs sensory and motor block duration.

**Keywords:** Ropivacaine, Dexmedetomidine, supraclavicular brachial plexus block, ultrasound.

## INTRODUCTION

Brachial plexus block is the most widely used approach for upper limb surgeries as an alternative to general anaesthesia or in combination with general anesthesia to achieve ideal operating conditions by providing adequate intraoperative analgesia, hemodynamic stability and unwanted side effects of general anaesthesia. Since the introduction of first brachial plexus block using cocaine by Halstead (1884) the technique of brachial plexus block has evolved from classical blind technique to use of nerve stimulators and ultrasound guidance for supraclavicular brachial plexus block (Halstead, C. 2003).

Ropivacaine is one of the most widely used amide local anesthetic as it has a longer duration of action varying from 5 to 8 hours and also has less cardiotoxic effects when compared to other amide local anaesthetics. Many additives such as morphine, Neostigmine, fentanyl, Hyaluronidase, Midazolam, dexmedetomidine, Clonidine, Dexamethasone etc. have been added to local anesthetics as an adjuvants to improve the quality of blockade and duration of postoperative analgesia (Hansen, T.G. 2004; Khanduri, K.C.2008; Akerman, B., & Hellberg, I.B. 1988)

Dexmedetomidine is an alpha 2 agonist having analgesic, sedative, antihypertensive, and anesthetic sparing effects when used in systemic route. Adding

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dexmedetomidine to local anesthetics during peripheral nerve blockade and regional anesthesia procedures may also prove efficacious for the surgical patients. In human studies, dexmedetomidine has also shown to prolong the duration of the block and post-operative analgesia when added to local anesthetic in various regional blocks (Aho, M. *et al.*, 1993; Kohli, S. *et al.*, 2013; Kettner, S.C. 2013).

Our current study was designed to evaluate the effects of dexmedetomidine as an adjuvant to 0.75% ropivacaine in supraclavicular brachial plexus block in terms of onset and duration of sensory and motor block, duration of analgesia, quality of block and adverse effects if any.

Material and Methods: After institutional ethical comitte approval aprospective randomized double blind study was conducted in LLRM medical college Meerut between over a period of one year. A total of 60 patients of ASA grade I and II of either sex, aged 18 years to 60 years undergoing various elective upper limb surgeries below mid humerus level under ultrasound guided supraclavicular brachial plexus block were included in study.

The exclusion criteria included Patient refusal, infection at injection site, history of brachial plexus injury, allergy to study drug, Pregnancy, history of severe respiratory, cardiac hepatic or renal disease, and patients with history of coagulation disorders. The patients were randomized by computer generated system into two groups (Group A and Group B) with 30 patients in each group. Group A received brachial plexus block with 20 ml of 0.75% ropivacaine along with intravenous dexmedetomidine (50 microgram) in 50 ml of normal saline infused over 15 min and Group B received brachial plexus block with 20 ml of 0.75% ropivacaine containing 50 microgram dexmedetomidine.

A written Informed Consent was obtained from each patient after explaining the procedure. The patients were instructed preoperatively about use of numerical rating scale for pain. Pre-anesthetic checkup was done a day before surgery. Study drugs were prepared by an anesthesiologist not involved in the study and handed over to the concerned anesthesiologist.

On arrival in the operating room, baseline vital parameters were recorded. An intravenous line was secured in unaffected limb and Ringer lactate was started.. All the patients received brachial plexus block through the supraclavicular approach by an experienced anesthesiologist different from the one assessing the patient intra and post operatively. Both were blinded to the treatment groups. Patient was pre-medicated with injection Midazolam( .04mg/kg)

After aseptic preparation , supraclavicular brachial plexus block was performed under ultrasound guidance (Sonosite, micromax machine with frequency 8-13 MHz, linear probe covered with sterile dressing. 20ml of ropivacaine0.75% containing dexmedetomidine (50µg) in group B was given. In group A 50 ml of normal saline containing 50µg dexmedetomidine was also started at the time of starting the block. Sensory and motor blocks were evaluated every 2-5 minutes, upto 30 minutes after injection.

Sensory Block was confirmed by pin-prick method using 23 G hypodermic needle in entire dermatomes innervated by the brachial plexus. Sensory block was assessed by using a 3-point scale:

- Grade 0 = normal sensation
- Grade 1 = loss of sensation of pinprick (Analgesia)
- Grade 2== loss of sensation of touch (Anesthesia)

**Motor blockade was assessed using Modified Bromage scale (MBS) for upper extremities as:**

- Grade 0 – able to raise the extended arm to 90° for a full 2 s
- Grade 1 – Able to flex the elbow and move the fingers but unable to raise the extended arm
- Grade 2 – Unable to flex the elbow but able to move the fingers
- Grade 3 – Unable to move the arm, elbow, or fingers

Onset time of sensory block was defined as the time interval between the end of total local anesthetic administration and time of dull sensation to pin prick (Grade1). The onset of motor block was defined as the time from injection to motor paralysis equivalent to Bromage score 2. Duration of sensory block was defined as the time interval between the end of local anesthetic administration and the complete resolution of sensory block (score 0). Duration of motor block was defined as the time interval between the end of local anesthetic administration and the recovery of full power in relevant muscle group (Modified Bromage Scale 4). On arrival in recovery room patient's perception of pain was assessed using visual analogue scale (VAS) (0–10), with 0 being no pain at all and 10 being the worst pain imaginable. VAS score was measured at 6 h, 12 h, and 18 h. Primary outcome measures were duration of analgesia while secondary measures were onset and duration of sensory and motor block, quality of analgesia and any adverse effects

The anesthesiologist at the end of surgery graded the quality of analgesia as:

- Excellent: no discomfort or pain
- Good: mild pain or discomfort, no need for additional analgesics
- Fair: pain that required additional analgesics

- Poor: moderate or severe pain or needed general anaesthesia.

Intraoperatively, heart rate, noninvasive blood pressure, and SpO2 were monitored throughout the procedure and also during the postoperative period. Patients were observed for incidence of drowsiness, pruritus, nausea and vomiting, Horner's syndrome, phrenic nerve palsy, Pneumothorax, respiratory depression and local anaesthetic toxicity.

**Statistical Analysis:**

Raw data were entered into a Microsoft Excel Spreadsheet and analyzed using standard statistical software SPSS® statistical package version 16.0 (SPSS Inc., Chicago, IL, USA). Demographic data (age, weight and height), duration of surgery, VAS score, total duration of motor block, and analgesia were expressed as mean ± standard deviation and differences between two groups were compared by the unpaired Student T test. Categorical variables i.e., ASA grade, type of surgery, and the incidence of adverse events (hypotension, bradycardia, nausea, vomiting, and headache) were presented as percentage and proportions. Categorical variables were compared between two groups using the Chi-square test. For all analysis, a two-tailed p-value of <0.05 was considered statistically significant.

**RESULTS:**

The study was carried out among 60 patients with 30 participants per group (Group A = 30 patients, Group B = 30 patients) and there were no dropout.

Both the groups were comparable in terms of demographic profiles (age, Sex, ASA grade, weight, height and duration of surgery) [Table 1].

**Table 1: Demographic profile**

| Variables | Group A (n=30) (Mean+-SD) (%) | Group B (n=30) (Mean+-SD) (%) |
|---|---|---|
| Age (yrs) | 36.2 ± 13.0 | 31.9 ±13.6 |
| Weight (Kg) | 56.3 ± 5.2 | 55.5 ± 5.8 |
| Height (cm) | 160.6 ± 6.16 | 162 ±6.492 |
| Gender (M/F) | 27/3 (90%/10%) | 25/5(83.7%/16.3%) |
| ASA grade (I/II) | 27/3 (90%/10%) | 23/7 (77%/23%) |
| Duration of surgery (min) | 60 ± 12.16 | 56.70 ± 11.988 |

Onset of sensory and motor Block was shorter in Group B (6.8± 2.4 and 16.1±3.4) than Group A (6.8 ± 5.0 and 18 ± 4.4). It was statistically significant for motor block (p=0.008). The durations of sensory and motor block were significantly prolonged in Group B (610.32±160.304 and569.69±143.607) than Group A (545.60±111.188 and510.21±121.628) (p 0.02). Duration of analgesia was significantly prolonged in Group B (954±4.950) than Group A (642±2.466) [Table2].

**Table 2: Block characteristics**

| Parameters | Group A (n=30) ( Mean+-SD) | Group B (n=30) ( Mean+-SD) | P value |
|---|---|---|---|
| Onset of sensory block( min) | 6.8 ± 5.0 | 6.8± 2.4 | 0.413 |
| Onset of motor block (min) | 18 ± 4.4 | 16.1±3.4) | 0.008 |
| Duration of sensory block (min) | 545.60±111.188 | 610.32±160.304 | 0.01 |
| Duration of motor Block (min) | 510.21±121.628 | 569.69±143.607 | 0.02 |
| Duration of Analgesia (min) | 642±2.466 | 954±4.950 | 0.001 |

The HR was significantly lower at 30, 45 min and 90 mins after administration of block ($P < 0.05$). However, no patient in both the groups had incidence of bradycardia (HR<50/min). [Figure 1]

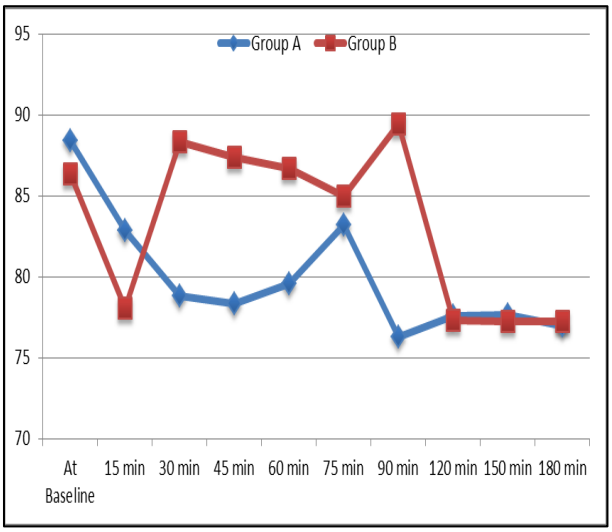


**Figure 1: Pulse Rate among study subjects:**

The SAP was significantly lower Group A than group B at 15, 30, 45, 60, 75, 90, and 120 mins after the institution of block (p<.05) (Figure 2).

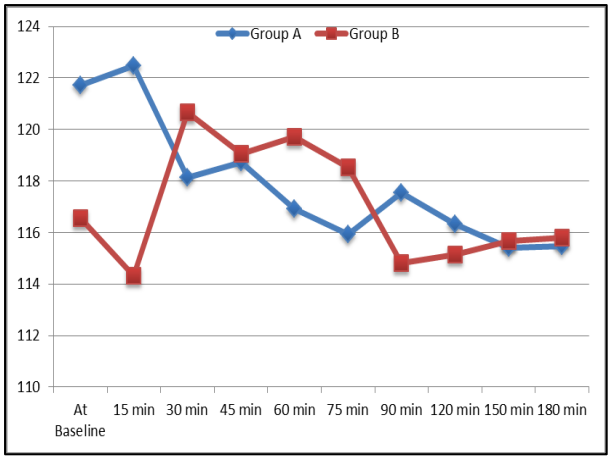


**Figure 2: Systolic BP levels among study participants**

The diastolic blood pressure was significantly lower in the patients in group A than group B at 15 min, 30 min, 45 min, 60 min, 75 min, 90 min, and at 120 minutes after administration of the drug ($P < 0.05$) [Figure 3]. However, there was no incidence of fall in blood pressure > 20% compares to baseline reading.

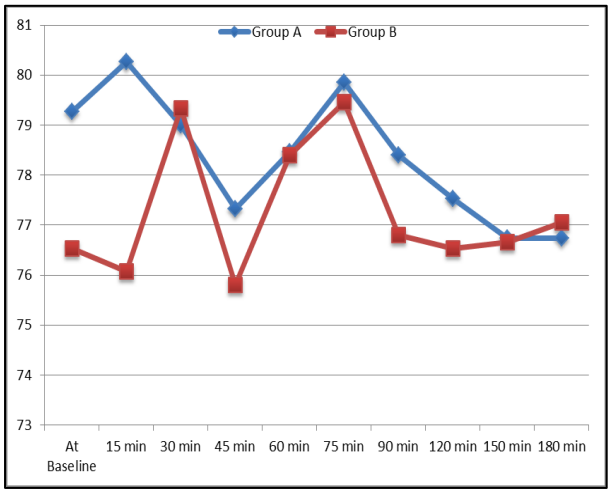


**Figure 3: Diastolic BP levels among study participants:**

Higher number of patients had excellent and good quality blocks in Group B, but the difference was statistically not significant (p > 0.05) [Table 3]

**Table 3: Quality of Analgesia**

| Grade | Group A (n=30) | Group B (n=30) | P value |
|---|---|---|---|
| Excellent | 26 (86.66%) | 27 (90%) | 0.640 |
| Good | 2 (6.66%) | 2 (6.66%) | |
| Fair | 2 (6.66%) | 1 (3.33%) | |
| Poor | 0 (0%) | 0 (0%) | |

There was no significant difference in the incidence of nausea and vomiting in either group. There was no incidence of persistent paraesthesias, pneumothorax, horner's syndrome or residual weakness of operated limb.

**DISCUSSION:**

Various adjuvants with local anesthetics in brachial plexus block are used to achieve a quick, dense, and prolonged block. Addition of α2 adrenergic agonist drugs has been suggested to improve the nerve block characteristic of local anesthetic solutions (Biradar, P.A. *et al.*, 2013; Singh, S., & Aggarwal, A. 2010; Chakraborty, S. *et al.*, 2010; Yoshitomi, T. *et al.*, 2008; ).

Animal studies have shown that dexmedetomidine enhances onset of sensory and motor blockade along with increased duration of analgesia. In human beings, dexmedetomidine has also shown to prolong the duration of block and postoperative analgesia when added to local anesthetic in various regional blocks (Zhang, Y. *et al.*, 2014; Marhofer, D. *et al.*, 2013; Kanazi, G.E. *et al.*, 2006; Agarwal, S. *et al.*, 2014; Esmaoglu, A. *et al.*, 2010).

Dexmedetomidine is a selective α2 adrenoceptor agonist, which has higher affinity to α2 receptors compared to clonidine. With ropivacaine, it results in a dose-dependent increase in the duration of sensory and motor block. However, their combination in supraclavicular brachial plexus block has not been studied much.

Very few literatures are available on the usage of dexmedetomidine as an adjuvant to 0.75% ropivacaine in supraclavicular brachial plexus block. The ideal dose of dexmedetomidine for nerve blocks is still uncertain. We empirically chose 50 µg dexmedetomidine based on earlier studies (Saadawy, I. *et al.*, 2009; Brummett, C.M. *et al.*, 2008; Brummett, C.M. *et al.*, 2009)

The results of our study clearly showed that the addition of dexmedetomidine to 0.75% ropivacaine in ultrasound-guided supraclavicular brachial plexus block shortens the onset of sensory and motor block, prolongs duration of sensory and motor block and the duration of analgesia Kathuria *et al.*, (2015) and Das *et al.*, (2014) similar to study of . We performed USG-guided supraclavicular blocks with 20 ml of 0.75% ropivacaine compared to 30 ml by Madhusushana *et al.*, (2011) and Rashmi *et al.*, (2017) to avoid the risk of increased total dose of local anesthetic.

Another study conducted by Brummett CM *et al.*,, found that dexmedetomidine when added to ropivacaine in peripheral nerve block caused approximately a 75% increase in the duration of analgesia Dexmedetomidine added to ropivacaine increased the duration of dense sensory blockade and time for return to normal sensory function in a dose-

dependent fashion (P < 0.005) (Brummett, C.M. *et al.*, 2009).

Study conducted by Abdallah FW *et al.*, showed contradictory results. They concluded that dexmedetomidine, regardless of the route of administration, produces a differential prolongation of sensory as well as motor block. They have signaled the potential for IV dexmedetomidine to prolong the duration of blockade (Abdallah, F.W. *et al.*, 2016).

In our study, no significant serious side effects were reported in any group similar to study by Swami *et al.*, (2012) and Esmaoglu *et al.*, (2010) except for lower pulse rates and blood pressures observed in dexmedetomidine groups.

The mechanism of the analgesic actions of α2 agonists is probably multifactorial and not fully eluciated. A number of supraspinal and spinal sites modulate the transmission of nociceptive signals in the CNS. Peripheral α2 adrenoceptors may also mediate the antinociception (Nakamura, M., & Ferreira, S.H. 1988). α2 blockers by acting at any of these sites reduce nociceptive transmission, leading to analgesia. The activation of inwardly rectifying G1-protein-gated potassium channels resulting in membrane hyperpolarization and decreasing the firing rate of excitable cells in the CNS is considered to be a significant mechanism of the inhibitory neuronal action of α2-adrenoceptor agonists (Birnbaumer, L. *et al.*, 1990). Reduction of calcium conductance into cells, thus inhibiting neurotransmitter release is other prominent physiologic action ascribed to α2 adrenoceptors. This effect involves direct regulation of entry of calcium through N-type voltage-gated calcium channels and is independent of cAMP and protein phosphorylation and is mediated by G0 proteins. These mechanisms represent 2 very different ways of effecting analgesia, that is, the nerve is prevented from firing, and it also prevents propagation of signals to the neighbors.

Hence, we hypothesize that mechanism of action of dexmedetomidine is mainly due to the direct peripheral action of dexmedetomidine on nerves in block rather than due to central action of dexmedetomidine after absorption through block site into systemic circulation resulting in its systemic effects. However, the central effects of dexmedetomidine also seems to play some role in prolongation of sensory and motor block duration, as 50 µg of dexmedetomidine intravenous infusion significantly prolonged brachial plexus block. Further detailed studies are needed to investigate the mechanisms of how α2 agonists, especially dexmedetomidine in supraclavicular brachial plexus block.

## CONCLUSION:

We conclude from our study that addition of dexmedetomidine to 0.75% ropivacaine in supraclavicular brachial plexus block is highly effective to shorten the onset of sensory and motor block, to prolong duration of sensory and motor block, to improve quality of analgesia and to prolong the duration of analgesia without any adverse effects. The mechanism of action of dexmedetomidine is peripheral rather than centrally mediated.

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**Conflict of interest**: None

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