Original Research Article

Indian Journal of Anesthesia and Analgesia
March – April 2020; 7(2): 465–472
DOI: http://dx.doi.org/10.21088/ijaa.2349.8471.7220.4

Comparison of Ropivacaine with $MgSO_4$ *versus* Ropivacaine with Dexmeditomidine as Adjuvants in Ultrasound-guided Supraclavicular Brachial Plexus Block in Upper Limb Surgeries

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Abstract

Introduction: Regional anesthesia is particularly indicated for patients undergoing peripheral limb surgery because it provides effective intraoperative anesthesia and postoperative pain control. Supraclavicular approach of brachial plexus block is the most commonly used approach and provides the most complete and reliable anesthesia for upper limb surgery. The concurrent injection of α_2 adrenergic agonist drugs has been suggested to improve the nerve block characteristic of LA solutions. *Objectives:* To assess the time of onset and duration of action of Ropivacaine with $MgSO_4$ and Ropivacaine with dexmeditomidine. *Materials and Methods:* Patients with American Society of Anesthesiologists physical status (ASA) Grade 1 or 2 posted for elective upper limb orthopedic surgeries were included in the study. The study patients were randomly divided into 2 Groups with 25 patients in each group namely Group A (n = 25): 20 ml 0.75% ropivacaine (150 mg) +2.5 ml (250 mg) $MgSO_4$ and Group B (n = 25): 20 ml 0.75% ropivacaine (150 mg) + 2.5 ml dexmedetomidine (1 mcg/kg + normal saline). Brachial plexus block through supraclavicular approach was performed. The primary outcome measure was the onset of sensory and motor blockade, while secondary was the duration of sensory and motor blockade. The adverse reactions during the perioperative period were recorded. *Results:* Overall, the onset of motor and sensory blockade in Group B was faster than Group A and the duration of motor and sensory blockade in Group B was longer than Group A, which was statistically significant with p - value < 0.001. ***Conclusion:*** Dexmedetomidine as an adjuvant to Ropivacaine in the supraclavicular brachial plexus block for upper limb surgery significantly shortens the onset time for sensory and motor block and prolongs the duration of sensory and motor blocks with the use of ultrasound guidance for the peripheral nerve blocks.

Keywords: Dexmedetomidine; Ropivacaine; Regional anesthesia; Brachial block.

How to cite this article:

Anjuna KC, Shivakumar KP. Comparison of Ropivacaine with $MgSO_4$ *versus* Ropivacaine with Dexmeditomidine as Adjuvants in Ultrasound-guided Supraclavicular Brachial Plexus Block in Upper Limb Surgeries. Indian J Anesth Analg. 2020;7(2): 465–472.

Introduction

Regional anesthesia is particularly indicated for patients undergoing peripheral limb surgery because it provides effective intraoperative anesthesia and postoperative pain control. Brachial plexus block is a versatile and reliable regional anesthetic technique and a suitable alternative to general anesthesia for upper limb surgical procedures. Supraclavicular approach of brachial

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Received on 21.01.2020, **Accepted on** 07.03.2020

plexus block is the most commonly used approach and provides the most complete and reliable anesthesia for upper limb surgery.

Ropivacaine is a local anesthetic that inhibits neuronal excitement and conduction by inhibiting neuronal sodium channels. Its effect is long-lasting, which makes it a commonly used anesthetic in nerve block anesthesia.[1]

Local anesthetics alone for supraclavicular brachial plexus block provide good operative conditions but have a shorter duration of postoperative analgesia. Dexmedetomidine has been reported as an effective adjuvant for regional anesthetic agents to shorten the onset time of the block, prolong the duration of the block, and increase the quality of analgesia without neurologic sequelae.[2]

The concurrent injection of α_2 adrenergic agonist drugs has been suggested to improve the nerve block characteristic of LA solutions. Dexmedetomidine is a selective α_2 adrenoceptor agonist, which has higher affinity to α_2 receptors compared to clonidine. With Ropivacaine, it results in a dose-dependent increase in the duration of sensory and motor block.[3-9]

The present study was undertaken to compare the effectiveness regarding onset and duration of complete sensory and motor block of 0.75% Ropivacaine with $MgSO_4$ *versus* 0.75% Ropivacaine with Dexmedetomidine in patients undergoing ultrasound-guided supraclavicular brachial plexus block.

Objectives

- To assess the time of onset and duration of action of Ropivacaine with $MgSO_4$;
- To assess the time of onset and duration of action of Ropivacaine with Dexmedetomidine.

Materials and Methods

With a level IV evidence, a hospital based interventional study was carried out for 2 months duration in the department of Anesthesiology, SS Institute of Medical Sciences and Research Centre, Davanagere, Karnataka.

After obtaining Institutional Ethical Committee approval and written informed consent from the close relatives of the patients, sample patients with American Society of Anesthesiologists physical status (ASA) Grade 1 or 2 posted for elective upper limb surgeries were included in the study. The study patients were randomly divided into 2 Groups with 25 patients in each group namely Group A (n =25): 20 ml 0.75% ropivacaine (150 mg) + 2.5ml (250mg) $MgSO_4$ and Group B (n = 25): 20 ml 0.75% ropivacaine (150 mg) + 2.5 ml dexmedetomidine (1 mcg/kg + normal saline).

Adult patients of either sex, without any comorbidity or with controlled comorbidities, admitted for elective upper limb surgeries, patients with age between 18 to 60 years and patients with ASA Grade 1 or 2 were included in the study. Patients with allergy to study drugs, patients who were contraindication for brachial plexus block (bleeding disorders, local or systemic infections), patients with history of cardiac, hepatic, or renal disease, chronic pain or psychiatry disorders and patients with BMI > 30 kg/m^2 were excluded from the study.

Definition of Study Parameters

1. **Onset of complete sensory block** is defined as the time between the last brachial injection of local anesthetic drug to the total abolition of pin prick response in areas innervated by radial, ulnar, and median nerve. Graded as:

   Grade 0 - Normal sensation to pin prick;

   Grade 1 - Dull response to pin prick (onset);

   Grade 2 - No response to pin prick (peak).

2. **Onset of complete motor block** onset of the complete motor block was the time from the end of injection of study drug to complete paralysis of upper limb.

   Bromage scale for motor block:

   Grade 0 - Normal motor function (no effect);

   Grade 1 - Decrease motor strength compared to contra lateral limb;

   Grade 2 - Complete motor block.

3. **Duration of motor block**: It is the time from the onset of motor block to complete recovery of motor block (able to hand raise above head with a movement of arm and forearm).

4. **Duration of sensory block**: It is the time from onset of sensory block to the first pain requiring rescue analgesic.

The preanesthetic assessment was done on the evening before surgery. A routine examination was done by assessing general condition, nutritional status, weight, airway assessment, complete examination of cardiovascular, respiratory system,

site of block, and investigation in all patients. All patients were kept electively nil per oral 6–8 hours before surgery. Written and informed consent was taken from the study population. Standard monitors such as electrocardiogram, pulse oximeter, blood pressure cuff were applied, and patient's baseline parameter such as pulse rate, blood pressure, respiratory rate, and SpO_2 was recorded.

Brachial plexus blockade: Through supraclavicular approach, the patients were placed in the dorsal recumbent position with the head turned away from the site of brachial block, under all aseptic precautions the transducer is positioned in the transverse plane immediately proximal to the clavicle, slightly posterior to its midpoint. The transducer is tilted caudally, to obtain a cross-sectional view of the subclavian artery. The brachial plexus is seen as a collection of hypoechoic oval structures posterior and superficial to the artery. Using a 23-gauge × 1.5 inch needle, 1–2 ml of local anesthetic is injected into the skin 1 cm lateral to the transducer. The local anesthetic is injected in increments around the brachial plexus under direct vision of the ultrasound.

Immediately after block, patients were evaluated for the assessment of onset of sensory and motor blockade. Sensory blockade was assessed by pin prick test and motor blockade by upper limb movements. If the block was considered to be adequate, surgeons were allowed to apply tourniquet and start the surgery. If the block was considered to be inadequate for surgery, the patient was given general anesthesia. Patients were monitored, as shown in (Table 1).

During the whole procedure, vital signs of the patients were recorded. The time of onset of sensory blockade was defined as the time between injection of the anesthetic and loss of sensation to needle prick, and the time of onset of motor blockade was defined as time between injection of the anesthetic and loss of thumb movement. The adverse reactions during the perioperative period were recorded (Fig. 1).

Data were statistically evaluated with IBM SPSS Statistics for Windows, Version 24.0, IBM Corp, Chicago, IL. The patient characteristics and intraoperative data is presented as Mean with SD. Student's *t*-test is used to compare continuous variables and Chi-square test (χ^2) is used to analyze the categorical variables. p - value < 0.05 is considered to be statistically significant.

Results

Fifty ASA 1 and 2 patients of either sex, aged between 18 and 60 years, posted for upper limb surgeries under ultrasound guided supraclavicular brachial plexus block were randomized and selected for the study. The purpose of this study is to compare the efficacy of Dexmedetomidine and $MgSO_4$ as an adjuvant to Ropivacaine in USG-guided Supraclavicular brachial plexus block for upper limb surgeries.

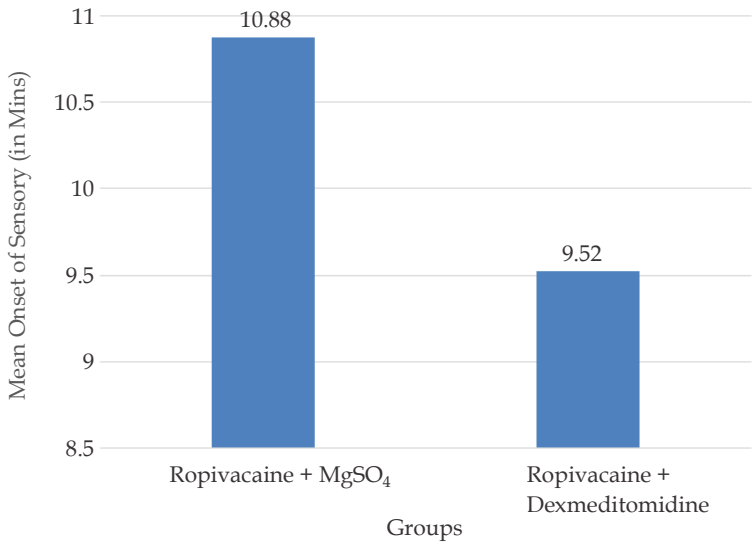

Fig. 1: Mean onset of sensory blockade among both the groups.

Table 1: Comparison of sensory and motor blockade among both the groups

	Ropivacaine + $MgSO_4$		Ropivacaine + Dexmedetomidine		*t*-value	*p* - value
	Mean	SD	Mean	SD		
Onset of Sensory (mins)	10.88	2.05	9.52	1.28	3.397	0.001
Onset of Motor (mins)	13.60	3.12	11.08	1.42	3.615	0.001
Sensory Duration (mins)	488.88	85.03	642.64	108.11	5.589	< 0.001
Motor Duration (mins)	386.48	86.43	508.56	89.89	4.895	< 0.001

The mean onset of sensory blockade in Group A was 10.88 ± 2.05 mins and in Group B was 9.52 ± 1.28 mins.

The mean onset of motor blockade in Group A was 13.60 ± 3.12 mins and in Group B was 11.08 ± 1.42 mins, as shown in Figure 2.

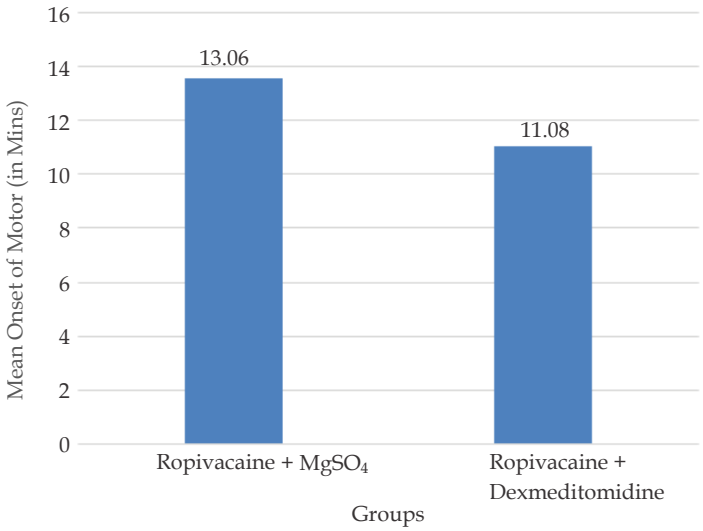

Fig. 2: Mean onset of motor blockade among both the groups.

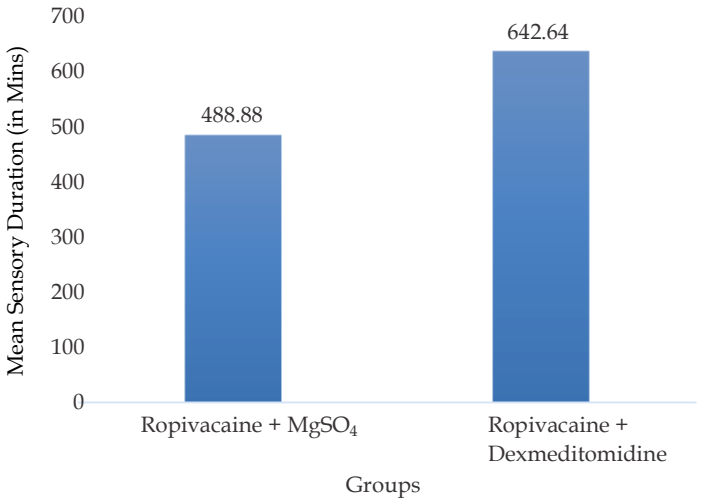

Fig. 3: Mean duration of sensory blockade among both the groups.

The mean duration of sensory blockade in Group A was 488.88 ± 85.03 mins and in Group B was 642.64 ± 108.11 mins, as shown in Figure 3.

The mean duration of motor blockade in Group A was 386.48 ± 86.43 mins and in Group B was 508.56 ± 89.89 mins, as shown in Figure 4.

Overall, the onset of motor and sensory blockade

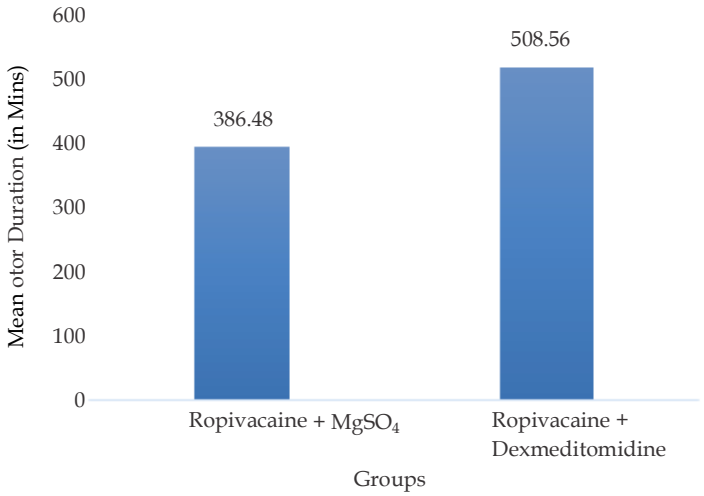

Fig. 4: Mean duration of motor blockade among both the groups.

in Group B was faster than Group A but the duration of motor and sensory blockade in Group B was longer than Group A, which was statistically significant with *p* - value < 0.001.

Discussion

The effective management of postoperative pain, relieve 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, reduced cost of care, and increased patient satisfaction.[10]

In modern anesthesia practice, peripheral nerve block has a significant contributory role to avail these benefits. Upper limb surgeries are mostly performed under brachial plexus block. Peripheral nerve blocks not only provide intraoperative anesthesia but also extended analgesia into the postoperative period without any systemic adverse effects using minimal anesthetic drugs. The supraclavicular brachial plexus block is commonly used, as the plexus is most compactly arranged here.[10]

A number of studies have attempted to study various adjuvants as a means of prolonging the duration of analgesia by single injection techniques.[11] α_2 agonists have also been used as adjuvants. However, it has been demonstrated that clonidine, as an adjuvant for peripheral nerve block, prolonged the duration of postoperative analgesia at a cost of an increased risk of sedation, hypotension, and bradycardia, known side-effects of systemic clonidine.[12] This was also observed with the use of dexmedetomidine.[3] Magnesium is known to produce antinociception, to enhance the effect of local anesthetic when given epidurally or intrathecally, by its action on the NMDA receptors found in the peripheral nerve and brachial plexus.[12]

Mukherjee K et al. conducted a prospective, double-blinded randomized controlled study to evaluate magnesium (150 mg) as an adjuvant in ropivacaine-induced supraclavicular brachial plexus block and concluded that it may increase the sensory and motor block duration and time to first analgesic use, and decrease total analgesic needs, with no side effects.[13] Haghighi M et al. randomized 60 patients and conducted a double-blinded study to see the effect of magnesium sulphate (5 mg/kg) on motor and sensory axillary brachial plexus block and concluded that the addition of magnesium sulphate to lidocaine increased the duration of motor and sensory block in the upper extremities during surgeries when compared to the use of lidocaine alone.[14]

Memis D et al.,[15] used the following grades to determine the quality of analgesia for operating condition in a study where dexmetitomedine was added as an adjuvant for lignocaine for intravenous regional anesthesia:

Grade 4 = (Excellent) No complaint from patient;

Grade 3 = (Good) Minor complaint with no need for the supplemental analgesics;

Grade 2 = (Moderate) Complaint that required supplemental analgesia;

Grade 1 = (Unsuccessful) Patient given general anesthesia.

The same grading was adapted by Ali QE et al.[16]

to find out the efficacy of clonidine as an adjuvant to ropivacaine in supraclavicular brachial plexus block.

Patients were also compared for the difference in the heart rate and systolic and diastolic blood pressure after the supraclavicular brachial plexus injection for every 5 mins till 10 mins, then every 10 mins till 30 mins, thereafter every 30 mins till the end of the procedure. Patients oxygen saturation and respiratory rate was also noted at regular intervals, side effects and complications were also noted.

Onset of sensory block

In our study, the time taken for onset of sensory block in Group A was 10.88 ± 2.05 mins and in Group B was 9.52 ± 1.28 mins with *p* - value of 0.001 which was significant. These findings show that there was significant difference in the time of onset of sensory block in both the groups. We observed early onset of sensory blockade in Group B than Group A.

Mukherjee et al. showed that the time of onset of sensory block with 0.5 % ropivacaine alone was 15.91 ± 1.60 mins and 0.5% ropivacaine with $MgSO_4$ is 16.27 ± 3.07 mins.[13] Mangal V et al. also conducted a similar study and the sensory onset time 20 ml 0.75 % ropivacaine alone with ultrasound guided technique was 6.74 ± 1.449 mins,[17] which more or less comes within the standard deviation of our study. In study conducted by Taneja et al. onset of sensory with ropivacaine alone and with $MgSO_4$ was found to be 5.5 ± 0.89 and 6.5 ± 0.65 mins.[18] Therfore, in many studies addition of $MgSO_4$ was found to slightly delay the onset though it was not statistically significant. This shows that Magnesium Sulphate does not have any effect on onset of sensory block when given along with ropivacaine for brachial plexus block.

Liu et al.[19] studied the effect of ropivacaine alone and ropivacaine combined with dexmedetomidine in brachial plexus block and revealed the onset time of 12.4 min in ropivacaine group and 8.9 min in ropivacaine with dexmedetomidine group for sensory blockade. They concluded the shorter onset of action in ropivacaine with dexmedetomidine group as shown in our study and study done by Khemka et al. (Group R was 20.1 ± 1.62 min, in Group R + D was 17.6 ± 1.25 min, with *p* - value of 0.001).[20]

Duration of sensory block

The mean duration of sensory blockade in Group A was 488.88 ± 85.03 mins and in Group B was 642.64 ± 108.11 mins which was statistically significant. Group B cases showed prolonged duration of sensory block than Group A cases.

Mukherjee et al. showed the duration of sensory block for ropivacaine alone was 289.67 ± 62.50 and with $MgSO_4$ was 456.21 ± 97.99 mins.[13] Taneja et al. found that duration for ropivacaine alone was 290 ± 26.95 mins and with $MgSO_4$ was 420 ± 30.25 mins.[18] Ropivacaine causes a greater motor and sensory differentiation with longer sensory blockade compared to other local anesthetics.

Liu et al. proved the duration of sensory blockade was more in ropivacine with dexmeditomidine (482.1 min) than ropivacaine (380.2 min) used alone in brachial plexus block for upper limb surgeries.[19] Khemha et al. showed the mean duration of sensory block in Group R was 561.0 ± 33.87 min and in Group R + D was 790.3 ± 41.23 min, with *p* - value 0.0001.[20] In our study, addition of dexmeditomidine to 0.75% ropivacaine further increased the duration of sensory blockade and hence analgesia.

Onset of motor block

In our study, the mean onset of motor blockade in Group A was 13.60 ± 3.12 mins and in Group B was 11.08 ± 1.42 mins, which was statistically significant with *p* - value < 0.001. Mukherjee et al observed the onset of motor block with ropivacaine alone was 17.80 ± 7.6 mins and with $MgSO_4$ was 19.20 ± 6.2 mins with a *p* - value of 0.30 which is not significant.[13] As Mukherjee et al. study used 0.5 % of ropivacaine they have a longer onset of action compared to our study.

In Taneja et al. study onset of motor blockade with ropivacaine alone and with $MgSO_4$ was found to be 12.4 ± 2.06 and 14.3 ± 2, 64 repectively with *p* - value of < 0.05.[18] In majority of the studies, conduted with ropivacanine there was no significant difference in onset of motor blockade when $MgSO_4$ was added.

In Liu et al. study, they proved that onset of motor blocakde was earlier in group used the combination of ropivacaine with dexmeditomidine (7.5 min) than in group used with ropivacaine alone (12.8 min).[19] Khemka et al. showed the mean onset time for complete motor block in Group R was 24.5 ± 1.48 min, and in Group R + D was 22.5 ± 1.50 min (*p* = 0.00001) which was statistically significant.[20] Our study showed, significant difference in onset of motor blockade when dexmeditomidine was added to 0.75% ropivacaine.

Duration of Motor block

While the prolongation of the sensory block is a desirable target, prolongation of motor block hampers postoperative recovery, especially if day care surgery is planned, and it is an undesirable outcome. The mean duration of motor blockade in Group A was 386.48 ± 86.43 mins and in Group B was 508.56 ± 89.89 mins, which was statistically significant with *p* - value < 0.001.

Mukherjee et al. found the duration of motor block with ropivacaine alone to be 242.16 ± 23.86 and with $MgSO_4$ 366.62 ± 24.42 with a *p* - value of 0.012 which is significant.[13] Taneja et al. also found the duration of motor block with $MgSO_4$ to be significant (motor block without $MgSO_4$ – 236 ± 20.6 and with $MgSO_4$ 350 ± 15.25, with the *p* - value of < 0.05).[18] Though with addition of $MgSO_4$ the motor duration was longer it was not statistically significant.

Liu et al. proved the duration of motor blockade was more in ropivacine with dexmeditomidine (430.1 min) than ropivacaine (350.1 min) used alone in brachial plexus block for upper limb surgeries,[19] which was similar to our study findings. Khemha et al. showed the mean duration of motor block in Group R was 508.0 ± 17.89 min, and in Group R + D was 680.7 ± 69.38 min which was statistically significant (*p* = 0.00001).[20]

There was no incidence of headache, nausea, vomiting, hypotension, bradycardia, chest pain, coughing, convulsion and respiratory depression, and procedure related complications. There was no CNS and CVS toxicity seen in either group in our study.

Our study demonstrated that addition of an alpha agonist like Dexmedetomidine to Ropivacaine resulted in early onset and prolonged duration of sensory and motor blockade in patients undergoing upper limb surgeries.

Conclusion

Dexmedetomidine as an adjuvant to Ropivacaine in the supraclavicular brachial block for upper limb surgery significantly shortens the onset time for sensory and motor block and prolongs the duration of sensory and motor blockade with the use of ultrasound guidance for the peripheral nerve block which is one of the latest, precise, and safe method in the present day.

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