Comparative Study of Ropivacaine 0.5% and Ropivacaine 0.5% with Dexmedetomidine 50 µg in Ultrasound Guided Supraclavicular Brachial Plexus Block for Upper Limb Orthopedic Surgery

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Abstract

Background and Objectives: The purpose of our study was to evaluate the effect of adding dexmedetomidine 50 µg to ropivacaine 0.5% in ultrasonography guided supraclavicular brachial plexus block. The primary end points were the onset and the duration of sensory and motor block and duration of analgesia.

Methods: A total of 50 American Society of Anesthesiologists (ASA) I and II patients scheduled for elective mid humerus, forearm, hand surgery were divided into two equal groups in a randomized double-blind fashion. In Group R (n = 25), 30 ml of 0.5% ropivacaine +1 ml saline and in Group RD (n = 25), 30 ml of 0.5% ropivacaine + 1 ml (0.5 ml of dexmedetomidine 50 µg mix with 0.5 ml of saline) were given. Onset time of sensory and motor block, duration of sensory and motor block, and duration of analgesia were recorded.

Results: Demographic parameters were comparable in both groups. Onset time of sensory and motor block were shorter in Group RD than in Group R (P = 0.001). Duration of sensory and motor blockade were longer in Group RD than in Group R (P = 0.001). Duration of analgesia was longer in Group RD than in Group R (P = 0.001). Systolic blood pressure in Group RD at 15, 30, 45, 60, 90, 120, 180, 240, and 300 min was significantly lower than those in Group R (P = 0.001). Diastolic blood pressure in Group RD at 15, 30, 45, 60, 90, 120, 180, 240, and 300 min was significantly lower than those in Group R (P = 0.001). Heart rate in Group RD except basal measurements was significantly lower than those in Group R (P = 0.001).

Conclusions: Dexmedetomidine when added to ropivacaine for brachial plexus block shortens the onset time and prolongs the duration of the block and the duration of post-operative analgesia.

Key words: Dexmedetomidine, Ropivacaine, Supraclavicular brachial plexus block, Ultrasound

INTRODUCTION

Brachial plexus blockade by supraclavicular approach is rapid, complete and predictable anesthesia for mid humerus, forearm and hand surgery. This approach is also known as spinal anesthesia of the upper limb because of its common

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application for upper limb surgical procedures. The anatomic characteristics are the key factor its high success rate. The compact structure of the plexus is an added advantage to nerve block at these levels. Peripheral nerve blocks provide good operating conditions when it used optimally. They not only provide excellent intraoperative analgesia but also good post-operative analgesia. They cause the least interference with the vital physiological functions of the body, reduction in stress response, systemic analgesia requirements, avoiding polypharmacy, opioid-related side effects and general anesthesia requirements. Regional blocks have traditionally been performed by eliciting paresthesia, anatomical landmarks, and fascia clicks. Serious

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complication like pneumothorax occurs due to blind technique because it is mainly dependent on anatomical landmarks. Over the past two decades, neurostimulation was the gold standard technique for nerve identification in regional blocks. However, it does not ensure the required level of nerve block. It also causes damages to the nerve structures by a direct puncture. Ultrasound visualization of anatomical structures facilitates safe methods for regional blocks.^{1,2} This technique enables the anesthetist to secure an optimal needle positioning and to monitor the distribution of local anesthetic in real time. The amount of local anesthetic required for effective nerve block can be minimized by directly monitoring its distribution. Most of the local anesthetic agents developed in the first half of the 20th century (1900-1940) were basically amino ester compounds. They lost their importance due to their shorter duration of action and associated allergic reactions and systemic side effects. This paved the way for synthesis of newer agents, namely, the amino amide compounds such as bupivacaine, levobupivacaine, and ropivacaine. Ropivacaine^{3,4} is considered to be superior over bupivacaine, as it provides more differential block when given via epidural route. Motor block is not preferable during epidural labor and post-operative analgesia. In these situations, ropivacaine offers greater sensory and motor separation. Ropivacaine causes less cardiovascular and central nervous system toxicity than bupivacaine. The decreased systemic toxicity is better when a potential for high concentrations of local anesthetic agents is used in peripheral nerve block and epidural anesthesia. Because of its advantages, ropivacaine may be a better choice to bupivacaine. To prolong the duration of analgesia various drugs has been studied as adjuvants to local anesthetic solution and techniques such as the continuous catheter placement in the brachial plexus have evolved. These adjuvant drugs added to peripheral nerve block are expected to enhance the duration of analgesia without causing any systemic adverse effects and prolonging motor blockade. Novel α -2 adrenergic agent, dexmedetomidine⁵⁻⁷ is eight times more selective for α -2 adrenoceptor than clonidine. It has an analgesic, sedative and good cardiovascular stabilizing effect.

Aim

To compare ropivacaine and ropivacaine with dexmedetomidine in ultrasound guidance supraclavicular brachial plexus block scheduled for the upper limb orthopedic surgery.

MATERIALS AND METHODS

After obtaining Institutional Ethics Committee approval, 50 patients belonging to ASA I and II of either sex, aged between 20 and 60 years scheduled for upper arm orthopedic surgeries were included in this study. The patients were randomly assigned using "slips in the box technique" to either of the following groups.

Group R: 25 patients received 30 ml 0f 0.5% ropivacaine + 1 ml saline.

Group RD: 25 patients received 30 ml of 0.5% ropivacaine +1 ml (1/2 ml of dexmedetomidine with 1/2 ml of saline).

Inclusion Criteria

ASA I and II, 20-60 years, both sexes, weight 50-70 kg,

mid humerus, elbow, forearm and hand surgeries were included.

Exclusion Criteria

Patient refusal, coagulopathy, ASA III and above, H/O severe cardiovascular, pulmonary, kidney, liver disease, neurological, psychiatric, neuromuscular disorder, infection/sepsis/allergy, pneumothorax, and peripheral neuropathy were excluded.

All patients were preoperatively evaluated, clinically examined and proper investigations were done before assessment. Procedures were explained to the patient, and informed consent was obtained. They were assessed with particular attention to any contraindications. Before the procedure, visual analog scale (VAS) on 0-10 cm was clearly explained to the patient.

On arrival of the patient in the operation room, pre-procedure parameters blood pressure, heart rate, and oxygen saturation were recorded and noted. In the opposite limb, an intravenous access was obtained with 18G cannula and Ringer's lactate was started. The patients were positioned supine with arm placed by the side and the head turned 45° to the contralateral side to be blocked. The anesthesiologist stands at the head end of the patient. Under sterile aseptic precautions, in the coronal oblique plane the probe was kept in the supraclavicular fossa. The pulsating hypo echoic subclavian artery was identified. While maintaining the view of the artery the probe was angled until both first rib and the pleura were seen simultaneously to visualize these two structures. Once the artery, rib, pleura, and plexus were simultaneously in view, the aim was to guide the needle inferior to the first rib, medial to the subclavian artery and superior to the nerves. After local skin infiltration, the needle was entered in-plane from lateral plexus was visualized as a group of hypo echoic nodules. The local anesthetic solution was injected after careful aspiration, and spread was seen encircling the trunks. After injecting the local anesthetic, the block was tested for both sensory and motor and was compared with the contralateral side. Sensory block was evaluated using 3-point scale by the pin prick method. After injecting the local anesthetic drug, the sensory block was assessed at every minute in the dermatome areas corresponding to median nerve, radial nerve, ulnar nerve and musculocutaneous nerve until the completion of sensory blockade (Table 1).

Evaluation of motor block was done at every minute until complete motor blockade after drug injection. Evaluation of motor block was done by thumb abduction (radial nerve), thumb adduction (ulnar nerve), thumb opposition (median nerve), flexion of the elbow in supination, and pronation of the forearm (musculocutaneous nerve) (Table 2).

Sedation of patient was assessed by the Ramsay sedation scale.

Patients were assessed for duration of analgesia as per VAS. After the surgery, it was monitored every 1 h until the score reaches 5. The rescue analgesia was given with parental use of diclofenac injection when the VAS reaches 5 and the time of the injection was recorded.

All patients are observed for any side effects such as nausea, vomiting, dryness of mouth and complications such as pneumothorax, hematoma, local anesthetic toxicity and post-block neuropathy in the intra and post-operative periods.

Time interval between the completion of local anesthetic solution administration and the complete resolution of anesthesia on all nerves is known as the duration of sensory block. The time interval between the completion of local anesthetic administration and the recovery of complete motor function of the hand and forearm is known as the duration of motor block. The parameters of age, weight, total time taken for surgery, heart rate, blood pressure, oxygen saturation, time taken for sensory and motor

Table 1: Grading for sensory blockade Grade Sensory blockade

0	Sharp pin felt
1	Analgesia, dull sensation
2	Complete anesthesia, absence of sensation

Table 2: Grading for motor blockade

Grade	Motor blockade
0	Full flexion, extension of elbow, wrist and fingers, normal
1	Decreased motor power, can able to move the fingers only
2	Inability to move the fingers, complete block

blockade, offset time for sensory and motor blockade and total time of analgesia were analyzed by independent *t*-test. Chi-square test was used for sex and ASA. A P < 0.05 was considered statistically significant.

RESULTS

There were no differences between the two groups with regard to demographic data (age, sex, and weight), ASA grades and duration of surgery (Figure 1).

The mean onset of sensory block was 9.2 min in Group R and 6.8 min in the Group RD, there is statistical significance (P < 0.0001) (Figure 2).

The mean onset of motor block was 13.12 min in Group R and 9 min in the Group RD, there is statistical significance (P < 0.0001) (Figure 3).

The mean duration of sensory block was 506.2 min in Group R and 709 min in the Group RD, there is statistical significance (P < 0.0001) (Figure 4).

The mean duration of motor block was 478.8 min in Group R and 669.2 min in the Group RD, there is statistical significance (P < 0.0001) (Figure 5).

The mean duration of analgesia was 568.2 min in Group R and 831.8 min in the Group RD, there is statistical significance (P < 0.0001) (Figure 6).

The mean time of rescue analgesia was 588 min in Group R and 850.4 min in the Group RD, there is statistical significance (P < 0.0001) (Figure 7).

The mean VAS of the Group R when compared to Group RD at 6, 10, 14, 18, and 24 h was found to be statistically significant (Figure 8).

There is no difference in heart rate in both groups till 10 min. From 15 min Group RD shown drop in the heart rate which all statistically significant (Figure 9).

There is no difference in systolic blood pressure in both groups till 10 min. From 15 min Group RD shown drop in the heart rate which all statistically significant (Figure 10).

There is no difference in diastolic blood pressure in both groups till 10 min. From 15 min Group RD shown drop in the heart rate which all statistically significant (Figure 11).

The mean sedation score of Group R was 1 and the mean sedation score in Group RD was 2.12. The difference was found to be statistically significant (Figure 12).



Figure 1: Ultrasonography image of supraclavicular block (SA: Subclavian artery, BP: Brachial plexus, N: Needle)



Figure 2: Distribution of onset of sensory block in two groups



Figure 3: Distribution of onset of motor block in two groups

DISCUSSION

Brachial plexus blockade provides an excellent alternative technique to general anesthesia for the upper limb surgical procedures. It not only offers excellent intraoperative pain relief but also good post-operative analgesia. Supraclavicular technique was chosen for this study because it provides a rapid onset, dense and predictable anesthesia with high success rate. In our study, we used ultrasound guided supraclavicular blocks. This technique allows the direct



Figure 4: Distribution of duration of sensory block in two groups



Figure 5: Distribution of duration of motor block in two groups



Figure 6: Distribution of duration of analgesia in two groups

visualization of nerves, anatomical structures, avoidance of complication and reduces the dose of local anesthetic agents. Abrahams et al.1 concluded that ultrasound method improves the quality of blockade when compared to peripheral nerve stimulator for nerve identification. Chan et al.8 conducted study in 188 patients and demonstrated that axillary brachial plexus block significantly improved the success rate under the guidance of ultrasound with or without nerve stimulation. Hickey et al.4 studied subclavian perivascular brachial plexus block using 30 ml of 0.5% ropivacaine under elicitation of paresthesia technique for localization of nerve. They found that the peak onset of sensory blockade was 28 min. In this study, the peak onset of sensory blockade was 9.2 min. The difference may be due to difference in technique used for the localization of brachial plexus. They used elicitation of paresthesia for



Figure 7: Distribution of time of rescue analgesia in two groups



Figure 8: Distribution of visual analog scale in two groups



Figure 9: Distribution of heart rate in two groups

localization of nerve plexus, which is not as accurate as the use of ultrasound in our study. Ropivacaine is a long-acting regional anesthetic that is structurally related to bupivacaine. It is a pure S (-) enantiomer, unlike bupivacaine. It developed for the purpose of reducing potential toxicity and improving relative sensory and motor block profiles. Ropivacaine has lower lipid solubility and has produced less central nervous system and cardiac toxicity than bupivacaine for which it is gaining popularity over bupivacaine for peripheral neural blockade when large volumes of local anesthetic are required. Ropivacaine is also used in the chronic pain management. Ropivacaine is as effective as bupivacaine and levobupivacaine when used in peripheral nerve blocks. However, it is less potent than bupivacaine when used in epidural or intrathecal route. Clinically adequate doses of ropivacaine appear to be associated with a lower grade of motor block than bupivacaine.9



Figure 10: Distribution of systolic blood pressure in two groups



Figure 11: Distribution of diastolic blood pressure in two groups



Figure 12: Distribution of sedation score in two groups

Ropivacaine is considered as an important option for regional anesthesia, post-operative pain management and labor analgesia due to the following reasons. (1) Efficacy, (2) lower propensity for motor block, (3) reduced potential for central nervous system toxicity and cardio toxicity. In our study, the mean onset time of sensory and motor was quicker in Group RD. The mean duration of sensory (709 min), motor (669.2 min) in Group RD, whereas in Group R the mean duration of sensory (506 min), motor (478.8 min). The duration of analgesia was extended in ropivacaine dexmedetomidine group than in ropivacaine group. El Saied *et al.*¹⁰ concluded that the adding additives like clonidine (150 μ g) to ropivacaine for brachial plexus blockade extends the duration of sensorimotor and that of analgesia without any side effects.

Klein et al.11 compared the efficacy of bupivacaine 0.5%, and different concentration of ropivacaine 0.5%, ropivacaine 0.75%. They used 30 ml in each group. They explored that there wasn't any significant difference in time of onset and recovery. On increasing the concentration from 0.5% to 0.75% of ropivacaine, it does not show any improvement in the onset or duration of analgesia. In this study, we used 0.5% of ropivacaine 30 ml which was similar to Klein et al. study. Post-operative analgesia can be extended by continuous catheter-based technique. But it needs extra time, skill, cost, and catheter-related complications. Pharmacologically active d-isomer of medetomidine is known as dexmedetomidine.6 It is more selective toward α -2 adrenoceptor agonist with α -2: α -1 binding selectivity ratio of 1620:1 and decreasing the unwanted side effect of α -1 receptors. High selectivity for α -2 receptors mediates analgesia, sedation, and anxiolysis. Memis et al.7 and colleagues first proposed dexmedetomidine, α -2 adrenoceptor agonist when used as an additive agent to local anesthetics with an ability of prolonging the sensory and motor block duration. Esmaoglu et al.12 added dexmedetomidine to levobupivacaine for axillary brachial plexus block and showed that it shortens the time taken for onset of sensorimotor block and prolongs the time of blockade and that of post-operative analgesia. A study by Obaya et al.¹³ and colleagues during greater palatine nerve block for cleft palate surgery added an adjuvant dexmedetomidine² to bupivacaine solution. When bupivacaine mixed with dexmedetomidine provided lower pain scores and prolonged analgesia with no negative effects on hemodynamics when compared to bupivacaine alone.

Several animal studies have investigated the analgesic effects of dexmedetomidine as an adjuvant. A study by Brummett et al.2 showed that when dexmedetomidine used with bupivacaine, increases the duration of bupivacaine anesthesia and analgesia of sciatic nerve block in rats without any damage to the nerve. The above studies show that selective α -2-adrenoceptor agonist like clonidine or dexmedetomidine, when added as adjuvant to ropivacaine in different peripheral nerve blocks, potentiates the sensorimotor blockade. The mechanism of action is probably due to activation of α -2 receptors in the locus coeruleus, inhibition of substance P release in the nociceptive pathway (central action) and also by decreasing the norepinephrine release (peripheral action). Adding adjuvant like dexmedetomidine^{9,14} to ropivacaine prolonging the analgesia with one shot block can result in a longer time of post-operative analgesia and can avoid continuous catheterization. The added advantage of conscious sedation, hemodynamic stability and the lack of significant side effects like respiratory depression make dexmedetomidine better choice as an adjuvant for supraclavicular brachial plexus block.9,14 None of the patients in Group RD required sedation intraoperatively. They were comfortable throughout the surgery with arousable sedative effect. This is due to partial vascular uptake of the drug and its transport to the central nervous system. As a-2 agonists produce sedation by central action and in the nociceptive pathway at the level of dorsal root neuron causes substance P release inhibition and in the locus coeruleus α-2 adrenoceptor activation. The limited duration of sedation could be explained by the fact that it is highly lipophilic and diffuses faster into the blood vessels by rapid clearance and short half-life. In our study, the highest sedation score was 3. No patient required airway assistance due to sedation. Hemodynamic variables such as heart rate, blood pressure, oxygen saturation were significantly low in Group RD from the 15th min of the onset of blockade. They were stable throughout the surgery. Only 2 patients had heart rate <60/min. But no patient required injection. Atropine or vasopressor support. The hypotension was only mild and corrected with intravenous crystalloids. No complications were observed.

CONCLUSION

In conclusion, dexmedetomidine 50 µg when added as an adjuvant to ropivacaine 0.5% for supraclavicular brachial plexus block, hastens the onset of sensory and motor blockade, and prolongs the duration of sensorimotor blockade and provides a longer pain-free period when compared to ropivacaine alone. The use of ultrasound aids in real-time visualization reduces drug volumes and also reduces complication rates of pneumothorax and intravascular injections.

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