The Comparison of Two Different Volumes of 0.5% Ropivacaine in Ultrasound-Guided Supraclavicular Brachial Plexus Block Onset and Duration of Analgesia for Upper Limb Surgery: A Randomized Controlled Study

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Abstract

Background: The study is based on the fact that a lower volume of local anesthetic drugs for ultrasound-guided supraclavicular brachial plexus block is useful for upper limb surgeries lasting for a shorter duration, and result in a lower incidence of complications. Aim: The aim of this study is to compare the effectiveness of 35 mL of 0.5% ropivacaine with 20 mL of 0.5% ropivacaine in ultrasound-guided supraclavicular brachial plexus block for upper limb surgery. Setting: Patients undergoing upper limb surgery in an industry-based government hospital in New Delhi, India. Patients were followed in the operation theater and the recovery room. Design: The study design involves a prospective, double-blind, randomized controlled trial. Materials and Methods: A total of 40 participants were recruited for this study. Twenty participants in each group (referred to as group 20 and 30) received 20 mL and 35 mL of 0.5% ropivacaine, respectively, in ultrasound-guided supraclavicular brachial plexus block. Statistical Analysis: The statistical analysis was performed using the software SPSS version 15 and a value of \( P \leq 0.05 \) was considered statistically significant. The statistical tests used included Student’s \( t \)-test to compare values between the two groups for the mean of parametric data, Mann–Whitney U-test for a median of nonparametric data, and Chi-square test or Fisher’s exact test for the categorical data. Results: The sensory and motor block onset in group 20 was 18.06 ± 3.04 and 23.89 ± 2.14 min, respectively. The sensory and motor block onset in group 30 was 17 ± 2.01 and 23.75 ± 2.22 min, respectively. The duration of analgesia in group 20 and 30 was 575.56 ± 104.39 and 730.75 ± 102.09 min, respectively (\( P < 0.001 \)). Conclusion: The onset of sensory and motor block of 20 mL of 0.5% ropivacaine is comparable to 35 mL of 0.5% ropivacaine for supraclavicular brachial plexus block for upper limb surgery. There was a 21% decrease in the duration of analgesia with a decrease in volume of 0.5% ropivacaine from 35 mL to 20 mL.

Keywords: Randomized controlled trial, ropivacaine, surgery, ultrasound-guided supraclavicular brachial plexus block, upper limb

INTRODUCTION

“Blockade of the brachial plexus is an effective method for providing anesthesia to the upper limb from the shoulder to the fingertips.”[1] Supraclavicular block is known to be associated with a number of complications such as pneumothorax, accidental intravascular injection of the local anesthetic drug, phrenic nerve injury presenting as the elevated diaphragm, Horner’s syndrome, and neuropathy.[1,2] The advent of ultrasound during the procedure has led to a lower incidence of complications as well as the use of the lower volume of local anesthetic drugs visualize the nerves.[3] The use of ultrasound allows real-time visualization of nerves, with accurately placed local anesthetic drugs for the block.[3] The brachial plexus originates from the anterior primary rami of fifth, sixth, seventh, and eighth cervical nerves, and the first thoracic nerve. Moreover, there can be variation in the anatomy

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due to the contribution from the fourth cervical and the second thoracic nerves. The brachial plexus is subdivided into roots, trunks, divisions, cords, and branches. In most adults, the brachial plexus is composed of five roots, three trunks, six divisions, three cords, and terminal branches. For the details of the anatomy of brachial plexus, the readers are advised to refer to a standard textbook of anatomy. The aim of this study was to investigate whether 20 mL of 0.5% ropivacaine is equally effective in comparison to 35 mL of 0.5% ropivacaine in ultrasound-guided supraclavicular brachial plexus block for upper limb surgeries.

**Materials and Methods**

The current study is a prospective, double-blind, randomized controlled study where 20 patients were allocated to each of the intervention and the control group after obtaining informed consent from the patients. All the patients included in the study underwent upper limb surgery by either the orthopedic surgeons or the general surgeons. This study was conducted in the operating room and the recovery area. Ethical clearance was obtained from the ethical committee of the hospital at the onset. The study duration was for 1 year from April 2016 to April 2017.

Randomization was achieved by using the sealed envelope technique [Figure 1]. Both, the subjects and the observer assessing the supraclavicular block were blinded to the volume of 0.5% ropivacaine. The baseline data and secondary outcomes were analyzed by applying the Student’s t-test to compare values between two groups for the mean of parametric data, Mann–Whitney U-test for a median of nonparametric data, and Chi-square test or Fisher’s exact test for the categorical data. The value of $P < 0.05$ was considered statistically significant. The statistical analysis was performed by using the software SPSS Inc released 2006. SPSS released for windows, version 15.0. (Chicago, SPSS Inc.). All patients undergoing upper limb surgery between the age of 18 and 80 years old, with a bodyweight over 50 kg, and American Society of Anesthesiologists (ASA) physical statuses I, II, and III were included in the study. All the patients with a known history of chronic obstructive pulmonary disease, renal impairment, hepatic impairment, mental illness, allergy to ropivacaine, infection at the site of injection, coagulopathy, and peripheral neuropathy were excluded from the study. After taking informed consent from the patient, each patient was placed supine, and an intravenous cannula was secured inside the operating room. In addition, the monitors for the plethysmograph, electrocardiogram, and noninvasive blood pressure were attached to the patient. The patient has explained the procedure in his/her language and asked to turn the head toward the contralateral side. After scrubbing with chlorhexidine solution, sterile drapes were placed at the site of the supraclavicular brachial plexus block. The block was subsequently performed under all aseptic precautions by two experienced anesthesiologists using the linear ultrasound probe connected to the Sonosite Titan (Bothell, WA, USA), and by utilizing the in-plane technique. The skin was infiltrated with 3 mL of 2% lignocaine, followed by placing the ultrasound probe in the coronal oblique plane. This was followed by the introduction of 18 Gauge and 50-mL measuring needle from the lateral side of the ultrasound probe. The needle was negotiated further until it reached the sheath of the brachial plexus with continuous visualization of the needle tip in the real-time by ultrasound [Figure 2]. The local anesthetic drug (0.5% ropivacaine) was then injected after negative aspiration for blood. The patients assigned to group 35 and group 20 received 35 mL and 20 mL of 0.5% ropivacaine, respectively.

**Results**

All the patients were in the age group of 18–62 years [Table 1]. The mean age of the patients in years was 44.80 ± 13.92 and 45.70 ± 13.41 in group 20 and group 35, respectively, which was comparable ($P = 0.836$, Table 1). The height of the patients varied from 150 to 170 cm [Table 1]. The mean height of patients in group 20 and group 35 was 159.10 ± 8.12 and 160.25 ± 6.21, respectively, which was comparable ($P = 0.618$, Table 1). The weight of the patients ranged from 50 to 74 kg [Table 1]. The mean weight of patients in group 20 and group 35 was 61.95 ± 5.87 and 61.70 ± 6.26, respectively, which was comparable ($P = 0.897$, Table 1). The total number of male patients in the group 20 and 35 were 8 and 9, respectively, while the number of female patients in the group 20 and 35 were 12 and 11, respectively [Table 2]. The sex ratio of the two groups was comparable ($P = 0.749$). The group 20 had an equal number of ASA I and ASA II patients.

| Table 1: Mean distribution of age, height, and weight between the two groups |
|-----------------------------|---------|----------------|---------|
| Group | n | Mean±SD | t | P |
| Age |
| Group 20 | 20 | 44.80±13.92 | 0.208 | 0.836 |
| Group 35 | 20 | 45.70±13.41 | | |
| Height |
| Group 20 | 20 | 159.10±8.12 | −0.503 | 0.618 |
| Group 35 | 20 | 160.25±6.21 | | |
| Weight |
| Group 20 | 20 | 61.95±5.87 | 0.13 | 0.897 |
| Group 35 | 20 | 61.70±6.26 | | |

SD=Standard deviation

| Table 2: Comparison of sex and American Society of Anesthesiologists status distribution between the two groups |
|-----------------------------|---------|---------|
| Group | Pearson $\chi^2$ | P |
| Sex |
| Male | 8 | 9 | 0.102 | 0.749 |
| Female | 12 | 11 | | |
| ASA |
| ASA I | 10 | 9 | 0.1 | 0.752 |
| ASA II | 10 | 11 | | |

ASA=American Society of Anesthesiologists
whereas in group 35, 9 patients were ASA I and 11 patients were ASA II which was comparable [P = 0.752, Table 2]. The patients with inadequate sensory and motor blocks were excluded from the analysis for this study. The sensory block was assessed by pinprick and was scored as 0, 1, and 2 for absent block, <50% decrease in sensation compared to the contralateral side, and complete effect of the supraclavicular block, respectively. The anatomical sites used for the assessment of sensory block of musculocutaneous, radial nerve, median nerve, and ulnar nerve corresponded to the lateral side of the forearm, first dorsal workspace of hand, distal phalanx (tip) of the index finger, and the distal phalanx (tip) of the little finger respectively. The mean onset of sensory block in the musculocutaneous, median nerve, ulnar nerve, and radial nerve distribution was 5.56 ± 1.62, 11.11 ± 2.74, 16.39 ± 3.35, and 16.11 ± 3.23 min, respectively, in the group 20 patients, whereas it was 5.50 ± 1.54, 10.75 ± 2.45, 16 ± 2.05, and 16.50 ± 2.35 min, respectively, in the group 35 patients, respectively [Table 3]. In addition, the overall sensory block onset was 18.06 ± 3.04 and 17.00 ± 2.51 min in group 20 and the group 35 patients, respectively [Table 3]. There was no statistical difference in the sensory block onset time in any of the nerve regions and the overall sensory block onset time among the two groups [P > 0.05, Table 3]. Moreover, the motor block was assessed by flexion of the elbow and hand against gravity and was labeled as Grade 1 to Grade 4 as complete flexion and extension of forearm, flexion, and extension of only the wrist and fingers, flexion, or extension of only the fingers, and no motion of the forearm, wrist, and fingers, respectively [Table 4]. The time of onset of motor block was 23.89 ± 2.14 and 23.75 ± 2.22 min in group 20 and 35, respectively [Table 4]. There was no statistically significant difference between the two groups (P = 0.846) [Table 4]. The duration of analgesia achieved in group 20 and 35 was 575.56 ± 104.39 and 730.75 ± 102.09 min, respectively, and the difference was statistically significant (P < 0.001) [Table 5].

**Table 3: Onset of sensory block in musculocutaneous, median, ulnar, radial, and overall nerve distributions**

| Group   | n  | Mean±SD | t     | P     |
|---------|----|---------|-------|-------|
| Musculocutaneous | 20 | 18 | 5.56±1.62 | 0.108 | 0.914 |
|         | 35 | 20 | 5.50±1.54 |       |       |
| Median  | 20 | 18 | 11.11±2.74 | 0.429 | 0.67  |
|         | 35 | 20 | 10.75±2.45 |       |       |
| Ulnar   | 20 | 18 | 16.39±3.35 | 0.437 | 0.665 |
|         | 35 | 20 | 16.00±2.05 |       |       |
| Radial  | 20 | 18 | 16.11±3.23 | 0.427 | 0.672 |
|         | 35 | 20 | 16.50±2.35 |       |       |
| Overall | 20 | 18 | 18.06±3.04 | 1.171 | 0.249 |
|         | 35 | 20 | 17.00±2.51 |       |       |

**Table 4: Onset of motor blocks in the two groups**

| Group   | n  | Mean±SD | t     | P     |
|---------|----|---------|-------|-------|
| Onset of motor block | 20 | 18 | 23.89±2.14 | 0.196 | 0.846 |
|         | 35 | 20 | 23.75±2.22 |       |       |

**Table 5: Duration of analgesia in the two groups**

| Group   | n  | Mean±SD | t     | P     |
|---------|----|---------|-------|-------|
| Duration of analgesia | 20 | 18 | 575.56±104.39 | 4.63 | <0.001 |
|         | 35 | 20 | 730.75±102.09 |       |       |

**Discussion**

A variety of approaches to the brachial plexus block have been described, for example, the interscalene block, the supraclavicular block, the infraclavicular, the axillary approach, intercostobrachial block, etc.[4] The supraclavicular block was introduced by Kulenkampff in 1911 as the landmark technique.[4] Historically, the supraclavicular block has been reported to provide a reliable and successful block for upper limb surgeries by blocking the brachial plexus at the level of trunks where the plexus is compact.[5] Moreover, the ultrasound also helps in minimizing the complications of the block, especially the complications associated with the higher volumes of local anesthetic drugs.[6,7] This study compares a conventional higher volume (35 mL of 0.5% ropivacaine) versus a lower volume (20 mL of 0.5% ropivacaine) in the ultrasound-guided supraclavicular plexus block because at our institution we observed that by gradually decreasing the volume, the minimum volume found to be effective with the ultrasound machine Sonosite Titan (Bothell; WA, USA) was 20 mL. Renes et al. investigated the “minimum effective volume” of 0.75% ropivacaine in the ultrasound-guided C7 root level block for shoulder surgery to vary between 2.9 and 3.6 mL.[8] In addition, Duggan et al. suggested the minimum volume of local anesthetic drugs (a mixture of 2% lidocaine combined with 0.5% bupivacaine with epinephrine) found to be effective during the ultrasound-guided supraclavicular block was 23 mL.[9] Taboada Muñiz et al. showed in their study of sciatic nerve block that a lower volume (20 mL) of 1.5% mepivacaine resulted in a shortened time of onset of complete sensory and motor block when compared to a higher volume (30 mL) of lower concentration (1%) mepivacaine.[10] The current study utilizing 20 mL of 0.5% ropivacaine compared to the conventional volume of 35 mL of 0.5% ropivacaine in the absence of any adverse events such as pneumothorax and Hemi diaphragmatic paresis, is in agreement with the results of above-mentioned studies. Moreover, ropivacaine was used over the other local anesthetic drugs due to the lower incidence of cardiac sideeffects.[11] In addition, in the current study, the onset of sensory and motor block was similar in both the groups, but the duration of analgesia was 21% lesser in the patients receiving 20 mL of 0.5% ropivacaine (575.56 ± 104.39 min versus 730.75 ± 102.09 min in group 20 and 30, respectively). This finding is in contrast to the findings shown in the study by Mosaffa et al., 2015 where the onset of sensory block was
significantly shorter in the patients receiving 10 mL of 1.3% lidocaine versus 7 mL of 2% lidocaine for ultrasound-guided block of brachial plexus cords. There was no incidence of pneumothorax and any evidence of hemi diaphragmatic paresis reported during the current study. Therefore, considering the advantages of using the low volume local anesthetic drug, we conclude that upper limb surgeries lasting for shorter duration and requiring enhanced recovery for discharge may be conducted using low volume ropivacaine. The limitations of the current study include the lack of precise assessment of sensory and motor function due to the presence of dressings and braces, nonblinding of the anesthesiologist performing the procedure in the operating room, and the inability to precisely assess the intraneural spread of the local anesthetic drug.

**Conclusion**

This study was conducted to compare two volumes of 0.5% ropivacaine in ultrasound-guided supraclavicular brachial plexus block. We investigated a total number of 40 patients, of which 20 patients in each group received 35 mL and 20 mL of 0.5% ropivacaine, respectively. The effectiveness of the supraclavicular block was assessed by the onset of sensory and motor block. The reduction of volume from 35 mL to 20 mL resulted in a reduction in the duration of analgesia by 21%. This study intends to highlight the need of more studies to evaluate the minimum effective volume of 0.5% ropivacaine for a complete sensory and motor block with a minimum requirement of intravenous analgesics in the postoperative period for upper limb surgeries.

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Nil.
Conflicts of interest
There are no conflicts of interest.

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