

Different Volumes of Local Anesthetics in Ultrasound-Guided Combined Interscalene-Supraclavicular Block for Traumatic Humeral Fracture

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Abstract

Background: Procedures that require anesthesia of entire length of the arm should have combined Interscalene block (ISB) and Supraclavicular block (SCB) to ensure adequate block. However, dual block requires high dose of local anesthetic (LA). We examined if Ultrasound (U/S) guided block helps to decrease the required volume of LA by visualizing trunks, so we only need injection of LA toward cervical nerve roots C5 and C6 aiming to block branches escaped from supraclavicular block. **Patients and methods:** Ninety-three patients were randomly allocated into one of three equal groups, each included 31 patients. All patients received SCB 20 ml (10 ml Bupivacaine 0.5% plus 10 ml lidocaine 2%) and ISB with different volumes of LA according to the group as follow: group A: 20 ml, group B: 15 ml, and group C: 10 ml. **Result:** No significant difference in onset of block (sensory and motor) and duration of block (motor only) between the three groups (P value > 0.05). The duration of sensory block was significantly longer in group A (760.65 ± 30.87 minutes) than in either group B (740.48 ± 21.15 minutes, P value < 0.003) or group C (662.87 ± 31.28 minutes, P value < 0.001). Sensory block was significantly longer in group B than in group C (P value < 0.001). The duration of analgesia was significantly longer in group A (930.52 ± 22.04 minutes) than in either group B (899.35 ± 21.82 minutes, P value < 0.002) or group C (850.32 ± 20.65 minutes, P value < 0.001). Analgesia was significantly longer in group B than in group C (P value < 0.001). **Conclusion:** A reduced volume of LA can be used in ultra sound guided ISB in combined with SCB to give satisfactory level of anesthesia to entire length of the arm, but the sensory block duration and duration of post-operative analgesia will be decreased significantly with decreasing the volume.

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Keywords

Interscalene Block, Supraclavicular Block, Volume of Local Anesthetic, Ultrasound

1. Introduction

Regional anesthesia for fractures of the proximal upper limb presents a challenge to the anesthetist as there is no single block that can provide a satisfactory level of anesthesia with high success rate. So the anesthetic management for surgical procedures that include the entire length of the humerus still includes general anesthesia either alone or combined with brachial plexus block [1].

The interscalene approach to brachial plexus blockade results in anesthesia of the shoulder, lateral two-thirds of the clavicle and proximal humerus [2]. Note that the skin over and medial to the acromion is supplied by the supraclavicular nerve, which is a branch of the cervical plexus. Supraclavicular nerves are usually blocked with the brachial plexus when an interscalene block is performed. This is because the local anesthetic invariably spills over from the interscalene space into the prevertebral fascia and blocks the branches of the cervical plexus [3]. The classic interscalene block is not recommended for hand surgery due to potential sparing of the inferior trunk and the lack of blockade of the C8 and T1 roots [4].

The terminal branches of the brachial plexus that supply the majority of the shoulder innervation are the suprascapular and axillary nerve. The suprascapular nerve gives sensory supply to 70% of the shoulder joint capsule [5]. The axillary nerve originates from C5-C6 nerve roots, and gives the cutaneous innervation to the skin overlying the deltoid muscle [6].

Supraclavicular block (SCB) provides anesthesia of the entire upper extremity in the most consistent, time-efficient manner of any brachial plexus technique [7]. The block is frequently used for hand surgery, wrist, forearm, elbow, and distal third of humerus. The suprascapular and axillary nerve that originates from C5-C6 nerve roots may be missed with this block, and supraclavicular nerve, which is a branch of the cervical plexus that supplies skin over shoulder not blocked by SCB. So, this limits the using of SCB block for shoulder and proximal humeral surgeries [8] [9].

Surgical treatment of traumatic humerus fractures includes intramedullary nail insertion or open reduction with long plate and screw. Whichever the surgical technique used, it requires the block of the entire brachial plexus in order to be carried out under regional anesthesia (RA) alone [10]. Hence, the use of combined ISB with SCB is required to provide a sole RA especially when general anesthesia carries a risk for the patient.

Ultrasound-guided nerve block has many advantages including that the US provides real-time visualization of the target tissues and surrounding structures, the higher success rate, faster onset time, and fewer complications [11]. Additionally, studies have demonstrated the ability to reduce the volume of local anesthetic and achieve more or less the same results as well as reduce side effects associated with certain blocks [12].

Few studies have been demonstrated the use of combined ISB and SCB to cover all dermatomes required for surgery involving the entire length of the arm. Martinez *et al.* [13] described a combination infraclavicular-suprascapular block in a patient with respiratory failure for the repair of fracture head of the humerus to avoid phrenic nerve paralysis. Other authors described combined axillary-interscalene block as a regional anesthetic for patients with multiple fractures of elbow joint, humerus, and shoulder [14]. Guttman *et al.* described an ultrasound guided supraclavicular-interscalene block for multiple pathologic fractures of the humerus in a severely ill, emaciated patient with metastatic hepatocellular carcinoma [15]. Christian R. *et al.* described US-guided interscalene-supraclavicular block for an intramedullary nailing of pathologic humeral fracture combined to GA [1].

2. Hypothesis and Study Objective

Procedures require anesthesia of entire length of the arm should have combined ISB and SCB to ensure high success rate. But dual block requires a high dose of local anesthetic. In our study, we don't need to give a full dose of local anesthetic in interscalene nerve block as US help to visualize all trunks and roots of brachial plexus so we need the only injection of local anesthetics toward C5 and C6 nerve roots aiming to block branches that may be escaped from supraclavicular nerve block.

3. The Aim of This Study

We aimed in this study to examine if Ultrasound-guidance helps to decrease the required volume of LA in combined SCB-ISB by visualizing trunks and roots and injecting LA only towards C5 and C6 nerve roots thus blocking branches escaped from supraclavicular nerve block.

4. Patients and Methods

This double-blinded randomized controlled clinical trial was carried out at Kasr Al-Ainy hospital, faculty of medicine, Cairo University, in the period from May 2013 to April 2015 after ethical approval by the departmental scientific and ethical committee. The study recruited Ninety-three ASA physical status I, II patients of both sexes, 18 - 55 years old, who underwent fixation of traumatic humeral fracture and required anesthesia to the entire length of the arm (intramedullary nail insertion or open reduction with long plate and screw). A written informed consent from patients was provided preoperatively. Exclusion criteria of this study were; refusal of the patient, trauma survey on head neck, chest and abdomen were free, patient with neurological deficits involving upper limb, bleeding tendency, anticoagulation therapy, patients with allergy to local anaesthetics, local infection at the injection site, patients on sedative or antipsychotic drugs and body mass index (BMI) > 35.

Patients were randomly allocated into one of three equal study groups using EXCEL 2010 (Microsoft Corp. U.S.A.). The randomization sequences were concealed in opaque sealed envelopes that were kept by the senior anesthesia staff. The envelope was opened at the beginning of the operation before initiation of the block.

Group A: 31 patients, received Supraclavicular Block (SCB) with 20 ml (10 ml bupivacaine 0.5% plus 10ml lidocaine 2%) and Interscalene Block (ISB) with 20 ml (10 ml bupivacaine 0.5% plus 10 ml lidocaine 2%).

Group B: 31 patients, received SCB with 20 ml (10 ml bupivacaine 0.5% plus 10ml lidocaine 2%) and ISB with 15 ml (7.5 ml bupivacaine 0.5% plus 7.5 ml lidocaine 2%).

Group C: 31 patients, received SCB with 20 ml (10 ml bupivacaine 0.5% plus 10 ml lidocaine 2%) and ISB with 10 ml (5 ml bupivacaine 0.5% plus 5 ml lidocaine 2%).

The primary outcome of this study was to compare the effect of different volumes of local anaesthetic used in ISB when combined with SCB on the onset and duration of the block. The secondary outcome was to assess changes in hemodynamics, respiratory rate, and oxygen saturation in the studied groups.

All patients were subjected to systematic preoperative assessment including history, examination, and investigations. Visual analogue pain score (VAS) was explained to all candidates where zero corresponds to no pain and 10 was indicative of the worst unbearable pain.

On arrival to the preparation room: A peripheral IV cannula (18 G) was inserted; premedication was done using 2 mg midazolam IV and one mic/kg fentanyl IV.

Patients were transferred to the operating room where basic monitoring (Electrocardiography (ECG), Non-invasive Blood Pressure (NIBP) and pulse oximetry (SpO₂)) were attached. Baseline heart rate, blood pressure, oxygen saturation and respiratory rate were recorded as pre-block values.

The patient was placed in supine position with the head turned 45 degrees to the contralateral side. First, for the safety of block to avoid intraneural injection we performed SCB before ISB as the patient can feel any pain or the injection pressure while performing both blocks. For the ultrasound-guided supraclavicular block, an ultrasound machine (Mindray M7) and a 12 MHz linear type probe were used. After skin preparation and local anesthetic infiltration of skin, the supraclavicular fossa was scanned to locate the subclavian artery, first rib, pleura and brachial plexus, then a 22 gauge, 5 cm, echogenic needle (B. Braun) was advanced from the lateral to medial in the long axis of the ultrasound beam. The needle was advanced towards the "corner pocket" where the lower trunk commonly lies at this area, between the subclavian artery medially, the first rib inferiorly and the plexus superiorly and then 10 ml of mixture local anesthetic was injected [16], the remaining volume was injected just above and lateral to the subclavian artery.

For ultrasound-guided interscalene block, the ultrasound transducer was placed in the axial, oblique plane at the level of the cricoid cartilage to obtain the transverse view of the brachial plexus. Nerves in the interscalene groove appear hypoechoic, distinctly round or oval, and were located between the anterior and middle scalene muscles. 5 cm 22 G needle was inserted at the outer end of the ultrasound transducer after local anaesthetic infiltration of the skin. The needle was advanced in the same plane along the long axis of the transducer; then injection was done toward C5 and C6 cervical nerve roots aiming to block nerves escaped from supraclavicular nerve block.

After the procedure, patients were taken for surgery, and we observed the onset of both sensory and motor blockade, duration of both motor and sensory blockade and duration of analgesia (first request for an analgesic) was measured by interviewing the patient in the early postoperative period (2 hours). Patients were monitored routinely, and any side effects were noted. In the postoperative period if patients started to complain (VAS >3); rescue analgesia was given in the form of pethidine 1 mg/kg, paracetamol (Perfalgan®) 1gm IV drip and/or diclofenac sodium (Voltaren®) 75 mg IM, till VAS ≤ 3.

5. Statistical Analysis

Assuming that the mean duration of the sensory block of bupivacaine is 6 hours, two-tailed α error probability of 0.05 and power of 85%; a total sample size of 93 patients, randomly allocated into three equal groups (31 patients each), was required to detect presumed minimum clinically significant difference of 10% in the duration of sensory block.

Collected data was presented as mean (\pm SD), numbers and percentages, as appropriate. Categorical variables were analyzed using *Chi-square* (χ^2). One way ANOVA univariate two-group repeated measures “mixed-design” analysis of variance (ANOVA) with post-hoc *Dunnnett’s test* as appropriate. Statistical analysis was performed using the computer program SPSS (Statistical Package for Social Sciences), Version 20, 2011. *P* value < 0.05 was considered statistically significant.

6. Results

Ninety-three ASA physical status I, II patients of both sex undergoing upper limb surgery require anesthesia of the entire length of the arm, who fulfilled the inclusion criteria, were enrolled in the study. All enrolled patients have already completed the study. Patients were randomly allocated into one of three equal groups, each included 31 patients. All patients received SCB 20 ml (10 ml bupivacaine 0.5% plus 10 ml lidocaine 2%) and ISB with different volumes of LA according to the group as follow: Group A: 20 ml, group B: 15 ml, and group C: 10 ml (of the same mixture of local anesthetic, bupivacaine 0.5% plus lidocaine 2%).

Demographic data including age, gender, weight, ASA classification and duration of surgery did not show any statistically significant difference between the three studied groups. About 79.5% of the total study population was ASA class I (**Table 1**).

Regarding sensory and motor block onset, results showed that; when decrease the volume of local anesthetic, the onset of both sensory and motor block were prolonged, but these difference were not statistically significant, *P* value > 0.05 (**Table 2**).

As regards the sensory block duration, the results showed that; the duration of sensory block were increased in group A (760.65 ± 30.87) than in group B (740.48 ± 21.15) and group C (662.87 ± 31.28) and the difference in sensory block duration were statistically significant (*P* value < 0.001). On the other hand, the motor block duration was increased in group A (455.81 ± 42.57) than group B (445.16 ± 38.81) and group C (430.23 ± 34.10) but these difference were not statistically significant (*P* value > 0.05) (**Table 3**).

Table 1. Demographic data.

	Group A (n = 31)	Group B (n = 31)	Group C (n = 31)
Age	40 \pm 13.5	37 \pm 10	42 \pm 14
Gender			
Male	22 (70.9%)	19 (61.3%)	23 (74.2%)
Female	9 (29.1%)	12 (38.7%)	8 (25.8%)
Weight	75.9 \pm 5.1	73.9 \pm 7.7	78.4 \pm 9
ASA			
I	25 (80.6%)	26 (83.9%)	23 (74.2%)
II	6 (19.4%)	5 (16.1%)	8 (25.8%)
Duration of surgery	2.5 \pm 0.9	3.5 \pm 1.1	2.8 \pm 0.7

Data are described as mean \pm SD or number of patients (percentage %). †ASA American Society of Anesthesiologists.

Table 2. Onset of sensory and motor blockade.

	Group A (n = 31)	Group B (n = 31)	Group C (n = 31)	p value		
				Group A vs. B	Group A vs. C	Group B vs. C
Onset of sensory block (min.)	9.55 ± 1.40	10.06 ± 1.41	9.71 ± 1.28	0.3	0.319	0.43
Onset of motor block (min.)	18.52 ± 1.61	19.02 ± 1.55	19.35 ± 1.50	0.09	0.2	0.107

Data are presented as mean ± SD. *P* value less than 0.05 is considered statistically significant.

Table 3. Duration of sensory and motor blockade.

	Group A (n = 31)	Group B (n = 31)	Group C (n = 31)	p value		
				Group A vs. B	Group A vs. C	Group B vs. C
Duration of sensory blockade (min)	760.65 ± 30.87	740.48 ± 21.15	662.87 ± 31.28	0.03*	<0.001*	<0.001*
Duration of motor blockade (min)	455.81 ± 42.57	445.16 ± 38.81	430.23 ± 34.10	0.45	0.23	0.35

Data are presented as mean ± SD. *P* value less than 0.05 is considered statistically significant*.

When comparing the duration of analgesia following nerve block administration, the duration of analgesia were increased in group A (930.52 ± 22.04) than in group B (899.35 ± 21.82) and group C (850.32 ± 20.65) and the difference in duration of analgesia between the three studied groups were statistically significant (*P* value < 0.001) (Table 4).

The nerve blockade administered was successful in all patients of the studied groups. None of the patients required rescue analgesia intraoperatively or postoperatively in the Post-Anesthesia Care Unit (PACU). No block related change in hemodynamics, There were only three patients manifested by Horner's syndrome in group A (9.6%) and two patients in group B (6.5%), About voice changes, only four patients in group A (12.9) and three patients in group B (9.6%) (Table 5).

7. Discussion

Our study examined if we can reduce the volume of local anesthetic needed in interscalene block when targeting cervical nerve roots C5 and C6 that may escape from supraclavicular block depending on visualization by Ultrasound (U/S) guided block. We compared three different volumes (20 ml, 15 ml, and 10 ml) of LA in ISB combined with SCB (20 ml). Our results revealed non-significant difference in onset of block (sensory and motor) and duration of block (motor only) between the three groups with the duration of sensory block and analgesia decreased significantly and in parallel with reducing volume of LA with no need for general anesthesia in any of the studied patients.

Procedures that require anesthesia for the entire length of the arm should have combined ISB and SCB to ensure high success rate as increasing volume injected in SCB may even fail to block C5 and C6 nerve roots [17]. However, dual block (ISB and SCB) requires a high dose of local anesthetic agents with potentially increased risk of LA toxicity and side effects.

Only a few studies have described the use of combination blocks to cover the entire proximal upper limb. Martinez *et al.* [13] described a combination infraclavicular-suprascapular block in a patient with respiratory failure for the repair of fracture head of the humerus. Other authors described combined axillary-interscalene block for patients with multiple fractures of elbow joint, humerus, and shoulder.

Guttmann *et al.* [15] described an ultrasound guided supraclavicular-interscalene block for multiple pathologic fractures of the humerus in a severely ill patient with metastatic hepatocellular carcinoma.

Christian R *et al.* [1] described US-guided interscalene-supraclavicular block for an intramedullary nailing of pathologic humeral fracture in combined to GA.

Table 4. Duration of analgesia.

	Group A (n = 31)	Group B (n = 31)	Group C (n = 31)	p value		
				Group A vs. B	Group A vs. C	Group B vs. C
Analgesia duration (min.)	930.52 ± 22.04	899.35 ± 21.82	850.32 ± 20.65	0.002*	<0.001*	<0.001*

Data are presented as mean ± SD. *P* value less than 0.05 is considered statistically significant*.

Table 5. Incidence of side effects in the block.

	Group A	Group B	Group C
Horners syndrome	3 (9.6%)	2 (6.5%)	0 (0%)
Voice change	4 (12.9%)	3 (9.6%)	0 (0%)
Respiratory distress or desaturation	0 (0%)	0 (0%)	0 (0%)
Hemodynamic changes^l	0 (0%)	0 (0%)	0 (0%)

Data are described as number of patients (percentage %).

Our study outcome correlates well with the work of Fredrickson *et al.* [18] who studied the effect of three different volumes of 0.75% ropivacaine (5, 10, and 20 ml) and two different volumes of 0.375% ropivacaine (20 and 40 ml) on the analgesic duration of interscalene block. They found that 5 ml resulted in an unacceptably high analgesic failure rate (30%) and that higher concentration and volume (and thus mass) were clearly associated with prolonged analgesia.

Nader *et al.* [19] who examined the effect of different volumes of 0.5% ropivacaine or bupivacaine on onset time and analgesic duration of the sciatic nerve block in total knee arthroplasty. Volumes studied ranged from 2.5 to 30 ml, volumes of less than 10ml was increased onset times and shortened analgesic durations. This study reports that mass of local anesthetic is the determinant factor of the onset and duration of nerve block.

In agreement with our study; Schoenmakers, who compared between 40 mL and 15 mL mepivacaine 1.5% for ultrasound-guided single shot axillary brachial plexus block (ABPB), and concluded that a decrease in the volume or dose 62.5% resulted in decrease duration of sensory and motor block 17% and 19% respectively [20]. Also Fenten *et al.* [21] found that a decrease in volume from 30 to 20 mL of mepivacaine in ABPB does not affect the block duration, but the duration of sensory and motor block were prolonged when a higher dose and concentration in equal volumes of 30 mL was used.

In contrary to our results, Sanjay K. Sinha *et al.* [22] who studied the effect of decreasing the local anesthetic volume from 20 ml to 10 mL for US-guided Interscalene block, concluded that there were no statistical differences in the duration of the block and home analgesic consumption between the groups. Serradell *et al.* [23] who used mepivacaine 1% for ABPB found that the differences in the analgesia duration when using 36 mL, 28 mL or 20 mL is statistically insignificant, and there is no relation between volume and duration of analgesia.

The results of the current study provide a reliable evidence about the correlation between the volume and subsequently the dose of local anesthetic injected and the duration of sensory block and analgesia provided. Additionally our study revealed that ultrasound targeted injection of reduced volume of LA provided a satisfactory block with no need for general anesthesia for the studied type of surgeries.

Limitations of the study; Despite our primary outcome was to compare the efficacy of different volumes of local anesthetic in brachial plexus block, we did not correlate between the volume or dose of LA used on one side and the weight and the height of the studied patients on the other side, this may affect our evaluation and comparison of the efficacy of the different volumes of LA. Another limitation is that our study was carried out in one center and one operator, future plan to apply our study in multiple centers carried out multiple operators can improve the accuracy of our investigation.

8. Conclusion

A reduced volume of LA can be used in ultra sound guided ISB in combined with SCB to give satisfactory level

of anesthesia to entire length of the arm, but the sensory block duration and duration of post-operative analgesia will be decreased significantly with decreasing the volume. So we can use this technique as alternative to general anesthesia in surgeries which require anesthesia to entire length of the arm without placing patient at additional risk of LA toxicity.

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