ORIGINAL RESEARCH

Comparison of ultrasound guided supraclavicular and infraclavicular blocks for upper limb surgery using ropivacaine 0.5%

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Received: 10 February, 2023 Accepted: 20 April, 2023

ABSTRACT

Aim: The aim of the present study was to compare efficacy of ultrasound guided Supraclavicular and Infraclavicular blocks for upper limb surgery using Ropivacaine 0.5%.

Material and Methods: A Randomized Controlled Trial was conducted in Vivekananda Institute of Medical Sciences, Kolkatta in between July 2016 to June 2017. Total 120 patients were divided in two groups i.e., 60 patients in each group. Group S (n=60) –Ultrasound guided Supraclavicular brachial plexus block was performed with 0.5% Ropivacaine. Group I (n=60) - Ultrasound guided Infraclavicular brachial plexus block was performed with 0.5% Ropivacaine.

Results: The t-test showed that there was no significant difference in mean Ages, Weight and Height of the patients of the two groups (p>0.05). There was no significant difference in mean heart rate of the patients of the two groups for different time intervals (p>0.05). The t-test showed that there was no significant difference in mean SPO2, Systolic and diastolic blood pressure of the patients of the two groups for different time intervals (p>0.05).

Conclusion: We concluded that ultrasound guided infraclavicular block provides superior quality of sensory, motor block and less side effect whereas duration of sensory block, motor block and postoperative analgesia was greater in USG guided supraclavicular block.

Key words: Infraclavicular block, interscalene block, supraclavicular block, success rate, upper arm and forearm surgery

Introduction

Pain defines as 'an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage'. Surgical pain is a universal phenomenon, affecting all patients in the perioperative period, causing several deleterious effects on the patients' body and mind. Regional nerve block can provide effective surgical anesthesia as well as postoperative analgesia which avoid the unwanted effects of anesthetic drugs used during general anesthesia and the stress of laryngoscopy and tracheal intubation. There have been several techniques designed and available to facilitate the correct placement of local anesthetic, including paresthesia-seeking, peripheral nerve stimulator, and most recently ultrasound guidance [1]. The introduction of Ultrasound imaging has greatly increased the use of blocks at the supraclavicular fossa, as visualization of the subclavian artery and lung make these critical structures easier to avoid [2]. Ultrasound imaging techniques also enable the anaesthesiologist to secure an accurate needle position and monitor the distribution of the local anaesthetic in real time, with the potential advantage of improving the quality of nerve block, shortening onset of the block, and reducing the minimum volume required to obtain a successful nerve block [3]. The supra-clavicular block results in anaesthesia of dermatomes C5 through T1, making it suitable for anaesthesia or

analgesia of entire upper extremity distal to shoulder, including the upper arm and elbow as well as forearm, wrist and hand [4]. The supra-clavicular approach to brachial plexus is characteristically associated with rapid onset of anaesthesia and a high success rate. However, the major disadvantages are higher incidence of complications such as inadvertent vascular injections, pneumothorax, phrenic nerve palsy and Horner's syndrome.

Brachial plexus block in the infraclavicular area offers excellent analgesia of the entire arm. Blockade occurs at the level of the cords and offers the advantages of avoiding pneumothorax while affording block of the musculocutaneous and axillary nerves. A nerve stimulator or ultrasound visualization is required because there are no palpable vascular landmarks to aid in directing the needle [1]. The main advantage of infraclavicular block is the fewer incidences of complications with ultrasound, and it is ideally suited for catheter techniques. The disadvantage is that plexus is situated deeper at this level and the angle of approach is more acute making synchronised visualisation of the relevant anatomy and needle challenging in inexperienced hands and in obese patients [5].

One of the most important properties of a long-acting local anaesthetic is to reversibly inhibit the nerve impulses, thus causing prolonged sensory and motor block appropriate for anaesthesia. Ropivacaine is a well-established long-acting amide local anaesthetic agent which produces effects similar to other local-anaesthetics via reversible inhibition of sodium ion influx in nerve fibres. It is less lipophilic, less cardio and central nervous system toxic and also possesses intrinsic vaso-constrictor property which metabolised extensively in liver and excreted in urine [6] and has a greater degree of motor-sensory differentiation as compared to others.

The aim of the present study was to compare efficacy of ultrasound guided Supraclavicular and Infraclavicular blocks for upper limb surgery using Ropivacaine 0.5%.

Material and Methods

A Randomized Controlled Trial was conducted in Vivekananda Institute of Medical Sciences, Kolkatta in between July 2016 to June 2017. Patients was allocated by simple random sampling in order to ensure equal number of patients in each group and to avoid bias. The first patient was randomly chosen and allocated to the 1st group (group S) using computer generated random number table. The following patients was automatically allocated to the subsequent groups in an odd even manner i.e., Group S and then again group I. The subjects were randomly allocated two equal groups of 60 each.

Also, the study was single blinded as neither the patients nor the observers who assessed the study parameters was aware about the procedure done to the patients.

Group S (n=60) –Ultrasound guided Supraclavicular brachial plexus block was performed with 0.5% Ropivacaine.

Group I (n=60) - Ultrasound guided Infraclavicular brachial plexus block was performed with 0.5% Ropivacaine.

Inclusion Criteria

a) Patients posted for upper limb surgeries in VIMS-RKMSP
b) Aged between 18-80 years.
c) Patients with ASA Class I and II.

Exclusion Criteria

a) Coagulopathy
b) Infection at the injection site.
c) Allergy to drugs under study.
d) Age <18 yrs and >80 yrs.
e) Mental incapacity or language barrier precluding informed consent.
f) A body mass index more than 35.
g) Pre-existing motor or sensory deficit in the operative limb.
h) Chronic renal or liver disease.
i) Patients with history of peptic ulcer disease.
j) Chronic analgesic therapy, patients receiving sedatives or anti-psychotics.
k) Failed block requiring general anesthesia or failed to obtain proper image of brachial plexus after 20 minutes of ultrasonography scanning.

Methodology

The procedures were carried out in the operating theatre of Ramakrishna Mission Seva Pratishthan. Patients were explained regarding the procedure and written informed consent was obtained from all the patients prior to including them in the study, during the pre-anesthetic check-up. Complete pre-anesthetic evaluation was performed in each patient including detailed history taking, thorough physical check-up, airway examination and assessment of routine investigations according to protocol. 120 patients were randomized to either to the supraclavicular (S) or the infraclavicular (I) group using computer generated random numbers table. Patients were explained in detail about the anesthetic technique, operating procedure and postoperative care and monitoring. Visual Analogue Scale (VAS) was explained to every patient included in the study in the preoperative period.

Patients received anxiolytic (alprazolam 0.5 mg oral) and H2 receptor antagonists (ranitidine 150 mg oral) on the night before surgery. Fasting for solid food up to 8 hours, for light meal up to 6 hours, for non-clear fluid up to 4 hours and for clear fluids up to 2 hours was ensured before surgery.

After coming to operating theatre, standard ASA monitors like ECG monitoring, Pulse oximeter, Non-invasive blood pressure were connected and baseline parameters were recorded. Intravenous access was

obtained in preferably non-operated upper limb with 16/18 G cannula and fluid infusion was started. Patients were sedated by IV midazomal(1-2 mg) before performing the procedure.

The block was performed using Ropivacaine 0.5% making upto a volume of 0.5 ml/kg (Maximum volume 40ml, Maximum dose up to 3mg/kg).

A LOGIQe ultrasound machine equipped with a linear probe 8-13 MHz probe (12L-RS)12, cross beam imaging capability and a colour Doppler was used for all patients. An exploratory scan was performed in each patient before the block, by positioning the probe in a coronal oblique plane above the clavicle (S group) or the parasagittal plane below the clavicle (I group). The frequency was set to 10MHz. The targets were: the plexus trunks/divisions in the S group and the axillary artery in the I group.

Position of the patient was supine with head rotated to the contralateral side. The upper limb to be anesthetized was adducted and extended along the side toward the ipsilateral knee as far as possible. Antiseptic dressing and draping of the site were done. After anaesthetizing the skin and the subcutaneous tissue with 2–4 ml of lignocaine 20 mg/ml, a 25G, Quinke's needle was inserted under the probe's long axis (in plane).

In the S group, the first half of the LA volume was injected superficial to the plexus and the remaining volume was injected after repositioning the needle tip to obtain a full circumferential LA spread around the nerves [7].

In the I group, the first half of the volume was injected posterior to the artery and the second half after repositioning the tip to obtain a posterolatero-medial, U-shaped LA spread. The individual plexus cords was not be used as the target.

Systolic blood pressure, Diastolic blood pressure, Mean arterial pressure heart rate and SPO2 were recorded 0 mins, 1min, 3mins, 5mins,10mins,15mins, 20mins, 30mins after brachial plexus block.

Sensory blockade was assessed by touch and needle (25G) prick test in all the 4 nerve areas i.e., lateral side of the forearm for musculocutaneous nerve; lateral side of the palm, thumb, second and third finger for median nerve; medial side of the palm and the dorsum of the hand, fourth and fifth finger for ulnar nerve; lateral side of the dorsum of the hand for radial nerve, every 10 mins until 30 mins. Failed block was considered if analgesia was not present in 4 peripheral nerve distributions and such patients were excluded from the study.

If 20 min elapsed without obtaining a proper image of the target, the procedure was abandoned and the patient will be excluded from further assessments. Duration of sensory block was defined as the time interval between the onset of sensory block of all four nerve (anesthesia, score-2) and complaining of first postoperative pain. Motor block was assessed by loss of thumb adduction for ulnar nerve; thumb abduction for radial nerve; thumb opposition for median nerve; flexion of the elbow and pronation of forearm for musculocutaneous nerve at 30 minutes after completion of block. Motor block was graded according to modified Bromage scale for upper extremities on a 3-point scale: 60.

After confirming the success of the block, surgical incision was allowed. Intravenous fluids (RL/RS) were administered continuously. Oxygen at the rate of 3 L/min was administered using a bi-nasal O2 cannula throughout the procedure and operation. If a part of the surgical territory was not completely anesthetized at the time of surgery, the block was supplemented at the elbow or wrist. If the patient still experienced pain despite supplementation, general anesthesia was induced by the attending anesthesiologist using his preferred technique and this group of patients will be excluded from this study. All physiological variables and drugs used were recorded in a data collection chart. The anesthesiologist who assessed the sensory and motor blockade was blinded to group allocation and type of block given.

Post operative management and data collection

After the end of surgery patients were sent to Post Anesthesia Care Unit under the observation of a resident (blinded from executed procedure). Occurrences of any complication due to accidental vascular puncture, suspected diaphragmatic paresis resulting in a change in the breathing pattern and/or coughing difficulty, the appearance of Horner's syndrome and clinically significant pneumothorax (respiratory distress or desaturation) were noted. The time of occurrence of first postoperative pain and the time of complete recovery of motor functions of the forearm and hand were recorded in every patient. The duration of analgesia (the time between onset of sensory block of all four nerve and the first dose of rescue analgesic based on patient's need/request or VAS score>4) were recorded in each case.

Statistical analysis

Statistical Analysis was performed with help of Epi Info (TM) 3.5.3 which is a trademark of the Centres for Disease Control and Prevention (CDC). Chi-squared test was used to test the association between categorical variables under study. Fisher's exact test was used in case of any one of cell frequency was found less than 5 in the bivariate frequency distribution. Test of proportion (Z-test) was used to test the significant difference between proportions. 't-test' was used to test the significant difference between means. $p<0.05$ was considered statistically significant.

Results

Table 1: Comparison of demographic parameters of the patients of the two groups

Demographic Parameters	Group-S (mean±s.d.) (n=60)	Group-I (mean±s.d.) (n=60)	Test Statistic	p-value
Age (in years)	42.55±10.37	45.95±11.51	t_{118}=1.70	0.09 NS
Gender (M:F)	28:32	26:34	χ^2=0.11	0.87 NS
Weight (in kg)	58.00±7.08	60.68±5.95	t_{118}=1.24	0.22 NS
Height (in cm)	152.65±8.45	154.22±6.66	t_{118}=1.12	0.26 NS
BMI (in kg/m^2)	24.87±2.12	25.51±1.89	t_{118}=1.74	0.08 NS
ASA (I:II)	33:27	35:25	χ^2=0.13	0.71 NS

't-test' showed that there was no significant difference in mean Ages, Weight and Height of the patients of the two groups (p>0.05). Chi-square test showed that there was no significant difference in the proportions of Gender and ASA grade of the patients in the two groups (p>0.05). Thus the patients of the two groups were matched for all demographic parameters.

Table 2: Comparison of heart rate (HR) per minute at different time of the two groups

Time Interval	Group-S (mean±s.d.) (n=60)	Group-I (mean±s.d.) (n=60)	Test Statistic	p-value
HR Base	83.63±3.22	83.25±4.16	0.56	0.57 NS
HR 0min	84.32±3.00	84.07±3.05	0.45	0.65 NS
HR 1min	80.57±6.74	80.22±6.64	0.28	0.77 NS
HR 3min	80.58±7.38	80.32±7.28	0.19	0.84 NS
HR 5min	81.25±5.25	80.83±5.45	0.42	0.67 NS
HR 10min	83.95±2.68	83.68±2.68	0.54	0.58 NS
HR 15min	81.30±3.28	81.48±3.49	0.29	0.76 NS
HR 20min	79.90±3.27	79.00±3.01	1.57	0.11 NS
HR 30min	79.25±3.18	78.05±3.02	1.68	0.08 NS

There was no significant difference in mean heart rate of the patients of the two groups for different time intervals (p>0.05).

Table 3: Comparison of Systolic Blood Pressure (mmHg) between the two groups

Time Interval	Group-S (mean±s.d.) (n=60)	Group-I (mean±s.d.) (n=60)	Test Statistic	p-value
SBP Base	125.37±3.20	125.37±3.20	0.01	0.99 NS
SBP 0min	125.23±3.38	125.23±3.38	0.01	0.99 NS
SBP 1min	121.47±7.50	121.47±7.50	0.01	0.99 NS
SBP 3min	124.23±3.23	124.23±3.23	0.01	0.99 NS
SBP 5min	124.23±2.83	124.23±2.83	0.01	0.99 NS
SBP 10min	123.00±2.03	122.97±2.00	0.09	0.92 NS
SBP 15min	125.27±4.03	124.80±3.81	0.65	0.51 NS
SBP 20min	125.73±4.59	125.10±5.84	0.66	0.51 NS
SBP 30min	125.00±5.64	126.23±6.83	1.07	0.28 NS

The t-test showed that there was no significant difference in mean Systolic blood pressure of the patients of the two groups for different time intervals (p>0.05).

Table 4: Comparison of Diastolic Blood Pressure (mmHg) between the two groups

Time Interval	Group-S (mean±s.d.) (n=60)	Group-I (mean±s.d.) (n=60)	Test Statistic	p-value
DBP_base	80.70±1.80	80.70±1.80	0.01	0.99 NS
DBP 0min	80.87±1.40	80.87±1.40	0.01	0.99 NS

DBP 1min	76.42±5.43	76.42±5.43	0.01	0.99 NS
DBP 3min	76.73±5.25	76.73±5.25	0.01	0.99 NS
DBP 5min	79.52±3.28	79.52±3.28	0.01	0.99 NS
DBP 10min	81.20±1.05	81.13±1.00	0.35	0.72 NS
DBP 15min	79.63±2.79	78.20±3.60	0.43	0.61 NS
DBP 20min	76.83±4.93	74.33±5.24	1.69	0.11 NS
DBP 30min	74.05±4.72	75.30±4.39	1.50	0.13 NS

The t-test showed that there was no significant difference in mean diastolic blood pressure of the patients of the two groups for different time intervals (p>0.05).

Table 5: Comparison of mean SPO2 at different time of the two groups

Time Interval	Group-S (mean±s.d.) (n=60)	Group-I (mean±s.d.) (n=60)	Test Statistic	p-value
SPO_2 Base	99.80±0.44	99.80±0.44	0.01	0.99 NS
SPO_2 0 min	99.28±1.80	99.40±1.46	0.39	0.69 NS
SPO_2 1 min	97.73±2.58	98.03±1.94	0.72	0.47 NS
SPO_2 3 min	97.83±2.64	98.23±1.97	0.94	0.34 NS
SPO_2 5 min	98.72±1.61	98.77±1.45	0.17	0.85 NS
SPO_2 10 min	99.90±0.35	99.92±0.28	0.28	0.77 NS
SPO_2 15 min	99.60±0.62	99.87±0.34	0.92	0.14 NS
SPO_2 20 min	99.42±0.85	99.87±0.34	1.80	0.08 NS
SPO_2 30 min	99.73±0.55	99.88±0.32	1.82	0.07 NS

't-test' showed that there was no significant difference in mean SPO2 of the patients of the two groups for all time intervals (p>0.05).

Table 6: Comparison of Sensory block quality of radial nerve at different time in two groups

	0 min			10 min			20 min			30 min		
	Score			Score			Score			Score		
	0	1	2	0	1	2	0	1	2	0	1	2
Group-S	60 (100%)	0	0	0	14 (23%)	46 (77%)	0	14 (23%)	46 (77%)	0	0	60 (100%)
Group-I	60 (100%)	0	0	0	10 (17%)	50 (83%)	0	2 (3%)	58 (97%)	0	1 (2%)	59 (98%)
Total	120 (100%)	0	0	0	24 (20%)	96 (80%)	0	16 (13%)	104 (87%)	0	1 (0.08%)	119 (99.2%)
ChiSquare statistic	NA			0.833			10.385			NA		
P value	NA			0.361			0.001			NA		
Comment	-			Not Significant			Significant			-----		

Association between Sensory block quality score of Radial Nerve and Treatment Groups (S & I) was found significant (p value =0.001 <0.05) at 20 min and NOT significant at 10 min (p value =0.361).

Discussion

The aim of this study was to compare the efficacy of ultrasound guided supraclavicular block and infraclavicular block for sensory and motor component as well as postoperative analgesia in patients undergoing upper limb surgery. Perioperative hemodynamic parameters were also compared and any obvious side effects noted. 60(50.0%) patients were in the Group-S and rest 60(50.0%) patients were in the Group-I. Thus the patients of the two groups were in ratio 1:1. It was seen that there was no statistically significant difference between the two groups in terms of demographic parameters like Age, Gender, Body Weight, Height, BMI,. P value was >0.05.

Demographic variable, duration and type of surgery findings in our study corroborates with studies done by Koscielniak-Nielsen ZJ *et al*. [8], Arcand *et al*, [9], Anatoli Stav *et al*, [10] and De Quang Hieu Tran *et al*. [11] We found that there was no statistically significant difference between the two groups in terms of heart rate, systolic blood pressure, diastolic blood pressure and mean arterial pressure at different time intervals (p>0.05).

We also found that there was no significant difference in SPO2 between the two groups as the p-value was >0.05 at all-time interval. In this study we found that the Sensory block quality score of Radial Nerve between the treatment Groups (S &I) was found

significant (p value =0.001 <0.05) at 20 min and NOT significant at 10 min (p value =0.361). Test of proportion showed that there were significant differences in the proportions of patients with Sensory block of median nerve between the two groups at 20min interval as the association between Sensory block quality score of Median Nerve and Treatment Groups (S &I) was found significant(p value =0.001 <0.05) at 20 min and NOT significant at 10 min(p value =0.455) & at 30 min(p value = 0.298) And also the number of patients with Sensory block of median nerve of Group-I (60%&95%)were higher than that of Group-S (50%&90%) at 10&30 minute.(*P*>0.05).

This finding corroborates with study done by Koscielniak-Nielsen ZJ [8] and Gurkan Y *et al*, [12] where in supraclavicular approach resulted in significantly poorer block of the median and the ulnar nerves than the infraclavicular approach. In study done by Arcand *et al*. [9] showed that sparing of radial nerve more in infraclavicular group than supraclavicular group as a single injection technique was used in this study. They explained it as the cords of the brachial plexus were compactly arranged around the axillary artery and the posterior cord was deeper from entry point of the needle than the lateral or median cords, resulted in incomplete block of the radial nerve. In study done by Koscielniak-Nielsen ZJ [8] found that after 30 min, the infraclavicular group had a more effective block, with 93% of patients ready for surgery compared with only 78% of patients in the supraclavicular group, corroborates with our study.

Our study finding corroborates with studies by Koscielniak-Nielsen ZJ *et al*, [8] (5min in the I group and 5.7 min in the S group), Mojgan Vazin *et al*, [13], Arcand *et al*, [9] (I group 4 min and S group 4.7 min). Chan *et al*. [13] in their studies of USG guided supraclavicular block took 9 min to administer the block. Sandhu *et al*, [14] and Sauter *et al*, [15] took 10 min and 4.1 min. respectively for performance of infraclavicular block. But study done by Gurkan Y *et al*, [12] shown that block performance time was shorter in Group I, than Group S (194.4±65; 226.3±59 sec, *p*<0.05). The less time in I group probably because target in infraclavicular block was axillary artery not plexus like supraclavicular block, which was easily identified in ultrasound. Proportion of patients with Horner's syndrome of Group-S (16.7%) was significantly higher than that of the patients of Group-I (0%) (*p*<0.01). This finding corroborates with study done by Koscielniak-Nielsen ZJ *et al*, [8], Gurkan Y *et al*. [12], Anatoli Stav *et al*, [10] and De Quang Hieu Tran *et al*, [11] where S group experienced more side effect than I group.

Conclusion

We concluded that ultrasound guided infraclavicular block provides superior quality of sensory, motor block and less side effect whereas duration of sensory block, motor block and postoperative analgesia was greater in USG guided supraclavicular block.

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