EFFECT OF TWO DIFFERENT VOLUMES OF ROPIVACAINE AND LIGNOCAINE AT TWO DIFFERENT SITES IN ULTRASOUND-GUIDED SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK ON DIAPHRAGM MOTILITY

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ABSTRACT

Ultrasound (USG) guided supraclavicular brachial plexus block (BPB) helps in precise delivery of local anesthetic injection, reduced volume or dose of drug providing excellent surgical anesthesia with fewer complications. Objective of the study was to compare effect of two different volumes of Ropivacaine and Lignocaine at two different sites of USG-guided supraclavicular BPB on diaphragmatic motility, quality of block and tourniquet pain. A prospective randomized double-blinded comparative study was conducted among adult patient with below elbow elective surgery. In group A patients (n=17), 20ml of anesthetic solution was injected in the corner pocket and 10ml in the nerve cluster guided with USG. In group B patients (n=17), 15ml of the anesthetic solution was injected in the corner pocket and 5ml in the nerve cluster guided with USG. Hemodynamic parameters, diaphragmatic excursion, onset of anesthetic effects were measured at frequent intervals. The data were analyzed using Statistical Package for Social Sciences at P-value less than 0.05. Hemodynamic profile of the patients were similar in both groups (P-value>0.05). Statistically significant hemi-diaphragmatic dysfunction (partial and complete paralysis) after 15 and 30minutes of blockade was more common in group A than Group B (P<0.05). At 30 minutes after the injection of the anesthesia, all patient in both the groups had complete sensory and motor block in all nerve territory. Tourniquet time was lower in group A (80.35±9.59 minutes vs 84.12±7.75 minutes); however, it was statistically not significant (P-value>0.05). The present study showed that the patients who received lesser half of the required volume of local anesthetics had less incidence of hemidiaphragmatic dysfunction with similar successful rate of blockage (100%) and similar quality of the block as compared to the patients who received greater half of the required volume of local anesthetics.

KEYWORDS

Brachial plexus block, hemodynamic, lignocaine, ropivacaine, tourniquet

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INTRODUCTION

Ultrasound (USG) guided supraclavicular brachial plexus block (BPB) is a valuable method of providing anesthesia for surgery of the arm, elbow, forearm and hand.[1] It is the technique of choice for procedures involving the distal two-thirds of the upper limb needing tourniquet application.[2] USG-guided regional anesthesia allows the operator to visualize, in real-time, needle placement and its relation to the target nerves. It helps in precise delivery of local anesthetic injection, reduced volume or dose of drug providing excellent surgical anesthesia of the forearm and hand with fewer complications compared with anatomic landmarks technique.[3-5] The ability to visualize the needle as it penetrates the surrounding structures significantly reduces the risk of intravascular or intraneural injections, and pneumothorax.[6,7]

Even with USG-guided supraclavicular brachial plexus block there lies risk of phrenic nerve palsy, Horner's Syndrome and recurrent laryngeal nerve palsy. Involvement of these nerves depend on spread of local anesthetic from the site of injection which also depends on volume of the local anesthetics. Various studies had reported that phrenic nerve involvement with hemi-diaphragmatic palsy is related to both the volume of local anesthetic as well as the drug deposition site.[2,8] In a study by Kang *et al*, hemi-diaphragmatic paresis was around 67% when larger volume of local anesthetic was injected in nerve cluster versus 28% when larger volume of local anesthetic was injected in corner pocket.[8] Renes *et al* reported that 20ml of 0.75% Ropivacaine produced complete block with no incidence of diaphragmatic hemiparesis.[2]

Drug deposition caudally and posterolaterally during BPB can possibly prevent the rostral spread of local anesthetic resulting in sparing of upper nerve roots and this also affects quality of the nerve block. Data on effect of two different drug deposition site using low volume of local anesthesia on diaphragmatic motility and function are limited. There is also scarcity of studies about the quality of supraclavicular BPB. The objectives of the present study was to compare effect of two different volumes of Ropivacaine and Lignocaine at two different sites of USG-guided supraclavicular BPB on diaphragmatic motility, quality of block and tourniquet pain. Injecting lowest possible volume of local anesthetic at the site away from phrenic nerve in the brachial plexus would reduce the incidence of diaphragmatic dysfunction and with optimal quality of the block.

MATERIALS AND METHODS

Type of study design: Prospective randomized double-blinded comparative study.

Study population: American Society of Anesthesiologists Physical Status (ASA PS) I and II adult patient with below elbow elective surgery.

Inclusion criteria:

1. Age between 18 and 60 years undergoing elective below elbow surgery of both gender.
2. American Society of Anesthesiologists physical status I and II
3. Body weight greater than 50kg

Exclusion criteria:

1. Patient's refusal for the supraclavicular brachial plexus block.
2. Not able to give informed consent.
3. Contraindications to brachial plexus block: Hemi-diaphragmatic dysfunction, coagulation disorders, neuropathy, pre-existing neurological disease affecting upper extremities.
4. Pulmonary and cardiac disorders/conditions
5. Pregnancy
6. Allergy to local anesthetic
7. Chest, shoulder and neck deformities

Setting: Operation theatre of B.P. Koirala Institute of Health Sciences, Dharan, Nepal

Study period: One year (May 2019-April 2020)

Ethical clearance: It was taken from Intuitional Review Committee of BPKIHS (IRC/1602/019).

Sampling technique: Non-probability purposive sampling technique was used.

Sample size and its calculation: This study considered 95% confidence interval and 80% power to estimate the sample size. We conducted pilot study in 20 patients, ten in each group who fulfilled selection criteria of this study. In our study considering diaphragmatic hemiparesis as primary outcome. 20ml of test solution was prepared by adding 10ml 0.5% Ropivacaine and 10ml of 2% Lignocaine with Adrenaline1:200000. In group A (10 patients), 10ml of the test solution was deposited in the nerve cluster and 10ml in the corner pocket; five (50%) of the patients had diaphragmatic hemiparesis whereas in group B (10 patients) in which 15ml was deposited in the corner pocket and 5ml inside the nerve cluster had one (10%) diaphragmatic hemiparesis. The formula below was used to estimate the sample size,

$n = (Z_{\alpha/2}+Z_{\beta})^2 * [p_1 (1-p_1) + p_2 (1-p_2)] / (p_1-p_2)^2$

Where $Z_{\alpha/2}$ is 1.96 for a confidence level of 95%, Z_{β} is 0.842. For a power of 80%, p_1 and p_2 are the expected sample proportions of the two groups (50% and 10%). The sample size became 17 in each group.

Method of randomization: Patients were assigned randomly into the two groups via a computer-generated random number sequence. Envelopes were made with numbers indicating the sequence of the patient on outside of the envelope and the allocated group inside.

Blinding: Both the patient and the anesthesiologist (who assessed the study outcome) were blinded to the study groups.

Study groups:

1. Group A: Out of 20ml of prepared solution (10 ml of 0.5% Ropivacaine plus 10ml of 2% Lignocaine with Adrenaline1:200000) was injected in the corner pocket and 10ml in the nerve cluster guided with USG.
2. Group B: Out of 20ml of the prepared solution (10 ml of 0.5% Ropivacaine plus 10ml of 2% Lignocaine with Adrenaline1:200000), 15ml was injected in the corner pocket and 5ml in the nerve cluster guided with USG.

Data collection tools: A self-designed proforma was used to collect the relevant data that consisted of heart rate, respiratory rate, systolic blood pressure, diastolic blood pressure, mean arterial blood pressure and oxygen saturation, diaphragmatic excursion, onset of sensory blockade and onset of motor blockade and time for completion of blockade, tourniquet inflation and deflation time, pain on tourniquet application, dose and the volume of local anesthetic and side effects (Horner's Syndrome and hoarseness of voice due to recurrent laryngeal nerve palsy).

Data collection techniques: Pre-anesthetic evaluation was done one day prior to the surgery. The study objectives were explained to the patients and informed written consent was taken. Before nerve blockade, in the procedure room all patients received intravenous access with 18G IV cannula and standard monitoring. The frequency 7.5MHz linear array ultrasound probe of the portable ultrasound machine (Micromax Sonosite) was used to locate the brachial plexus. Under all aseptic precautions local infiltration of 1ml of 2% Lidocaine was given at the needle insertion site. In group A patients, 10 ml of 20ml mixture of the 0.5% Ropivacaine with 2% lignocaine prepared for the patient was injected in corner pocket and 10ml in the nerve cluster in USG guided supraclavicular brachial plexus block. In group B patients, 15ml of 0.5% Ropivacaine and 2% lignocaine was injected at the corner pocket and 5ml of the remaining solution was injected inside the nerve cluster each within the plexus sheath.

Hemodynamic monitoring including heart rate, respiratory rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure and oxygen saturation were monitored continuously and noted. The diaphragmatic function was measured before the injection and at 15min and 30min after the injection using USG (Micromax Sonosite). Each patient performed three deep breathing maneuvers, diaphragmatic excursion from baseline was measured in centimeters using the digital calipers on the ultrasound machine interface. Three measurements were made, and the average was taken. The diaphragmatic excursion was categorized into three categories as follows: (i) Complete hemi-diaphragmatic paralysis (>75% reduction in diaphragmatic excursion in the deep breathing test from baseline), (ii) Partial hemi-diaphragmatic paralysis (25% to 75% reduction in diaphragmatic excursions in the deep breathing test from baseline and (iii) No hemi-diaphragmatic paralysis (<25% reduction in diaphragmatic excursions in the deep breathing test from baseline).

After the injection, the patient were assessed for sensory and motor block at 5, 10, 15 and 30 minutes. Onset of sensory blockade and onset of motor blockade and time for completion of blockade were also assessed. Sensory block in the territories of median nerve (palmar surface of index finger), ulnar nerve (palmar surface of little finger), radial nerve (dorsal surface of first web space/ thumb) and musculocutaneous nerve (lateral side of volar surface of forearm) were assessed by pinprick test using a 3-point scale and recorded accordingly: 0 (normal sensation), 1 [loss of sensation of pinprick (analgesia)], 2 [loss of sensation of touch (anesthesia)]. The time of onset of sensory block and time to complete sensory block were recorded. Onset time of sensory block was defined as the time interval (in min) from time-0 to the time the sensory block started to be detected (i.e. score=1). Time for complete sensory block was the time interval (in min) from time-0 to the time complete sensory block was achieved (i.e. score=2). Motor block was recorded by evaluating thumb flexion/ opposition (median nerve), thumb extension (radial nerve), finger abduction (ulnar nerve) and elbow flexion with forearm in full supination (musculocutaneous nerve) on a

3-point scale for motor function: 0 (normal motor function), 1 (reduced motor strength but able to move), 2 (complete motor block). The onset time of motor block and time to complete motor block was recorded and was defined as the time interval (in min) from time-0 to the time the motor block started to be detected (i.e. score ≥ 1). Time for complete motor block was the time interval (in mins) from time-0 to the time complete motor block achieved (score =3). Successful blockade was assigned if there was a complete sensory blockade (sensory block score = 2 in all four terminal nerve distributions) assessed at 30 minutes after the local anesthetic injection.

After successful injection of local anesthetics, Paracetamol 15mg/kg IV infusion, injection ketorolac (30mg) and injection fentanyl 0.5 mcg/Kg IV were given to the patient before start of surgery. After the successful block, surgery was permitted. When vascular tourniquet was applied, tourniquet inflation and deflation time were noted and discomfort or pain with its application if any was recorded in the numerical rating scale. The pain was managed with injection fentanyl 0.5mcg/kg IV bolus. If partial block occurred in one sensory nerve distribution, local anesthetic drug infiltration was given at the surgical incision site and the volume of local anesthetic was noted. If incomplete or partial sensory block occured in more than one sensory nerve distribution, surgery was conducted under general anesthesia and supraclavicular block was noted as failed block. Side effects like Horner's Syndrome and hoarseness of voice due to recurrent laryngeal nerve palsy were also recorded.

Statistical analysis: The collected data were entered in Microsoft office excel 2016 software and analyzed using SPSS (Statistical Package for Social Sciences), version 11.5. For descriptive statistics percentage, mean and standard deviation was calculated along with the graphical and tabular presentation. Independent t-test was used to compare the mean diaphragmatic excursion and quality of block between the two groups. Paired t-test was used to compare the mean diaphragmatic excursion before and after the study drug administration within the same group. For inferential statistics, Chi-square test was used for comparing two categorical data. Mann-Whitney U test was used to compare ordinal or non-discrete data between two groups. Probability of significance was set to 5% level.

RESULTS

Both groups (A and B) were similar with respect to age, gender, weight and ASA PS and diagnosis (Table 1).

Hemodynamic profile of the patients (heart rate, systolic blood pressure, diastolic blood pressure, mean arterial blood pressure, saturation of oxygen in blood and respiratory rate) were similar in the groups A and B at baseline, 15 minutes and 30 minutes after the block (Table 2).

Comparison of hemi diaphragmatic dysfunction after USG guided supraclavicular BBB between both groups is shown in Table 3. Statistically significant hemi-diaphragmatic dysfunction (partial and complete paralysis) after 15 and 30minutes of blockade was more in group A than Group B (P<0.05).

More patient in Group B had earlier onset of anesthesia in the area supplied by median nerve and radial nerve; however, it was statistically not significant (P-value>0.05) (Table 4).

Table 1: Socio-demographic data of the patients (n=34)

Variables		Group A (n=17)	Group B (n=17)	P value
Age (Years)		37.24 ± 12.24	36.94 ±12.59	0.94
Gender	Male	9 (64.30%)	5 (37.70%)	0.6
	Female	8 (40.00%)	12 (60.00%)	
Weight (Kg)		66.18 ±6.20	62.53 ± 6.12	0.10
ASA PS	I	13 (54%)	15 (46%)	0.32
	II	4 (38.46%)	2 (61.54%)	
Diagnosis	Implant Removal Forearm	4 (56.25%)	3 (43.75%)	0.89
	Radius Fracture	5 (46.66%)	6 (53.33%)	
	Ulna Fracture	2 (57.14%)	3 (42.86%)	
	Both bone Forearm Fracture	5 (45.45%)	4 (54.55%)	
	Others	1 (5.8%)	1 (5.8%)	

Table 2: Hemodynamic parameters in the patients after injection of local anesthesia (n=34)				
Hemodynamic variables		**Group A (n=17)**	**Group B (n=17)**	**P value**
Heart rate	Baseline	79.76±6.15	79.29±7.10	0.83
	After 15 min	77.82±4.92	78.29±6.11	0.80
	After 30 min	81.76±2.97	80.41±2.81	0.18
Systolic Blood Pressure	Baseline	120.41 ± 8.49	120.65 ± 5.56	0.75
	After 15 min	124.65 ±7.47	123.00 ±7.42	0.363
	After 30 min	119.65±5.22	122.24±6.03	0.07
Diastolic Blood Pressure	Baseline	69.06±5.37	67.47±6.50	0.84
	After 15 min	65.06±7.85	64.94±9.09	0.93
	After 30 min	68.88±3.24	66.41±3.62	0.65
Mean arterial blood pressure	Baseline	92.70±9.33	91.23±12.27	0.10
	After 15 min	94.53±10.28	93.70±11.24	0.24
	After 30 min	93.17±11.50	92.33±10.11	0.69
Oxygen saturation	Baseline	98.41±0.80	97.88±0.93	0.08
	After 15 min	98.18±0.88	97.7±0.92	0.13
	After 30 min	97.94±0.90	97.82±0.95	0.71
Respiration rate	Baseline	15.87±1.25	15.77±1.27	0.83
	After 15 min	15.63±1.24	15.30±0.91	0.18
	After 30 min	15.50±0.97	15.17±1.08	0.60

Table 3: Comparison of hemi diaphragmatic dysfunction after USG guided supraclavicular block between both groups				
Time (minutes)	**Diaphragmatic hemiparesis**	**Group A (n=17)**	**Group B (n=17)**	**P value**
15	No	11 (64.70)	17 (100)	<0.001
	Partial	2 (11.76)	0 (0)	
	Complete	4 (23.52)	0 (0)	
30	No	7 (41.17)	15 (88.23)	<0.001
	Partial	3 (17.64)	1 (5.84)	
	Complete	7 (41.17)	1 (5.84)	

Table 4: Median and Radial nerve assessment				
Time (minutes)	**Characteristics**	**Group A (n=17)**	**Group B (n=17)**	**P value**
Median nerve				
5	Normal sensation	3	2	0.62
	Analgesia	14	15	
	Anesthesia	0	0	
10	Normal sensation	0	0	0.50
	Analgesia	7	2	
	Anesthesia	10	15	
15	Normal sensation	0	0	0.30
	Analgesia	1	0	
	Anesthesia	16	17	
30	Normal sensation	0	0	0.30
	Analgesia	1	0	
	Anesthesia	16	17	
Radial nerve				
5	Normal sensation	3	2	0.69
	Analgesia	14	15	
	Anesthesia	0	0	
10	Normal sensation	0	0	0.67
	Analgesia	2	1	
	Anesthesia	15	16	
15	Normal sensation	0	0	0.69
	Analgesia	2	1	
	Anesthesia	15	16	
30	Normal sensation	0	0	0.50
	Analgesia	1	0	
	Anesthesia	16	17	

Table 5: Ulnar and Musculocutaneous nerve assessment				
Time (minutes)	**Characteristics**	**Group A (n=17)**	**Group B (n=17)**	**P value**
Ulnar nerve				
	Normal sensation	**5**	**3**	
5	Analgesia	**12**	**14**	**0.5**
	Anesthesia	**0**	**0**	
	Normal sensation	**0**	**0**	
10	Analgesia	**6**	**3**	**0.6**
	Anesthesia	**11**	**14**	
	Normal sensation	**0**	**0**	
15	Analgesia	**4**	**2**	**0.5**
	Anesthesia	**13**	**15**	
	Normal sensation	**0**	**0**	
30	Analgesia	**2**	**1**	**0.5**
	Anesthesia	**15**	**16**	
Musculocutaneous nerve				
	Normal sensation	**2**	**3**	
5	Analgesia	**15**	**14**	**0.5**
	Anaesthesia	**0**	**0**	
	Normal sensation	**0**	**0**	
10	Analgesia	**1**	**0**	**0.5**
	Anaesthesia	**16**	**17**	
	Normal sensation	**0**	**0**	
15	Analgesia	**1**	**0**	**0.5**
	Anaesthesia	**16**	**17**	
	Normal sensation	**0**	**0**	
30	Analgesia	**1**	**0**	**0.6**
	Anaesthesia	**16**	**17**	

Table 6: Median Nerve (Thumb Flexion) and Radial nerve (Thumb extension)				
Time (minutes)	**Characteristics**	**Group A (n=17)**	**Group B (n=17)**	**P value**
Median nerve (Thumb Flexion)				
	Normal motor function	2	3	
5	Reduced motor strength, but able to move fingers	15	14	0.5
	Complete motor block	0	0	
	Normal motor function	0	0	
10	Reduced motor strength, but able to move fingers	1	0	0.5
	Complete motor block	16	17	
	Normal motor function	0	0	
15	Reduced motor strength, but able to move fingers	1	0	0.5
	Complete motor block	16	17	
	Normal motor function	0	0	
30	Reduced motor strength, but able to move fingers	1	0	0.6
	Complete motor block	16	17	
Radial nerve (Thumb extension)				
	Normal motor function	3	2	
5	Reduced motor strength, but able to move fingers	14	15	0.5
	Complete motor block	0	0	
	Normal motor function	0	0	
10	Reduced motor strength, but able to move fingers	2	1	0.5
	Complete motor block	15	16	
	Normal motor function	0	0	
15	Reduced motor strength, but able to move fingers	1	0	0.5
	Complete motor block	16	17	
	Normal motor function	0	0	
30	Reduced motor strength, but able to move fingers	1	0	0.6
	Complete motor block	16	17	

Table 7: Ulnar Nerve (Finger abduction) and Musculocutaneous nerve (elbow flexion)				
Time (minutes)	**Characteristics**	**Group A (n=17)**	**Group B (n=17)**	**P value**
Ulnar Nerve (Finger abduction)				
5	Normal motor function	5	4	0.6
	Reduced motor strength, but able to move fingers	12	13	
	Complete motor block	0	0	
10	Normal motor function	0	0	0.5
	Reduced motor strength, but able to move fingers	3	2	
	Complete motor block	14	15	
15	Normal motor function	0	0	0.5
	Reduced motor strength, but able to move fingers	3	2	
	Complete motor block	14	15	
30	Normal motor function	0	0	0.6
	Reduced motor strength, but able to move fingers	2	1	
	Complete motor block	15	16	
Musculocutaneous nerve (elbow flexion)				
5	Normal motor function	2	3	0.5
	Reduced motor strength, but able to move fingers	15	14	
	Complete motor block	0	0	
10	Normal motor function	0	0	0.5
	Reduced motor strength, but able to move fingers	1	0	
	Complete motor block	16	17	
15	Normal motor function	0	0	0.5
	Reduced motor strength, but able to move fingers	1	0	
	Complete motor block	16	17	
30	Normal motor function	0	0	0.6
	Reduced motor strength, but able to move fingers	1	0	
	Complete motor block	16	17	

More patient in Group B had earlier onset of anesthesia in the area supplied by Ulnar and Musculocutaneous nerve; however, it was statistically not significant (P-value>0.05) (Table 5).

More patient in Group B had earlier onset of and completion of motor blockade at 30 minutes; however, it was statistically not significant (P-value>0.05) (Table 6 and 7).

In the present study at 30 minutes after the injection of local anesthesia, all patient in both the groups had complete sensory and motor block in all nerve territory; thus success rate in our study in both groups was 100%. Tourniquet time was lower in group A (80.35±9.59 minutes vs 84.12±7.75 minutes); however, it was statistically not significant (P-value>0.05). None of the patient in both groups had complaints of tourniquet pain.

DISCUSSION

In the present study, there were no differences in the demographic characteristics between the two groups reflecting proper randomization; however, there were more female patients compared to male patients. This signified that incidence of trauma and injury was higher in female as compared to male. Similarly, with comparing age and weight, maximum numbers of patients were between the age group of 30-50 years and weight between 60-75 Kg. This signified that patients at this age and weight are more active and prone to injury.

In the present study, incidence of hemidiaphragmatic paresis was more in Group A patients who received 10ml of the solution (10ml of 0.5% Ropivacaine plus 10ml of Lignocaine with Adrenaline1:200000) each in nerve cluster and corner pocket compared

to those patients Group B who received 5ml of the solution inside nerve cluster and 15ml in the corner pocket for supraclavicular brachial plexus block. In contrast to this, Kang *et al*[8] found that hemi-diaphragmatic paresis was around 67% when larger volume of local anesthetic was injected in nerve cluster versus 28% when larger volume of local anaesthetic was injected in corner pocket. However, incidence of diaphragmatic hemiparesis in present study with lesser volume (5ml) of the anesthetic solution in the nerve cluster was less (11%) and when 20ml of the solution was deposited inside nerve cluster, the incidence of hemidiaphragmatic paresis was 67% which was higher than that of our study when we deposited 10ml of the solution inside the nerve cluster and had 59% of hemidiaphragmatic paresis without any compromise in quality and success of block. The variation in diaphragm dysfunction may be due to the difference in volume 10ml vs 20ml and the other factor may be the variation in individual's skill in delivery of the drug and the observer's variation.

Similarly in a study conducted by Petrar *et al*,[9] they enrolled 64 patients undergoing right-sided upper extremity surgery using 30ml of 0.5 % ropivacaine. Drug was deposited at multiple injection site depending on anatomical brachial plexus layout and local anaesthetic spread via ultrasound guided supraclavicular brachial plexus approach. Eleven (34%) of 32 patients in Petrar *et al*[9] study showed complete hemidiaphragmatic paresis, but in the present study only ten patients (58.8%) in group A and two patient (11.7%) in group B had partial and complete hemidiaphragmatic paresis respectively. The reason of more hemidiaphragmatic paralysis in the study conducted by Petrar *et al*[9] could be due to more volume of 0.5% Ropivacaine deposited in the brachial plexus compared to our study. The success rate of their study was 100% which was similar as compared to the present study. Petrar *et al*[9] had mentioned that the quality of block in their study was optimal except that two patients who received rescue block local infiltration by the surgeons but haven't mentioned about the site of local infiltration.[8,9] However, in the present study in both groups, the quality of block was optimal and comparable and any rescue block was not required. Requirement of rescue block in their study case could be due to imprecise drug deposition site although resulting in 100% success due to a comparatively larger volume used. Renes *et al* also found no incidence of complete or partial diaphragmatic hemiparesis and in their study block success was 100%; but in our study ten patients in group A and two patients in group B had partial and complete diaphragmatic hemiparesis respectively.[2] These variations of hemidiaphragmatic paresis could be due to variations regarding the drug deposition site i.e. caudal and posterolateral in their study versus corner pocket and nerve cluster in our study. Drug deposition caudally and posterolateral can possibly prevent the rostral spread of local anaesthetic resulting in sparing of upper nerve roots and this will definitely affect the quality of block. William *et al*[5] had reported that about 40-60% patients in their study showed diaphragmatic hemiparesis after 30 minutes of anesthetic injections, but in our study only 10% of the patient had diaphragmatic hemiparesis when only 5ml of the solution was deposited in nerve cluster. The reasons behind the variations of diaphragmatic hemiparesis between two studies could be higher volume of local anesthetics deposited in brachial plexus in the study conducted by William *et al*[5] compared to our study. Similarly a drug injections technique was also different as compared to the present study. Success rate of block in their study was 85% but in our study block success rate is 100% here the difference could be due to deposition of drug at distant site from brachial plexus by William *et al*;[5] but in our study we have deposited the drug inside the nerve cluster so is the result in both success and obtained optimal quality of block but they haven't mentioned about the quality of block.

The present study have some limitations. Anatomical variation in the brachial plexus position as seen via USG also might had affected the findings since we had to deposit the anesthetic agent in precise location. We could not perform arterial blood gas analysis of the patients after they had hemidiaphragmatic paresis and hence we couldn't estimate the level of respiratory compromise that could have reflected by the changes in their blood gas parameters. We couldn't include the total duration of hemidiaphragmatic paresis and\or the time required for the return of the diaphragm normal function after hemidiaphragmatic paresis. We had no any equipments or tools to measure the extent of spread of local anesthetic. The sensory and motor effect after the block was evaluated every 5 min in our study although the standard practice is to measure every minute. We couldn't study about the relative changes that could have occurred in the contralateral lungs and the diaphragm as a result of hemidiaphragmatic paresis.

In conclusion, the present study showed that the patients who received lesser half of the

required volume (20ml) of local anesthetics i.e. 5ml inside the nerve cluster which lies closer to phrenic nerve had less incidence of hemidiaphragmatic dysfunction with similar successful rate of blockage (100%) and similar quality of the block as compared to the patients who received greater half of the required volume of local anesthetics (10ml) inside the nerve cluster. The results of this study signify that if we deposit only one-third of drug inside the nerve cluster and rest two-thirds in the corner pocket, it would result in less incidence of hemidiaphragmatic dysfunction. Further studies with large sample sizes are warranted to validate these findings.

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REFERENCES

1. Mian A, Chaudhry I, Huang R, Rizk E, Tubbs RS, Loukas M. Brachial plexus anesthesia: A review of the relevant anatomy, complications, and anatomical variations. *Clin Anat* 2014; 27: 210-21.
2. Renes SH, Spoormans HH, Gielen MJ, Rettig HC, van Geffen GJ. Hemidiaphragmatic paresis can be avoided in ultrasound-guided supraclavicular brachial plexus block. *Reg Anesth Pain Med* 2009; 34: 595-9.
3. Casati A, Danelli G, Baciarello M *et al*. A prospective, randomized comparison between ultrasound and nerve stimulation guidance for multiple injection axillary brachial plexus block. *Anesthesiology* 2007; 106: 992-6.
4. Perlas A, Lobo G, Lo N, Brull R, Chan VW, Karkhanis R. Ultrasound-guided supraclavicular block: outcome of 510 consecutive cases. *Reg Anesth Pain Med* 2009; 34: 171-6.
5. Williams SR, Chouinard P, Arcand G *et al*. Ultrasound guidance speeds execution and improves the quality of supraclavicular block. *Anesth Analg* 2003; 97: 1518-23.
6. Klaastad O, Sauter AR, Dodgson MS. Brachial plexus block with or without ultrasound guidance. *Curr Opin Anaesthesiol* 2009; 22: 655-60.
7. Gelfand HJ, Ouanes JP, Lesley MR *et al*. Analgesic efficacy of ultrasound-guided regional anesthesia: a meta-analysis. *J Clin Anesth* 2011; 23: 90-6.
8. Kang RA, Chung YH, Ko JS, Yang MK, Choi DH. Reduced hemidiaphragmatic paresis with a "corner pocket" technique for supraclavicular brachial plexus block: single-center, observer-blinded, randomized controlled trial. *Reg Anesth Pain Med* 2018; 43: 720-4.
9. Petrar SD, Seltenrich ME, Head SJ, Schwarz SK. Hemidiaphragmatic paralysis following ultrasound-guided supraclavicular versus infraclavicular brachial plexus blockade: a randomized clinical trial. *Reg Anesth Pain Med* 2015; 40: 133-8.