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ORIGINAL RESEARCH

Comparison of ultrasound guided supraclavicular and in fraclavicular brachial plexus blocks for upper limb surgery

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ABSTRACT

Background: The brachial plexus block has been shown to be an effective way to provide anesthesia for upper limb surgeries.The supraclavicular approach is the most widely used technique due to its ease of usage and effectiveness. The infraclavicular block usually results in a near complete blockade and provides stability for catheter placement.A high frequency linear (5-12)MHz probe is used for the block.Use of USG for these blocks has improved effectiveness and reduced complications.

Methods: This prospective randomized single blinded study was performed at SKIMS Medical College & Hospital in 118 patients divided into Group S of 59 patients undergoing Supraclavicular block and Group I of 59 patients undergoing Infraclavicular block under Ultrasound guidance. The data regarding following parameters was collected: age,gender,time taken for block,onset of sensory and motor block;andit was analysed using students ttest,Chi-square test and SPSS version 20.0.

Results: The average age difference between the two groups was found statistically insignificant.The Gender distribution between the two groups was found comparable with a p-value of 0.712.Average time taken for block in S group was 6.1 min.versus 5.7 min.for I group.Onset of sensory block in group S was 16.1 min. while in group I was 12.6 min. with p-value of <0.001.The onset of motor block in group S was 18.2 min. while in group I it was 17.6 min.The number of patients with adverse events was low more so in I group which was statistically significant.

Conclusion: The USG guided Supraclavicular and Infraclavicular blocks are highly effective and safe for upper limb surgeries.

Keywords and Abbreviations: ASA,SBP,DBP,SC-BPB,IC-BPB,LA,MAP,PNB,PNS. Supraclavicular, Infraclavicular, Brachial Plexus, Ultrasound ,Localanaesthetic.

INTRODUTION

Brachial plexus block around the clavicle has been commonly used for upper extremity surgery. The use of regional anesthesia has also been associated with reduced incidence of postsurgical pain, decreased risk of prolonged opioid use[1-3].Regional anaesthesia may positively impact long term healing and immune function and the incidence of pneumothorax and inadvertent vascular puncture may be reduced.High success rate and less complications of USG guided supraclavicular brachial plexus blocks[SC-BPB] and infraclavicular brachial plexus blocks[IC-BPB] have been reported.However both approaches have their advantages and disadvantages[4].Both the patient assessment and evaluation involve a review of the following: the patients medications, allergies, medical/surgical/anaesthetic history, psychosocial health,respiratory,cardiovascular,renal,hepatic,gastrointestinal,neurologic,endocrine,musculoskeletal and hematologic systems[5].Regional nerve blocks may be performed in pre-procedure room, operating room, or PACU. Appropriate monitors, oxygen, equipment and drugs and qualified staff must be available at the time of procedure. Drugs must also include intravenous lipid emulsion for anticipated local anesthetic toxicity resuscitation. Local anaesthetics may be used alone or in combination with other drugs to provide regional anaesthesia or analgesia.[7-8.]

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The pharmacokinetics of local anesthetics vary in onset (slow,intermediate,rapid)and durationof action. Therefore local anesthetic is selected based on the patient, type of block, procedure and post procedure plan. Meticulous aseptic technique is critical to prevent infection in the placement and management of regional anesthesia [9].The AANA Infection Prevention and Control Guidelines for Anesthesia Care are followed.Various nerve block technique include anatomic landmark based techniques (LM),peripheral nerve stimulation guided (PNS) and USG guided techniques.

Ultrasound guidance for nerve blocks is rapidly emerging as a standard of care with a availability of less expensive portable high resolution systems. Ultrasound guidance aids in real time visualization of the needle and the relevant anatomy[11].When compared to nerve stimulation, use of USG for brachial plexus block has been shown to improve efficiency and block success, reduce complications like vascular puncture and local anesthetic toxicity[12]. The use of supraclavicular and infraclavicular blocks are indicated for upper limb surgeries distal to the shoulder, arm ,elbow,wrist and hand.

AIMS AND OBJECTIVES

The primary aims of this prospective, randomized, single-blinded study was:

- To assess the intensity of sensory block (anesthesia or analgesia of the seven terminal nerves:axillary, medial cutaneous brachii, medial cutaneous antebrachial, musculocutaneous, radial, median and ulnar) and surgical block effectiveness(numbers of patients with anesthesia or analgesia of the five nerves below the elbow)after 10,20 and 30 min.
- To compare motor block
- To evaluate the safety of both approaches(incidence of adverse events and complication).

Ages Eligible for Study:

- 18 years to 65 years(Adults, Older Adults)
- Sexes Eligible for Study: Both

Inclusion Criteria:

- 18-65 years old
- ASA I-II
- Patients scheduled for hand, wrist and forearm surgery

Exclusion Criteria:

- Uncoordinating patients having a disease that prevents sensory block evaluation
- Coagulopathy
- Known allergies to drugs to be used
- Those with anatomical disorders
- Pregnant women
- Patients below 18 years age
- Patients with local anaesthetic allergy
- Patients with sepsis
- Skin infection at the injection site.

MATERIALS AND METHODS

The patients were randomized to either the supraclavicular(S) or the infraclavicular(I)group using computer-generated random numbers and a close envelope method. After arrival to the anesthetic room,an IV line wassecured,a blood pressure cuff and a pulse oximetry probe was attached to the non-operative arm. Intravenous infusion with crystalloid solution was started at 5ml/kg infusionand via face mask supplemental oxygen(5L/min) is provided.The patient was lightly sedated with fentanyl 25-50mg and midazolam 1-2mg.A mixture containing Inj.Ropivacaine 0.5 % 2mg/kg + Inj. Lingnocaine 2%5mg/kg+Normal saline to make a total volume of 20 ml.A randomization envelope was opened and the patient was allocated to either the S or the I group.Ahigh frequency ultra sound transducer was used to conduct 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 5-10MHz. The targetwas :the plexus trunks/divisions in the S group and the axillary artery in the I group.If 10 min elapsed without obtaining an adequate image of the target, the approach was abandoned and the patient was excluded from further assessments. Qualified staff members or supervising residents performed all the blocks. After anaesthetizing the skin and the subcutaneous tissue with 2-4ml of lidocaine 10mg/ml,a 5 cm block 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. 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.Theindividual plexus cords were used as the target.The number of advancements and the time from the first insertion of the blocking needle to its removal (block performance time) was recorded by an independent observer. The following adverse events was recorded: accidental vascular puncture, paraesthesia/pain on LA injection, suspected diaphragmatic paresis resulting in a change in the breathing patternand/or coughing difficulty and the appearance of Horner's syndrome.

Assessment

A blinded observer (Apo or SY – both anaesthesia trainees), who were not present during block placement entered the room and asked subjects :How would you rate your discomfort during block on a scale of zero – 10. If zero is no discomfort and 10 is the worst discomfort imaginable and 'Did you experience an electric shock-like sensation in the arm

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during the procedure'. The same observer then assessed pin-prick sensory and motor block in the distribution of the median, radial, ulnar and musculocutaneous nerve every 5min for 30 min or until blocks were complete. Time zero was defined as the time at which the block needle exited the skin. Sensory block was graded on a 3-point scale(normal=2, reduced =1 or absent=0) relative to pin-prick sensation in the contralateral arm. Motor block was graded on a 3-point scale (normal=2, reduced=1 or unable to overcome gravity=0) relative to the contralateral arm. Sensory block success was defined as complete pin-prick sensory blockade in all four sensory nerves within 30min.

SENSORY ASSESSMENT

Sensory assessments was performed every 10 min after needle removal for 30 min, by a colleague not involved in the block performance. Patient's skin in the sensory areas of seven terminal nerves was pinched with alligator clamp. The sensory score for each nerve was documented as: anesthesia-2points, analgesia-1 point and pain-0 point.In case of doubt, the other arm was pinched for comparison.

Motor Assessment

Motor block was assessed at 30 min as: complete – a limp hand and elbow, or incomplete/poor – partial/normal movements. After 30 min, the unblocked median, radial, ulnar and musculocutaneous nerves was imaged either at the elbow or mid-humeral and supplemented. The medial cutaneous antebrachii nerve was supplemented by the subcutaneous LA injection at the elbow. Patients was ready for surgery when they had anesthesia (no pain, no touch sensation) or analgesia of five nerves distal to the elbow.

Statistical Methods

The recorded data was compiled and entered in a spreadsheet (Microsoft Excel) and then exported to data editor of SPSS Version 20.0 (SPSS inc., Chicago, Illinois , USA). Continuous variables were expressed as Mean± SD and categorical variables were summerised as frequencies and percentages. Graphically the data was presented by bar graphs. The Shapiro- Wilk test was applied to test the normality of the data. Student's independent t-test or Mann-Whitney U-test, whichever feasible, was employed for comparing continuous variables. Chi-square test or Fisher's exact test, whichever appropriate, was applied for comparing categorical variables. A P-value of less than 0.05 was considered statistically significant.

OBSERVATION AND RESULTS

Table1:Age distribution of study patients in two groups

Age (Years)	Group S		Group I		P-value
	No.	% age	No.	% age	
18-30 Years	27	45.8	24	40.7	
31-45 Years	21	35.6	19	32.2	
>45 Years	11	18.6	16	27.1	
Total	59	100	59	100	
Mean±SD (Range)	34.2±13.47 (18-67 Years)		35.9±13.78 (20-65 Years)		0.504

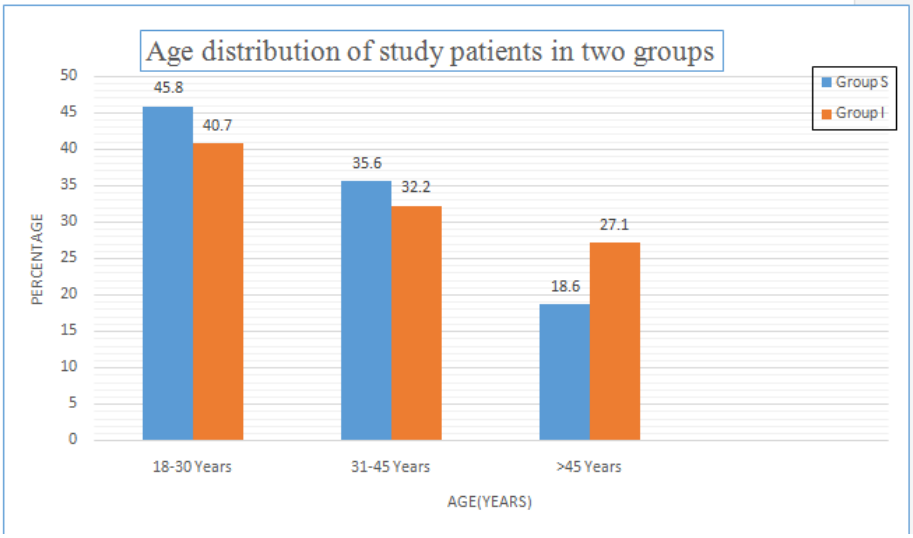

Table 1 reflects the age distribution of patients placed into two different groups;the average age of patients in Group 1 was (34.2±13.47) years compared to (35.9±13.78) years in G group 2.However with a p-value of 0.504, the difference was statistically insignificant.

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Table 2: Comparison based on duration of surgery in two groups					
Group	**N**	**Mean**	**SD**	**95%CI For Mean**	**P-value**
Group S	59	38.2	4.49	37.1-39.4	0.126
Group I	59	36.9	4.57	35.8-38.1	

CI: Confidence Interval

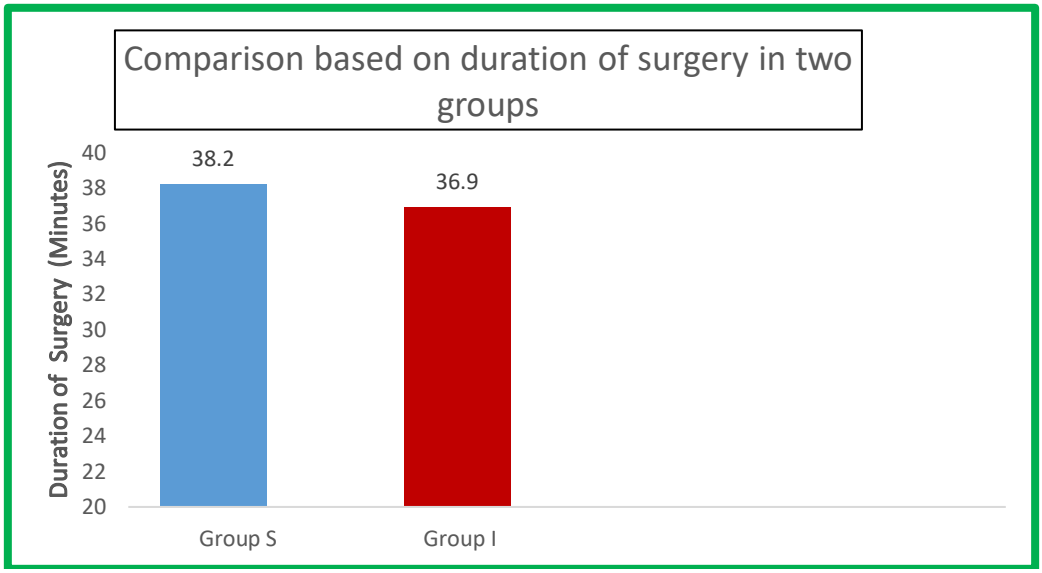

Table 2 shows the average duration of surgery in two groups;group S showed average of 38.2% patients and group I showed 36.9% patients. However, the difference was statistically insignificant with a p-value of 0.126.

Table 3: Time taken for block(minutes) in two groups					
Group	**N**	**Mean**	**SD**	**95%CI For Mean**	**P-value**
Group S	59	6.1	1.53	5.78-6.32	
Group I	59	5.7	1.72	5.53-6.14	0.184

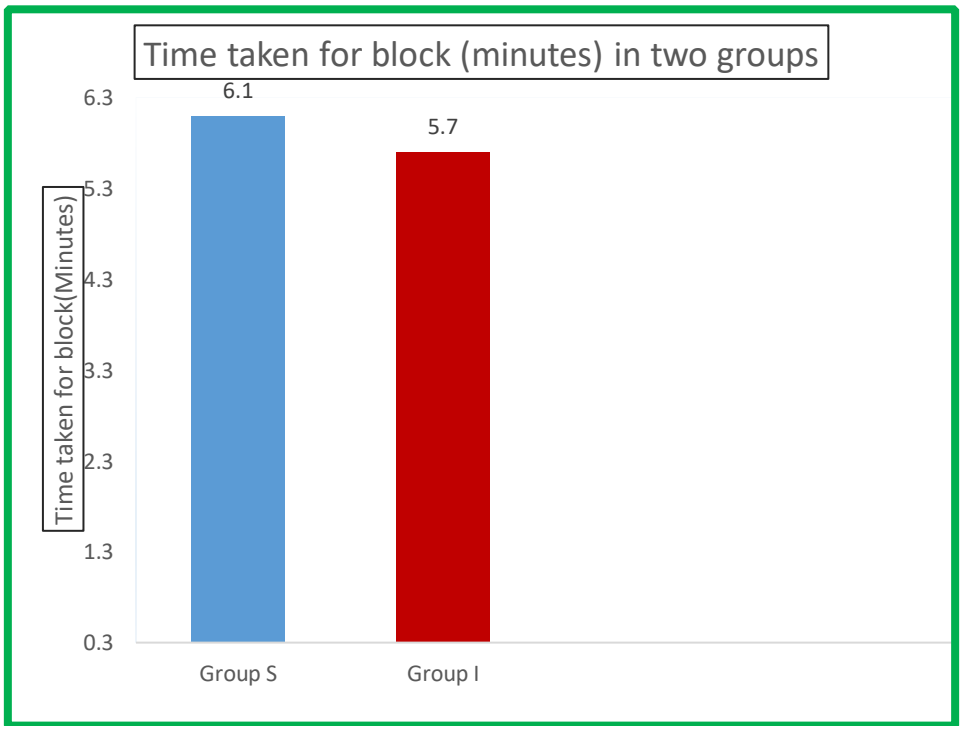

Table 3 reflects the time taken for block by patients in group S and group I;we observe that group S patients took 6.1 min. as compare to group I.However the difference was statistically insignificant with a p-value 0.184.

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Table 4: Comparison based on onset of sensory block(minutes) in two groups					
Group	**N**	**Mean**	**SD**	**95%CI For Mean**	**P-value**
Group S	59	16.1	1.93	15.6-16.7	<0.001*
Group I	59	12.6	2.08	12.1-13.2	

Statistically Significant Difference (P-value<0.05);CI:Confidence Interval

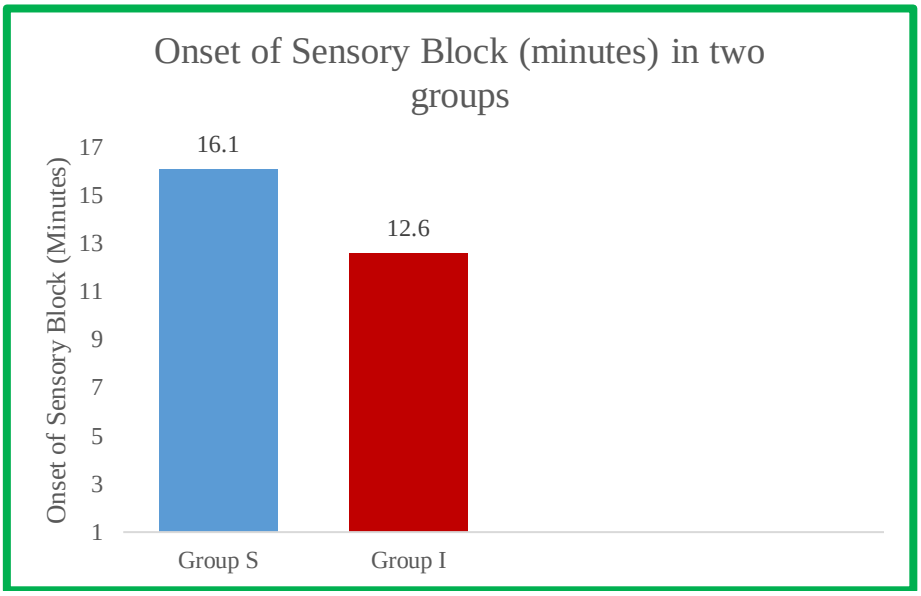

Table 4 we observe that the average onset of sensory block (minutes) in group S was 16.1 minutes and group I was 12.6 minutes. Evidently, all the possible pairwise revealed a significant difference;(group S vs group I: p-value of <0.001.

Table 5: Comparison based on onset of motor block(minutes) in two groups					
Group	**N**	**Mean**	**SD**	**95%CI For Mean**	**P-value**
Group S	59	18.2	2.17	17.6-18.7	0.128
Group I	59	17.6	2.26	16.9-18.2	

CI: Confidence Interval

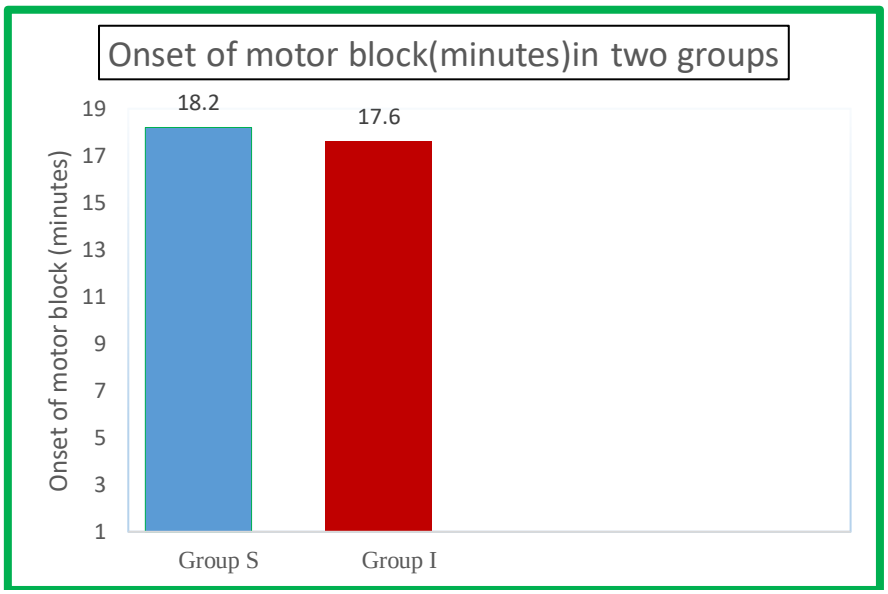

Table 5 shows the onset of motor blockin two groups.Group S had an average of 18.2 minutes and Group I had an average of of17.6 minutes. However,onset of motor block in two groups was insignificant with a p-value of 0.128

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Table 6: Comparison based on duration of anesthesia (minutes) in two groups					
Group	**N**	**Mean**	**SD**	**95%CI For Mean**	**P-value**
Group S	59	592.1	39.53	576.9-607.2	0.178
Group I	59	604.2	47.78	584-618.7	

CI: Confidence Interval

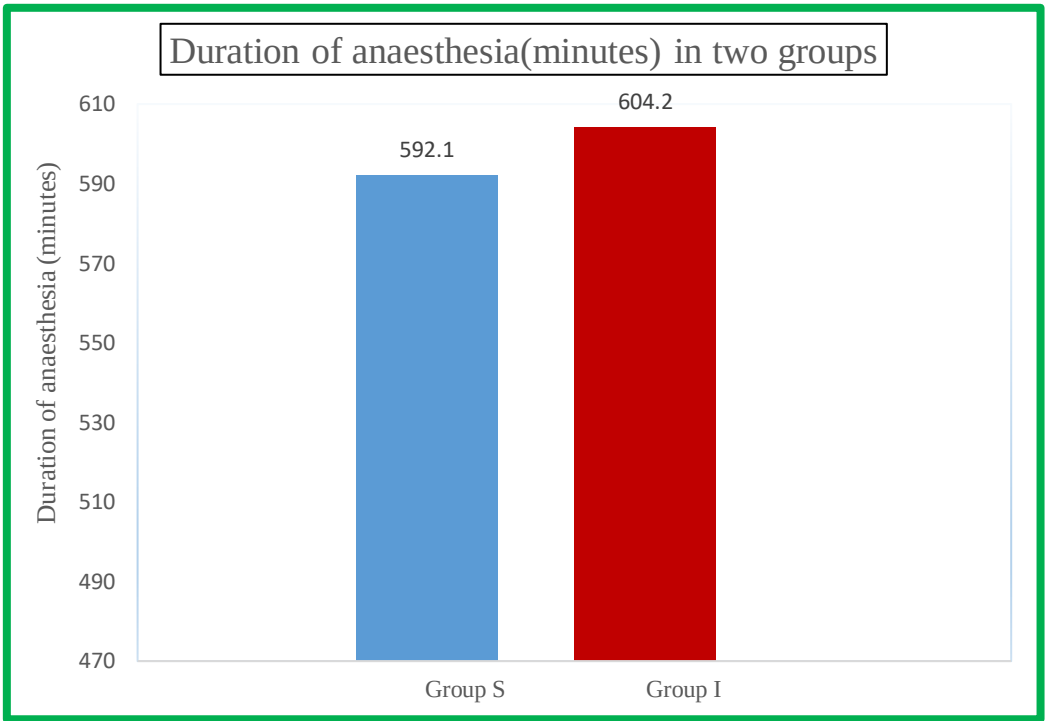

Table 6shows the average duration of anaesthesia in group S compared to group I (592.1 mins vs 604 mins).The pairwise comparison revealed insignificant difference with ap-value of 0.178.

Table 7:Intensity of sensory block(analgesia or anesthesia) to the seven terminal nerves					
Sensory block of the terminal nerves	**Group S**		**Group I**		**P-value**
	No.	**% age**	**No.**	**% age**	
Medial cutaneous brachii	32	54.2	34	57.6	0.710
Axillary	49	83.1	36	61.0	0.008*
Medial cutaneous antebrachi	54	91.5	55	93.2	0.729
Musculocutaneous	57	96.6	56	94.9	0.648
Radial	56	94.6	57	96.6	0.648
Median	52	88.1	59	100	0.013*
Ulnar	47	79.7	58	98.3	0.003*

*Statistically Significant Difference (P-value<0.05)

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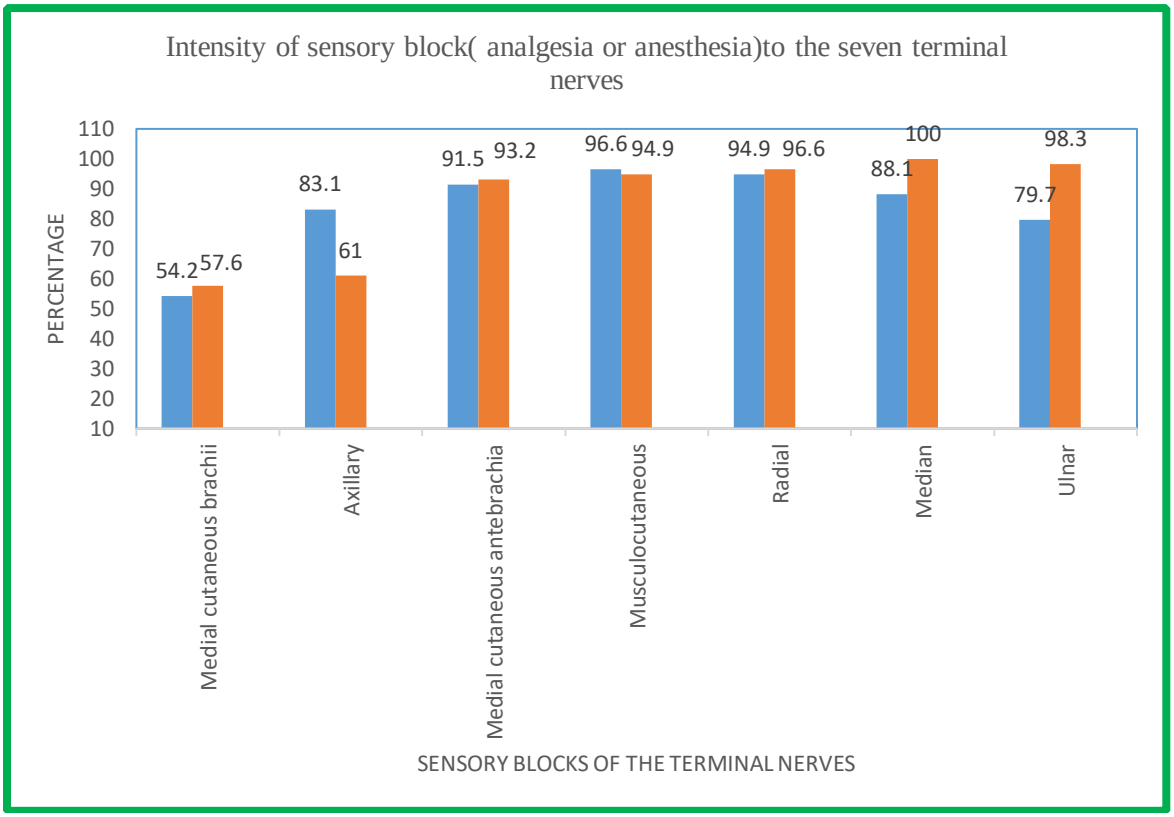

Table 7 showed the intensity of the sensory block (analgesia or anesthesiato the seven terminal nerves;we observed that theintensity of sensory block in Group I in median and ulnar nerves as statistically significant as shown in the table.

Table 8:Incidence of adverse events in two groups

Adverse events	Group S		Group I		P-value
	No.	% age	No.	% age	
Paraesthesia/pain on LA injection	21	35.6	7	11.9	0.002*
Horner's syndrome	16	27.1	2	3.4	0.0009*
Suspected diaphragmatic paresis	8	13.6	1	1.7	0.037*
Vessel puncture	2	3.4	1	1.7	0.559

*Statistically Significant Difference(P-value<0.05)

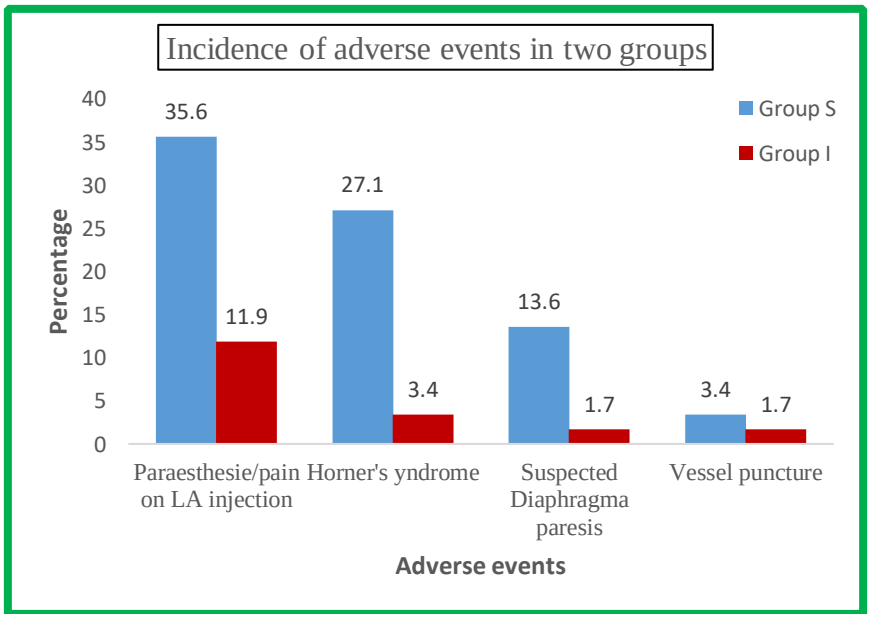

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Table 8 reflects the proportion of patients who faced complications in group S and group I.In group S paresthesia and pain on LA injection was evident in 35.6% patients and in group S was it was 11.9% which was statistically significant as shown in the table. The Horner's syndrome was evident in group S in 27.1% and in group I was 3.4% which was statistically significant. The suspected diaphragmatic paresis in group S was 13.6% and in group I was 1.7% which was statistically significant.

Summary & Conclusion

In the present prospective randomized study on the performance of ultrasound guided supraclavicular block with ultrasound guided infraclavicular block, following results were observed:

- Group S patients had an average age of 34.2±13.47 and group I had an average age of 35.9±13.78 years. However, all the groups were comparable with p-value of 0.504.
- The gender distribution and ASA status of studied patients was comparable between the groups.
- Group S patients had comparable difference with group I on the basis of duration of surgery.
- Group S patients had an insignificant time for block compared to group I patients.
- The average onset of sensory block (minutes) in group S was 16.1 minutes and 12.6 minutes in group I.The difference between the groups was significant.
- The average onset of motor block (in minutes) in group S was 18.2 minutes and 17.6 minutes in group I.However, the difference was insignificant.
- The average duration of anesthesia in group S was 592.1 minutes and 604.2 minutes in group I.However,all the groups were comparable with a p-value of 0.178.
- The intensity of sensory block in group I in nerves median and ulnar (100% and 98.3%) and in group S in nerves difference between the groups median and ulnar (88.1% and 79.7%).The difference between the groups was significant.
- The difference between the groups in the proportion of patients with different presenting complication like pain/ paresthesia on LA injection, Horner's syndrome and suspected diaphragmatic paresis in group S was 35.6%, 27.3% and 13.6% as compared to group I it was 11.9%, 3.4% and 1.7%. The difference between the groups was significant.

The present study demonstrated that patients who have to undergo upper extremity surgery anesthetized by ultrasound guided Infraclavicular block with (Inj. Ropivacaine 0.5%2mg/kg+Inj. Lignocaine 2%5mg/kg+Normal Saline to make a total volume of 20 ml) has higher success rate with fewer complications when compared to ultrasound guided Supraclavicular Block (Inj.Ropivacaine0.5%2mg/kg+Inj lignocaine 2% 5mg/kg making a total of 20ml) because it has quick onset of sensory block,higher intensity of sensory block, less need for anesthesia during and after surgery and lesser incidence of complications.

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