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Original Research Article

A comparative study of the efficacy between conventional and ultrasound-guided brachial plexus block in the upper limb surgeries at our centre (ASRAM)

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Abstract: Background: Upper limb surgeries can be performed by the administration of general anaesthesia or regional nerve blocks. Brachial Plexus Block either conventional or Ultrasound-guided is preferred to general anaesthesia.

Aim and Objectives: This study was designed to compare the conventional paresthesia technique with an ultrasound-guided approach for supraclavicular brachial plexus block with regard to the onset and duration of sensory and motor block, success rate, and incidence of complications.

Methods: The study was conducted in the operation theatre complex in Alluri Sitarama Raju Academy of Medical Sciences (ASRAM) over a period of one year, from January 2022 to December 2022.

Results: Ultrasound-group had a significantly longer duration of motor block and sensory block when compared to the conventional approach.

Conclusion: In conclusion, ultrasound-guided approach for supraclavicular brachial plexus block is superior to conventional block with longer duration of sensory and motor block, decreased analgesic requirements and lesser incidence of complications.

Keywords: Brachial plexus block; Ultrasound-guided; Conventional supraclavicular block.

1. Introduction

Analgesia, the main part of anaesthesia can be achieved by different techniques and drugs. Regional anaesthesia can be used to provide anaesthesia or as analgesic supplementation which can prevent adverse effects of general anaesthesia including stress response to laryngoscopy and intubation [1].

Brachial plexus block provides ideal operating conditions for upper limb surgeries. Supraclavicular approach is the easiest and most effective method done at the level of trunks causing diffuse and faster onset block. here are various approaches for brachial plexus block. The paraesthesia technique, a blind classical approach is associated with more failure rate and injury to the vessels, nerves, and surrounding structures [2]. Ultrasound visualization of the anatomical structures is the only method offering safe3 and superior block by optimal needle positioning [3].

2. Aim and Objectives

This study was designed to compare the conventional paresthesia technique with an ultrasound-guided approach for supraclavicular brachial plexus block with regards to the onset and duration of sensory and motor block, success rate, and incidence of complications.

3. Material and Methods

3.1. Study Design

This is a randomized comparative study conducted at Alluri Sitarama Raju Academy of Medical Sciences (ASRAM) in Eluru District, Andhra Pradesh.

3.2. Study area and Period

The study was carried over a one-year period from January 2022 to December 2022 in ASRAM.

3.3. Study Population

The study was done on sixty ASA I & II patients,18 to 50 years old who underwent elective surgeries for the upper limb under supraclavicular block.

Written informed consent was obtained from all the patients or family members. A pre-programmed proforma was used to record the results.

Our Exclusion criteria included ASA III & IV patients, Patient refusal, Infection at the site of block, Coagulopathies, Allergy or anaphylaxis to local anaesthetic solutions, Pulmonary pathology, Preexisting neuropathy, Pregnant patients, emergency surgical procedures.

Each patient was randomly allocated into one of the two groups of thirty patients each using computerized random numbers.

Group-C: received Supraclavicular brachial plexus block given by conventional subclavian perivascular technique after eliciting paresthesia.

Group- US: Supraclavicular brachial plexus block given under ultrasound guidance.

Block was performed with 30 ml of 0.5% bupivacaine and 0.25 ml of sodium bicarbonate and 67 ml of NS in both groups.

3.4. Preanaesthetic Evaluation

Pre-anesthetic evaluation is done for every patient and ASA risk was stratified. The patients with co-morbidities were stabilized before surgery. Basic investigations such as Hemoglobin (Hb)%, bleeding time, clotting time, blood urea and serum creatinine, blood grouping and cross matching, Urine sugars and albumin, and microscopy, Electrocardiography (ECG) and chest x-ray P/A view were done. Fasting rules were followed. Tab. Alprazolam 0.5 mg was given on the night before surgery and Tab.Pantoprazole 40 mg was given on the night before and the day of surgery.

3.5. In the operating room

An 18G intravenous line was placed and intravenous fluid started before shifting the patients into the operating room. All equipment needed for the procedure including drugs for emergency resuscitation were kept ready.ECG,Pulse oximetry, and non-invasive blood pressure monitor were connected and baseline parameters were recorded for all patients.

The patient was placed supine with head turned to the opposite side of the block, arm adducted and hand extended towards the ipsilateral knee.

3.6. Procedure

3.6.1. Group C, conventional [3]

In Group C, conventional subclavian perivascular technique [4] block is given by eliciting paresthesia. With the patient supine, the block site was prepared and draped. After identification of the interscalene groove and the subclavian artery pulsations, a 5 cm 22 G Huber point needle is inserted 2.5cm lateral to the sternocleidomastoid. The plexus was identified by eliciting paresthesia and 30 ml of local anaesthetic solution was injected with intermittent negative aspiration.

3.6.2. Group US, ultrasound [3]

In group US, an ultrasonogram machine with a 10-6 MHz transducer was utilized to administer brachial plexus block [5]. The transducer was placed in the supraclavicular fossa behind the middle third of the clavicle in the sagittal plane to see the brachial plexus. The brachial plexus had two distinct appearances at the supraclavicular regions: three hypoechoic circles with hyperechoic outer rings located superior and lateral to the subclavian artery.A 22 G needle connected to a syringe with a 10 cm extension line was inserted into

the plexus and a 30ml of the local anaesthetic solution was injected with intermittent negative aspiration. The spread of the solution was confirmed by the sonographic vision in tissue planes.

3.7. Assessment of parameters

Each patient was monitored for Time taken for the procedure, Sensory block onset and duration, Motor block onset, and duration, Overall effectiveness of block, Success Rate, and Incidence of complications.

3.7.1. Block assessment- sensory

Hollmen's sensory scale was used to evaluate sensory blockade:

Sensory block onset was assessed as the time between administration of the drug and perception of pinprick as touch (Hollmen's scale 3) in any one of the major nerve distribution areas.

Sensory block duration was defined as the time elapsed between the administration of the drug and the appearance of pain requiring analgesia (Hollmen's scale less than or equal to 1) in all 4 major nerve distribution areas.

3.7.2. Block assessment- motor

Lavoi's scale is used for the evaluation of motor blockade:

Motor block onset was assessed as the time interval between administration of the drug and loss of flexion or extension movements in the arm (Lavoie's scale 3) Motor block duration was defined as the time elapsed from the injection of the drug and the return of muscle power completely(Lavoie's scale 1)

3.8. Overall assessment of the block

1. **Effective:** Intended surgical procedure being able to be performed with no sedation. For statistical convenience, Hollmen's sensory scale of 3 or 4 in areas supplied by all four major nerves of the upper limb after 30 minutes of the procedure was considered an effective block.
2. **Partially effective:** Intended surgical procedure being able to be performed with minimal sedation. Patients with Hollmen's sensory scale of 3 or 4 in 2 or 3 major nerve distribution areas and a scale of 2 or 3 in the areas supplied by 1 or 2 major nerves after 30 minutes of the procedure were considered partially effective blocks. The patients were sedated intraoperatively after the block was classified (i.e., after 30 minutes of the procedure). When required, an Injection pentazocine (0.5 mg/kg) bolus dose and intermittent doses of injection ketamine (0.5 mg/kg) were given intravenously to supplement the anaesthesia.
3. **Failed block:** Intended surgical procedure not being able to be performed under the block, and requires general anaesthesia conversion. Hollmen's sensory scale less than or equal to 2 even after 30 minutes of the procedure were considered a failed block.

3.9. Success rate

All the effective and partially effective blocks were considered successful blocks.

3.10. Complications

Patients were watched intraoperatively and 24 hours postoperatively for complications.
Intraoperative complications:

1. Vessel puncture and hematoma formation
2. Any toxic or allergic reaction to the drug

Postoperative complications: All the patients were monitored for nerve injury, pneumothorax, Phrenic nerve block, Horner's syndrome, and recurrent laryngeal nerve block

Every patient was administered supplemental oxygen and intravenous fluids throughout the operative procedure.

Post-operative monitoring was done for 24 hours.

Rescue analgesics were given to the patients at the onset of pain postoperatively.

4. Observation and Results

4.1. Statistic tools

The information collected regarding all the cases was recorded in a Master sheet. Data analysis was done with the help of a computer using MS Excel, SPSS 22.0 (Trail version). Using this software, frequencies, percentage, range, mean, and standard deviation. Chi-test, ANOVA-test, and p-values were calculated. A p-value <0.05 is shown to have a significant relationship.

Terms used for Statistical significance;

NS: not significant,

S: Significant,

HS: highly significant,

4.2. Demographic data

Table 1. Age - Wise Distribution of study groups

Age in years	Group C		Group US		t* Value	P Value	Significance
	No.	%	No.	%			
18-30	9	30	5	16.6	1.201	0.11	Not Significant
31-45	9	30	8	26.7			
46-60	12	40	17	56.7			
TOTAL	30	100	30	100			

Samples are age-matched with a p-value of 0.11(p>0.05), Hence, it is not significant and the groups are comparable

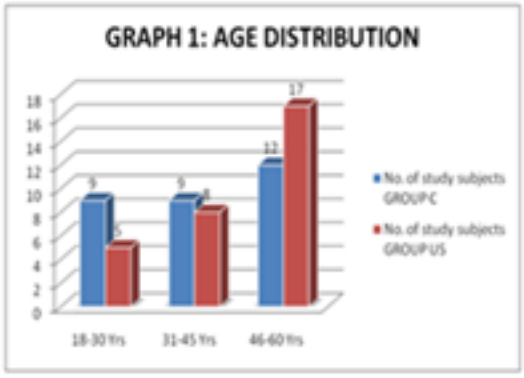

Figure 1. Age distribution

Table 2. Comparison of ultrasound-guided block and conventional based on the gender of patients

Gender	Study Group		P Value	Significance
	C Group C	US Group		
Male	14	12	0.602	Not significant
Female	16	18		

The gender distribution (male: female ratio) in the C group was 14:16 while in the US GROUP, it was 12:18. The p-value was 0.602 (p>0.5). Hence, it is not significant and the groups are comparable.

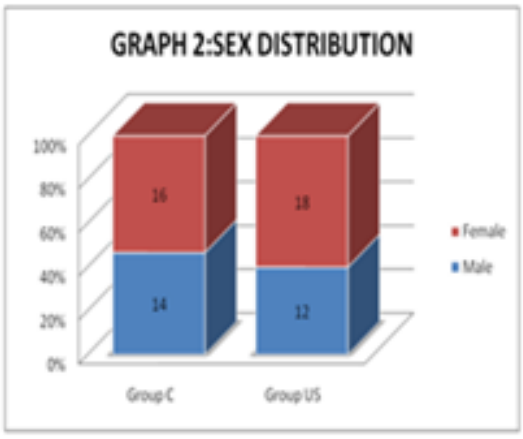

Figure 2. Sex Distribution

Table 3. Comparison of ultrasound-guided block and conventional block based on patient mean body weight

Study Group	Mean ± SD(kgs)	Mean Difference	T Value	P Value	Signification
Group C	62.13 ± 13.5	3.22	1.182	0.122	Not Significant
Group US	58.91 ± 12.4				

The patients mean weight in US group was 58.91±12.4 kilograms and in group C, it was 62.13±13.5 kilograms and it is not statistically significant(p=0.122)

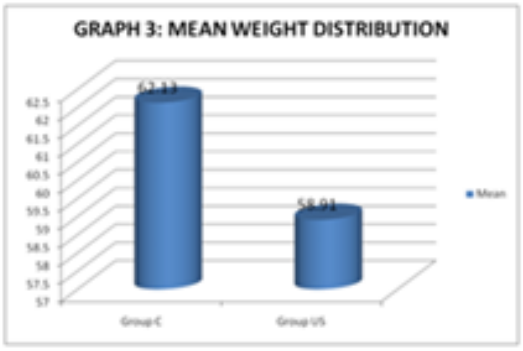

Figure 3. Mean Weight Distribution

Table 4. Comparison of ultrasound-guided block and conventional block based on the time taken for the procedure (brachial plexus block)

Study Group	Mean ±SD(mins)	Mean Difference	t* Value	P value	Significance
Group C	7.7±2.23	3.8	5.45	0.000**	Highly Significant
Group Us	11.5±3.09				

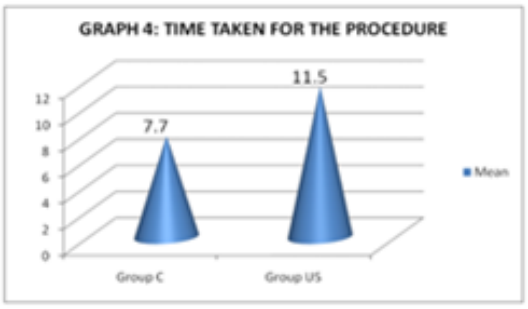

Figure 4. Time taken for the procedure

The statistical analysis by student's unpaired, 'test showed that, the conventional technique was significantly faster to perform when compared to ultrasound-guided technique (p<0.001).

Table 5. Comparison of ultrasound-guided block and conventional block based on the time taken for the onset of sensory blockade

Study Group	Mean ±SD(mins)	Mean Difference	t* Value	P value	Significance
Group C	10.08±2.98	1.2	1.57	0.05*	Significant
Group Us	9.6±2.56				

Table 6. Comparison of ultrasound-guided block and conventional based on motor block onset time

Study Group	Mean ±SD(mins)	Mean Difference	t* Value	P value	Significance
Group C	13.03±2.9	1.07	1.65	0.05*	Significant
Group Us	11.96±3.16				

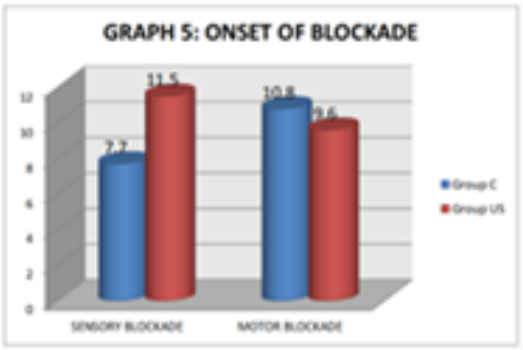

Figure 5. Onset of Blockade

Table 7. Comparison of ultrasound-guided block and conventional block based on the duration of sensory blockade

Study Group	Mean ±SD(hrs)	Mean Difference	t* Value	P value	Significance
Group C	5.5±0.99	3.2	14.41	0.001**	Highly Significant
Group Us	8.7±0.71				

The unpaired student's 't' test used revealed that the length of the sensory block in group US was considerably longer than in group C, with a p-value of 0.001 (p 0.01).

Table 8. Comparison of conventional block and ultrasound-guided block based on the duration of motor blockade

Study Group	Mean ±SD(hrs)	Mean Difference	t* Value	P value	Significance
Group C	4.8±1.17	2.1	8.48	0.001	Highly Significant
Group Us	6.9±0.77				

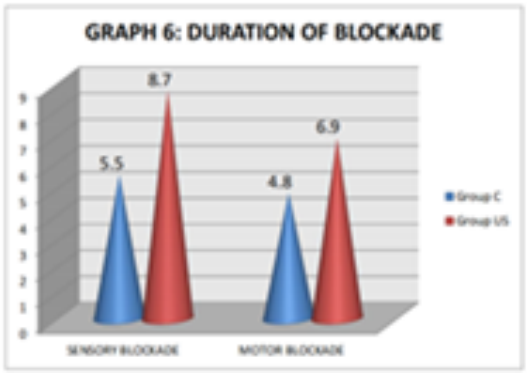

Figure 6. Duration of Blockade

The unpaired 't' test used by the students revealed that group US had a longer length of the motor blockage than group C, which is statistically significant (p 0.01)

Table 9. Comparison of conventional block and ultrasound-guided block in terms of requirement of intraoperative analgesic supplementation

Study Group	Analgesic Supplementation		Chi-square value	P value	Significance
	Required	Not Required			
Group C	8	22	6.45	0.011	Highly Significant
Group Us	1	29			

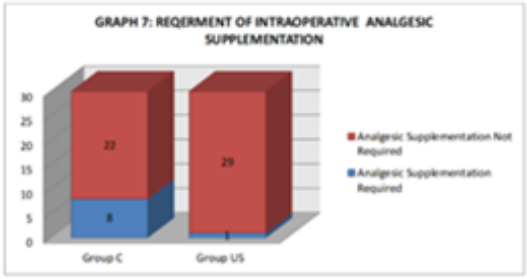

Figure 7. Requirement of intraoperative analgesic supplementation

The chi-square value is 6.45. The requirement for analgesics was significantly reduced in the ultrasound group than in the conventional group. (p = 0.011)

Table 10. Comparison of conventional block and ultrasound-guided block in terms of overall block effectiveness

Study Group	Totally effective	Partially effective	Conversion to GA	Chi Square	P value	Significance
Group C	22	5	3	6.627	0.036	Significant
Group US	29	1	0			

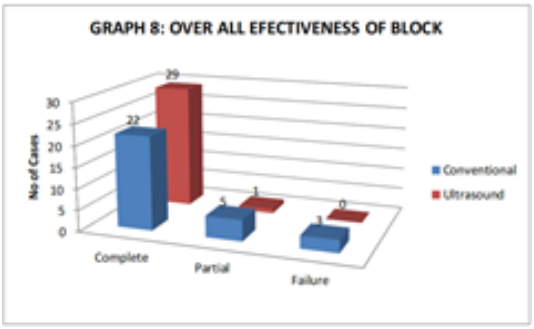

Figure 8. Over all effectiveness of block

in group US, 29 patients(96.67%) had an effective blockade; in 1 patient, the block was partially effective(3.33%), and there was no conversion to GA in the US group. Whereas in group C, only 22 patients had a total effective block, in 5 patients the block was partially effective and in 3 patients block failed and required general anaesthesia conversion. This difference is statistically significant by chi-square test with a p-value of 0.036($\chi 2 = 6.627$, $p < 0.05$)

Table 11. Comparison of conventional block and ultrasound-guided block based on success rate

Group	Success		Chi-square value	P value	Significance
	No.	%			
Group C	28	93.33	2.069	0.150	Not Significant
Group Us	30	100			

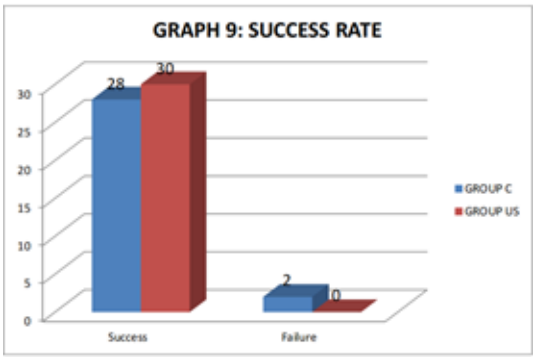

Figure 9. Succes Rate

this difference is not significant statistically (p=0.150).

Table 12. Comparison of conventional block and ultrasound-guided block in view of complication

Complication	Group C	Group US
Vessel puncture/ Hematoma	4	1
Drug Toxicity	0	0
Nerve injury	0	0
Pneumothorax	0	0

Table 13. Statistical Analysis of Incidence of vessel puncture between the study groups

Study Group	Vesselpuncture		Chi-square value	P value	Significance
	Present	Absent			
Group C	4	26	1.96	0.16	Not Significant
Group US	1	29			

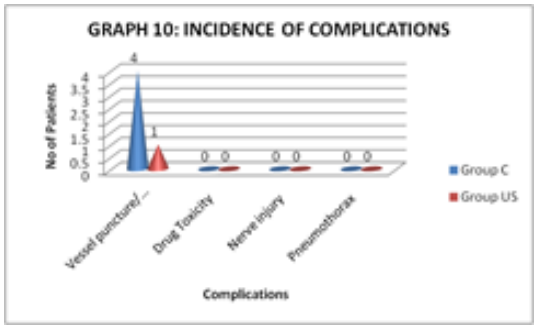

Figure 10. Incidence of complication

Comparison of conventional block and ultrasound-guided block based on pulse rate (beats/min)

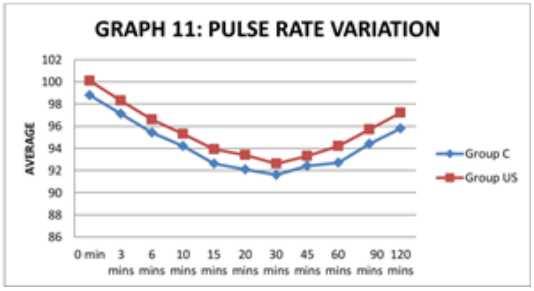

Figure 11. Pulse rate variation

Comparison of conventional block and ultrasound-guided block based on Systolic and Diastolic blood pressure

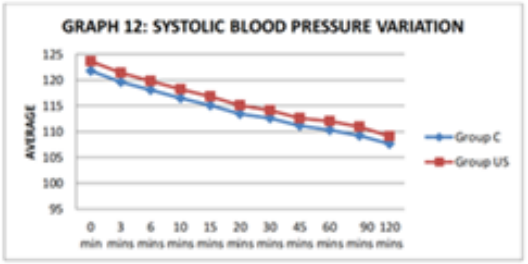

Figure 12. Systolic blood pressure variation

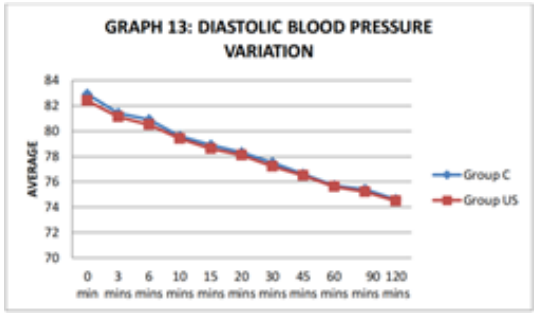

Figure 13. Diastolic blood pressure variation

there is no significant change in the systolic and diastolic blood pressure between the 2 groups.
Comparison of conventional block and ultrasound-guided block based on oxygen saturation

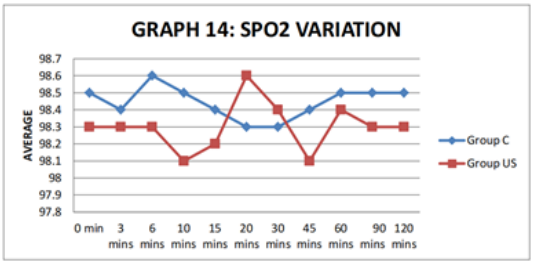

Figure 14. SPO2 Variation

there is no significant change in the oxygen saturation between the 2 groups (p>0.05). There was no episode of desaturation.

5. Discussion

This study was done to compare the conventional paraesthesia technique with an ultrasound-guided approach to supraclavicular brachial plexus block in certain characters like time taken for the procedure, sensory block onset and duration, onset & duration of motor block onset and duration, success of block & the complications with both techniques.

5.1. Patient characteristics across groups

Patients in our study did not vary much concerning age, sex, and weight. The p-value was 0.11 for age-wise distribution among the groups and 0.122 for weight distribution (p>0.05) and is not significant. Hence, both groups are comparable.

5.2. Changes in the perioperative cardiovascular parameters

In terms of PR, systolic blood pressure, diastolic blood pressure, and O2 saturation perioperatively between the two study groups there is no significant difference [6]. These mentioned parameters were recorded at 1min, 3 mins, 6 mins, 10 mins, 15 mins, 20 mins, 30 mins, 60mins, 90 minutes,120mins. The p values measured during these intervals for the above-mentioned variables are not significant. (p>0.05) [7].

5.3. Dose of the drug

In this study, 30ml of 0.5% bupivacaine with sodium bicarbonate of 0.25ml is taken in both groups

According to Tran et al [8], the volume of local anaesthetic solution effective for a supraclavicular block in 90% of patients using ultrasound technique was 32 ml. Hickey et al [9] conducted a study to define the subclavian perivascular block and its influence on the paresthesia location of the upperlimb. They used a 30 ml volume for the conventional technique. Raizada et al [10] also used 30 ml of local anaesthetic solution for the blind subclavian perivascular technique.

In 50% of patients, 23ml is the minimum volume sufficient for ultrasound-guided supraclavicular brachial plexus block whereas in 95% 42ml is sufficient. In that study the calculated local anaesthesia volume for both the ultrasound-guided technique and conventional technique is the same and does not differ much So, we have decided to take a 30ml of local anaesthetic solution.

5.4. The procedure time for brachial plexus block

In the present study, ultrasound-guided supraclavicular block takes a mean time of 11.5±3.09 minutes and for the conventional technique, it was 7.7±2.23minutes. The p-value was 0.000. Hence, the conventional technique is significantly faster to perform than the ultrasound-guided technique (p<0.005) [11].The time delay in the US technique was found to be due to the variable Sonoanatomy, difficulty in orienting the shaft, and also the needle tip should be longitudinal to the probe, and difficulty in keeping the probe at one position.

5.5. Sensory block onset

The mean time for sensory block onset in the ultrasound group [7] (US) was 9.6±2.56minutes whereas in the conventional group, it is about 10.8±2.98minutes. The difference between the 2 groups is significant

statistically with a value of p 0.05. This can be due to the direct visualization of structures in the ultrasound group.

5.6. Motor block onset time

The motor block is assessed by Lavoie's scale and is taken as the time interval between drug administration and loss of flexion or extension movements in the arm (Lavoie's scale 3) The mean motor block onset time in the conventional technique was 13.03±2.9minutes and in the ultrasound group were 11.96±3.16minutes. The p-value was 0.05. Thus, it has been proven that there is a significantly faster motor block onset in the ultrasound-guided group when compared to the conventional group [12].

5.7. Complications [13]

Among the 30 cases in the ultrasound group, only one patient had vascular puncture [14] of the subclavian artery which resolved immediately with compression for 15 minutes. In the ultrasonography group, there were no cases of pneumothorax, nerve damage, bronchospasm [15], or local anaesthetic toxicity. Among the 30 patients in the conventional group, 4 patients had a vascular puncture, in which only one went for hematoma formation which resolved within two days.

There were no further complications in this group. With a p-value of 0.16 (p>0.05), the difference between the two groups was not statistically significant. In previous days, pneumothorax was a more frequent complication of supraclavicular block with a reported incidence of 0.6% to 6.1%. With the introduction of ultrasonography, the supraclavicular block has enjoyed a renaissance with reduced incidence of pneumothorax [16].

6. Conclusion

In Group C, the supraclavicular approach of brachial plexus block was done by a conventional subclavian perivascular technique by eliciting paresthesia, and in Group US, by the ultrasound-guided approach. 30ml of 0.5% bupivacaine and sodium bicarbonate 0.25ml is added to the local anaesthetic solution this was used for both groups.

Parameters observed were procedure time, onset time for sensory and motor blockade, sensory block duration and motor block duration, the overall effectiveness of block, success rate, analgesic supplementation required, and complications [17].

This study shows that:

1. Time taken for a conventional brachial plexus block is less when compared to the ultrasound-guided technique.
2. The onset time for the sensory block and the motor block is found to be earlier in ultrasound-guided technique [13] compared to that of conventional subclavian perivascular technique.
3. The sensory block and motor blockade are found to be prolonged in ultrasound-guided technique than in conventional subclavian perivascular technique.
4. Analgesic requirement is reduced in ultrasound-guided technique compared to conventional subclavian perivascular technique.
5. Complications and their incidence are slightly more in conventional subclavian perivascular technique than in ultrasound-guided technique but were not significant.
6. Ultrasound-guided technique has a higher success rate compared to the conventional subclavian perivascular technique but there is no statistical significance
7. Ultrasound-guided technique blocks were overall more effective than conventional subclavian perivascular technique.

Author Contributions: All authors contributed equally to the writing of this paper. All authors read and approved the final manuscript.

Conflicts of Interest: "The authors declare no conflict of interests."

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