A COMPARATIVE STUDY BETWEEN CONVENTIONAL TECHNIQUE AND ULTRASOUND GUIDED SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK IN ELECTIVE UPPER LIMB SURGERIES .

Dr . Bhavani Gonapa[1] , Dr. G.K.V. Satyanarayana [2], Dr. V.V. Ramesh[3],

Dr. Shaik Aslam[4], Dr. Saranya Mudu [5]

[1,2,3] Assistant Professor, Department of Anaesthesiology and Critical Care, Government Medical College, Srikakulam, Andhra Pradesh, India.

[4,5] Postgraduates, Department of Anaesthesiology and Critical Care, Government Medical College, Srikakulam, Andhra Pradesh, India.

Corresponding Author: Dr. V.V. Ramesh, Assistant Professor, Department of Anaesthesiology and Critical Care, Government Medical College, Srikakulam, Andhra Pradesh, India.

ABSTRACT

Introduction:

Peripheral nerve blocks prove beneficial by avoiding stress response and adverse effects of general anesthesia. Brachial plexus blockade is useful for upper limb surgeries. As the conventional paresthesia technique is a blind technique, it may have a high rate of failure, cause injury to nerves and vessels.

Ultrasound usage allowed better localization of the nerve/plexus. It has improved the success rate as well as safety margin. Hence, this study was planned for comparing the efficacy of conventional supraclavicular brachial plexus block with ultrasound-guided technique.

Methods:

After obtaining the Institutional ethical committee approval and patient consent, 60 patients ranging in age from 18 to 60, undergoing elective upper limb surgeries under the supraclavicular block were enrolled in this prospective randomized study, randomly divided into two groups:Group US and Group C. Both groups received 0.5% bupivacaine and 2 % lignocaine with Adrenaline according to the body weight .

The parameters compared between the two groups were procedure time, sensory blockade,onset and duration, motor blockade start and duration, block effectiveness and complications. The failed blocks were supplemented with general anesthesia.

Results:

Demographic data were comparable in both groups. In the ultrasound-guided technique onset of sensory and motor blockade is faster with prolonged duration and reduced analgesic requirement compared to conventional technique.The conventional method had a slightly higher rate of complications but the difference

was not significant. The overall effectiveness of the block was significantly better in ultrasound-guided technique but took slightly longer than the usual.

Conclusion:

Ultrasound-guided supraclavicular block had rapid onset, prolonged blockade with reduced analgesic requirements and lower complications than conventional technique with only limitation of a little longer performance time .

Keywords: Paresthesia, supraclavicular block, ultrasound

INTRODUCTION

The International Association for the Study of Pain's definition of pain is as follows: Pain[1] is defined as a "unpleasant sensory and emotional experience resulting from real or potential tissue injury."

Peripheral nerve blocks prove beneficial by avoiding stress response and adverse effects of general anesthesia.[2]. It provides pain relief, intraoperatively and postoperatively.

In upper limbsurgeries, brachial plexus block can be a substitute for general anesthesia. Among brachial plexus block techniques, the supraclavicular approach is the simplest and most successful. It provides complete and reliable anesthesia for the surgeries of the upper limb.

In 1892[2], William Stewart Halsted was the first to administer a brachial plexus block. He injected cocaine into the brachial plexus, which was directly exposed. Kulenkampff devised the traditional supraclavicular method in 1911[3]. Winnie and Collins proposed the subclavian peri-vascular technique to brachial plexus block in 1964.[4]

The conventional technique is a blind technique, it may have a high rate of failure, cause injury to nerves and vessels[5].Ultrasound visualization of anatomical structures is proved to offer a superior quality, safe block with an optimal positioning[6] of the needle.

Despite ultrasound having an increased success rate, exceptional localization and refined safety margin, conventional technique is preferred for its cost-effectiveness and speed of procedure .

This study was designed to compare conventional approach and ultrasound-guided block concerning the time taken for the procedure, the onset of block, and its duration, rate of success, the gross block effectiveness and incidence of complications.

AIM OF THE STUDY: To compare the effects of the conventional paraesthesia method and ultrasound-guided supraclavicular brachial plexus block in the aspects

of Procedure time, Sensory blockade onset and duration, Motor blockade start and duration , Success rate, Block effectiveness and Complications.

MATERIALS AND METHODS: After obtaining approval from institutional ethical committee, patient consent, a prospective single blinded comparative study was done in 60 patients belonging to ASA I or II, scheduled for elective upper limb surgery, below the level of mid humerus, ranging in age from 18 to 60 years.

EXCLUSION CRITERIA: 1. Patient refusal 2. Patients below 18 and above 60 years and total body weight less than 50kg 3. Patients with coagulopathy or peripheral neuropathy 4. A.S.A. grade III or IV patients 5. Allergy to local anesthetics

Random allocation of 30 patients in each group using computerized random numbers was done. **a. Group-C**: Supraclavicular brachial plexus block given by conventional technique after eliciting paresthesia. **b. Group- U.S.:** Supraclavicular brachial plexus block was given with ultrasound guidance.

The block was accomplished with 15 ml of 0.5 %bupivacaine and 15 ml of 2 % lignocaine with Adrenaline at a ratio of 1:2,00,000 in both groups, calculated according to the body weight

All the patients were kept nil per oral as per fasting guidelines. The night before surgery, all patients were given alprazolam 0.5 mg and ranitidine 150 mg tablets. Written informed consent was taken.

In the operating room secured a peripheral line, in supine position with the head turned to the opposite side of the intended block, arm adducted and hand extended along the side. A pillow placed below the shoulders. The proposed site of the block was aseptically prepared and draped.

GROUP **C:** [4,7,8,9] In Group C, the block was performed by eliciting paresthesia.A 22gauge, 5cm Huber point needle was inserted at the lowest point of the interscalene groove, tangential and posterior to the subclavian artery pulsation.After eliciting paresthesia 30 ml of local anesthetic solution was given after negative blood aspiration. Patients were withdrawn from the research if paresthesia was not elicited after 20 minutes.

GROUP US, [5,6,10] the block was performed after real-time visualization of the vessels, nerves and bones with an "in-plane approach." This procedure was done using a Mindray ultrasonogram machine with a 6-10 MHz transducer. The brachial plexus was seen by placing the transducer in the supraclavicular fossa behind the middle-third of the clavicle in the sagittal plane. A23G spinal needle was entered from the lateral end of the transducer to the medial end and the needle movement was monitored in real-time. After negative aspiration of blood 30 ml of local anesthetic solution was injected inside the brachial plexus sheath and the drug spread was observed.

ASSESSMENT OF PARAMETERS: All the patients were monitored for a)Procedure time b) Sensory blockade onset and duration c) Motor blockade start and duration d) Block effectiveness e) Complications.

a) TIME TAKEN FOR THE PROCEDURE : The time taken for the procedure is from the moment of needle insertion to the time of removal.

b)ASSESSMENT OF SENSORY BLOCKADE : Hollmen's sensory scale was used to evaluate sensory blockade. Pinprick with 23G hypodermic needle in skin dermatomes supplied by four major nerves(radial, median, ulnar and musculocutaneous nerves) once in every minute for initial 5 minutes, then every 2 minutes up to 10 minute, then every 5 minutes for 30 minutes and every half an hour after that.

1- Normal sensation of pinprick

2- Pinprick felt as sharp-pointed but weaker compared to the area in the opposite limb.

3- Pinprick recognized as touch with a blunt object.

4- No perception of pinprick.

The sensory onset of block was assessed as the time interval between administration of drug and perception of pinprick as touch (Hollmen's scale 3) in any of the major nerve distribution area.Time interval elapsed between the injection of the drug and the analgesic requirement determines the sensory block duration. (Hollmen's scale less than or equal to 1) in all four major nerve distribution areas.

c)ASSESSMENT OF MOTOR BLOCKADE: Lavoie's scale was used for evaluation of motor blockade:

Grade 1- 0% – flexion and extension in both the hand and arm against resistance

Grade 2 -33%- flexion and extension in both the hand and arm against gravity but not against resistance

Grade 3- 66%- flexion and extension movements in hand but not in the arm

Grade 4- 100%- No movement in the entire upper limb.

Onset motor blockade was assessed as the time interval between administration of drug and loss of flexion or extension movements in the hand (Lavoie's scale 3). The time interval elapsed between the injection of drug and complete return of muscle power determines the motor block duration (Lavoie's scale 1).

d)THE BLOCK'S OVERALL EFFECTIVENESS:

1) Totally effective: Surgical procedure being performed with no sedation. Hollmen's sensory scale 3 or 4 in areas supplied by all four major nerves after 30 minutes of the procedure was considered a totally effective block.

2) Partially effective: Surgical procedure being performed with minimal sedation. Patients with Hollmen's sensory scale 3 or 4 in 2 or 3 major nerve distribution areas and scale 2 or 3 supplied in the areas by 1 or 2 major nerves after 30 minutes of the procedure were considered partially effective blocks. The patients were sedated

intraoperatively with Injection fentanyl (1 mcg/kg) bolus dose and intermittent doses of injection ketamine (0.5 mg/kg) when required.

3) Failed block: Surgical procedure not being able to be performed under the block and requiring conversion to general anesthesia. Hollmen's sensory scale less than or equal to 2 in more than two major distribution areas even after 30 minutes of the procedure was a failed block.

E)COMPLICATIONS: Patients were watched intraoperatively and 24 hours postoperatively for complications.

Intraoperative complications: 1.Hematoma formation, vessel puncture 2. Any drug-related toxicity or allergic reaction

Postoperative complications: 1. Nerve Injury 2. Pneumothorax 3. Phrenic nerve block 4. Horner's syndrome 5. Recurrent laryngeal nerve block.

All the patients were administered supplemental oxygen and intravenous fluids throughout the operative procedure. At 0, 3, 6, 10, 15, 20, 30, 45, 60, 90, 120, 240, 480 minutes, heart rate and noninvasive blood pressure were recorded. After surgery, all patients were observed for 24 hours. At the commencement of postoperative pain (Hollmen's sensory scale 1), patients were administered rescue analgesics.

OBSERVATION AND RESULTS

The goal was to compare the time taken to perform the procedure, the onset and duration of the blockade, the success rate, the overall effectiveness of the block and complications.

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	9	30			
31-45	12	40	12	40			
46-60	9	30	9	30			
TOTAL	30	100	30	100	0.388	0.349	Not significant

Table 2: Comparison of conventional and ultrasound guided block on the basis of gender of the patients

Gender	Study Group		P value	Significance
	Group C	Group Us		
Male	22	21	0.77	Not significant
Female	8	9		

Table 3: Comparison of conventional and ultrasound guided block on the basis of mean body weight of the patients

Study Group	Mean±SD (kgs)	Mean Difference	t* value	P value	Significance
Group C	61.13±6.57	1.53	0.398	0.346	Not significant
Group US	59.6±7.37				

Table 4: Comparison of conventional and ultrasound guided block based on the time taken for the procedure

Study Group	Mean±SD (kgs)	Mean Difference	t* value	P value	Significance
Group C	5.71±1.7	2.59	2.763	0.003	Highly significant
Group US	8.3±2.18				

GRAPH 1 : TIME TAKEN FOR THE PROCEDURE

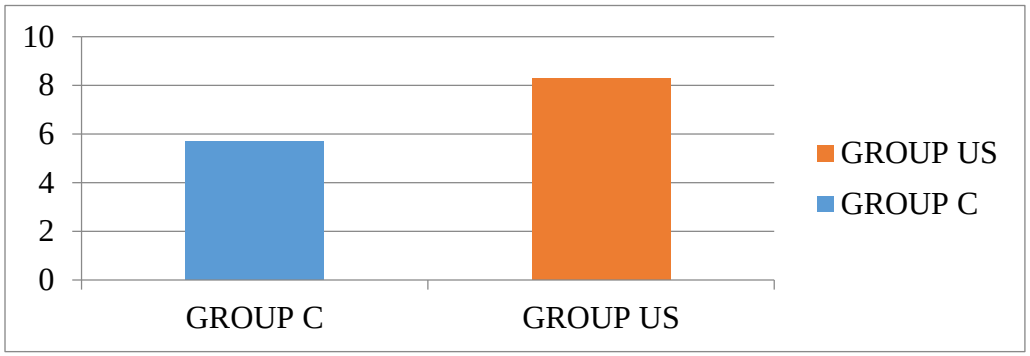

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Table 5: Comparison of conventional and ultrasound guided block based on the time taken for the onset of sensory blockade

Study Group	Mean±SD (mins)	Mean Difference	t* value	P value	Significance
Group C	11.16±2.85	3.95	3.34	0.001	Highly Significant
Group US	7.21±2.32				

*student's unpaired t test Highly significant -p<0.01

Table 6: Comparison of conventional and ultrasound guided block based on the time taken for the onset of motor blockade:

Study Group	Mean±SD (mins)	Mean Difference	t*value	P value	Significance
Group C	13.98±2.29	4.49	2.515	0.007	Highly significant
Group US	9.49±3.52				

* Student's unpaired t test Highly significant - p<0.01

GRAPH 2 : ONSET OF BLOCKADE

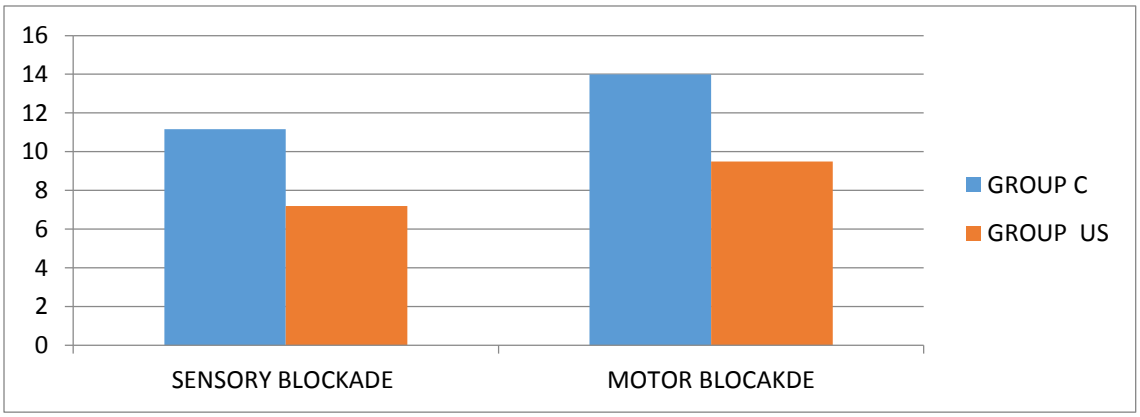

Table 7: Comparison of conventional and ultrasound guided block on the basis of duration of sensory blockade

Study Group	Mean±SD (hrs)	Mean Difference	t*value	P value	Significance
Group C	5.41± 0.89	1.04	3.41	0.001	Highly significant
Group US	6.45± 0.97				

* Student's unpaired t test Highly significant - p<0.01

Table 8: Comparison of conventional and ultrasoundguided block-based on duration of motor blockade

Study Group	Mean±SD (hrs)	Mean Difference	t*value	P value	Significance
Group C	**4.93**±0.86				Highly

Group US	5.9± 0.86	**0.97**	**3.00**	**0.001**	significant

* Student's unpaired t test Highly significant - p<0.01

GRAPH 3 : DURATION OF BLOCKADE

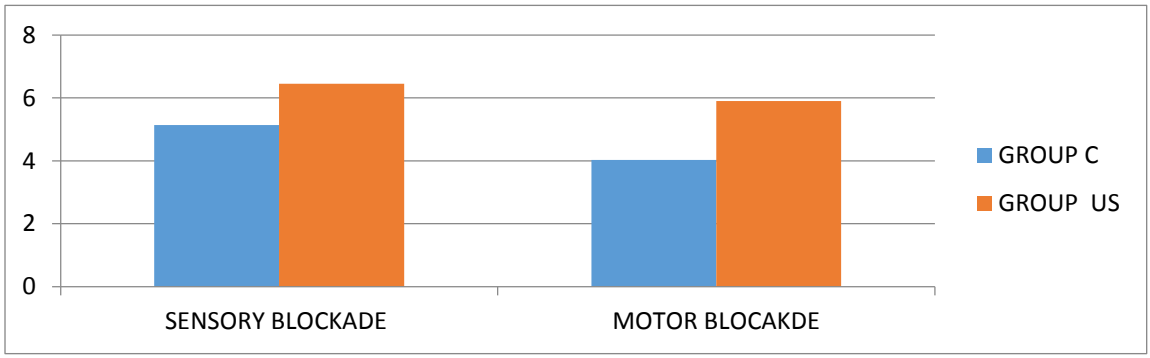

Table 9: Comparison of conventional and ultrasoundguided block-based on the overall effectiveness of the block

Study Group	Totally effective	Partially effective	Conversion To GA	Chi square	P Value	Significa nca
Group C	22	6	2	6.53	0.038	Significant
Group US	29	1	0			

Chi square test Significant- p<0.05

GRAPH 5: OVERALL EFFECTIVENESS OF BLOCK

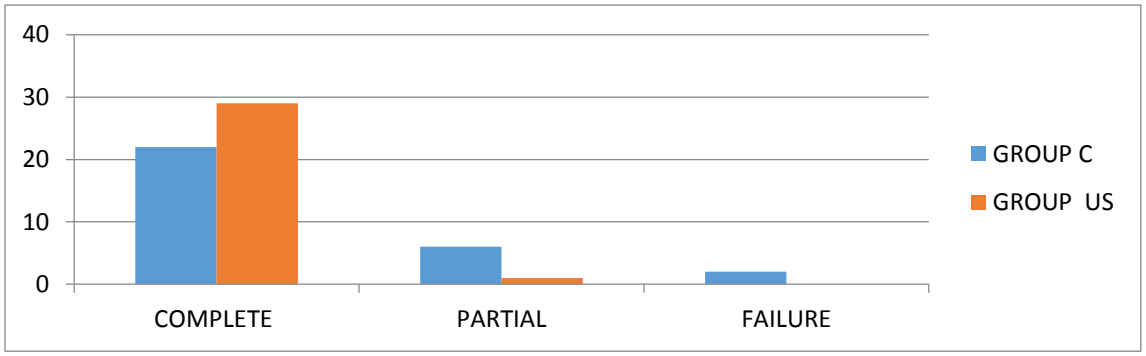

Table 10: Comparison of conventional and ultrasound guided block on the basis of success rate:

Group	Success		Chi square	P value	significance
	No	%			
Group C	28	93.33	2.069	0.150	Not significant
Group US	30	100			

Chi square test p>0.05, not significant

Table 11: Comparison of conventional and ultrasound guided block on the basis of complication:

Complication	Group C	Group US
Vessel puncture/Hematoma	2	1
Drug Toxicity	0	0
Nerve injury	0	0
Pneumothorax	0	0
Phrenic nerve blockade	0	0
Horner's Syndrome	0	0
RLM block	0	0

* Student's unpaired t test NS = Not Significant (p value > 0.05)

Table 13: Comparison of conventional and ultrasound guided block on the basis of pulse rate (beats / min)

Time of Assessment	Mean +-/SD		Mean Differnce	t* Value	P value	Significance
	Group C	Group US				
0min	81.87± 9.23	76.35± 12.01	5.52	0.102	0.46	NS
3mins	82.10± 9.78	77.93± 11.41	4.17	0.065	0.47	NS
6mins	81.87± 10.05	77.67± 11.59	4.2	0.068	0.47	NS
10mins	82.03 ± 10.42	78.70± 11.93	3.33	0.107	0.45	NS
15mins	83.43 ± 11.45	78.96± 12.30	4.47	0.073	0.47	NS
20mins	83 .43± 11.98	78.96± 10.80	4.73	0.055	0.47	NS
30mins	84.47 ± 10.74	78.93± 11.99	5.54	0.031	0.48	NS
45mins	84.27 ± 10.58	79.45± 12.42	4.82	0.054	0.47	NS
1 hour	82 . 93 ± 10.81	79.35± 11 .60	3.58	0.108	0.46	NS
1 1/2hours	83.27± 10.71	79.64±10.43	3.63	0.093	0.46	NS
2 hours	84.17± 11.67	78.87± 10.27	5.30	0.035	0.48	NS
4 hours	82.50± 10.41	80.22± 10.27	2.28	0.197	0.42	NS
8 hours	82.93± 9.53	79.0± 10.02	3.93	0.060	0.47	NS

Table 14: Comparison of conventional and ultrasound guided block on the basis of Systolic blood pressure

Time of Assessment	Mean +-/SD		Mean Differnce	t* Value	P value	Significance
	Group C	Group US				
0min	129.50± 13.53	125.48 ± 9.62	4.02	0.096	0.46	NS
3mins	129 .70± 10.27	124 87 ±9.12	4.83	0.028	0.48	NS
6mins	128.70± 10.59	123.67 ± 10.44	5.03	0.032	0.48	NS
9mins	127.70± 9.05	125.58 ±10.50	2.12	0.200	0.42	NS
12mins	126.20± 8.17	123.48±9.37	2.72	0.119	0.45	NS
20mins	126.20± 8.41	124.67± 10.90	1.33	0.303	0.38	NS
30mins	126.10 ± 6.45	123.87 ±11.01	2.23	0.172	0.43	NS
45mins	123.30 ± 5.24	121.45 ±9.65	1.85	0.177	0.43	NS
1 hour	122.40 ± 7.87	121.93± 10.79	0.47	0.429	0.33	NS
1 1/2hours	122.70 ± 6.49	121.35± 10.36	1.35	0.272	0.39	NS
2 hours	123.40 ± 6.02	122.09 ±9.68	1.31	0.264	0.39	NS
4 hours	123.60± 4.66	121.48 ± 7.54	2.12	0.099	0.46	NS
8 hours	123.20 ± 4.36	120.93 ±6.73	2.27	0.059	0.47	NS

DISCUSSION

This study was planned for a prospective randomized study in Government Medical College & Hospital, Srikakulam, to compare the efficacy of ultrasound-guided technique of supraclavicular brachial plexus block with the conventional subclavian perivascular technique.

Patient characteristics across the groups:

The patients in present study did not vary much concerning age, sex, and weight.

Mean age group for the conventional group was 37.97±11.58 years, and in the ultrasound group, it was 37.06±12.73 years with p value 0.349 (p>0.05).

The mean weight of the patients in the conventional group was

61.13±6.57kgs, and in the ultrasound group was 59.60±7.37kgs with p value 0.346 for weight distribution ($p>0.05$) and were not significant. Hence, both groups were comparable.

Changes in the perioperative cardiovascular parameters:

Both study groups did not show significant differences in pulse rate, systolic blood pressure, diastolic blood pressure perioperatively. The parameters were recorded at 0min, mins, 6mins, 10mins,15mins, 20mins, 30mins, 45mins, 1hr, 2hrs, 4hrs, 8hrs.The p values measured during these intervals for the variables were not significant ($p>0.05$).

Gajendra Singh et al. [11]**,**concluded that heart rate, systolic , diastolic and mean arterial blood pressures, oxygen saturation were comparable between the study groups and did not change significantly in the perioperative period.($p>0.05$)

Kapral et al. [12]compared the efficacy of ultrasound-guided technique with nerve stimulator-guided supraclavicular block and found no significant change in hemodynamics between the groups and were concordant with present study.

Dose of the drug:

30 ml of 1:1 ratio of 0.5% Inj. Bupivacaine, and 2% Inj. Lignocaine with adrenaline was used for both the groups.

Gajendra Singh et al.[11]also used the same drug combination for both conventional and ultrasound-guided groups.

Duggan et al.[13]studied minimum effective volume of lignocaine, bupivacaine mixture for ultrasound-guided supraclavicular block, concluded that ED50 is 23ml and ED95 is 42ml without any significant complications

Tran et al. [14], found that ED 90 was 32ml for patients using the ultrasound technique.

Dae Geun Jeon et al. [15] mentioned ED90 for a local anesthetic solution was 30 ml without any toxic effects.

Hickey et al. [7]**, Raizada et al.** [9] used 30 ml volume for the conventional technique.

Time taken for the procedure:

The mean time spent for the ultrasound-guided block was 8.3± 2.18 minutes and for the conventional technique, was 5.71± 1.7 minutes. The p value was 0.003. Hence, the conventional technique is significantly faster to perform than the ultrasound-guided technique ($p<0.005$).

The time delay in the ultrasound-guided technique could be due to the variable sonoanatomy, difficulty in orienting the shaft and the tip of the needle longitudinal to the probe and keeping the probe at one point.

Gajendra Singh et al. [11]observed the meantime for ultrasound guided supraclavicular block was 10.1± 1.15 minute, for the conventional technique was 5.43± 1.45 minutes and concluded conventional technique is significantly faster to perform than the ultrasound-guided technique ($p<0.0001$) which is similar to present study.

Veeresham et al. [16]discovered that the conventional group took 5.37±1.45 minutes to complete the procedure, but the ultrasound group took 9.97±2.44 minutes (p0.0001), is concordant with present study.

Mithun Duncan et al. [17] compared the efficacy of ultrasound-guided technique with nerve locator guided method, the time taken in the ultrasound group was 7.27±3.87 minutes.

Onset of sensory block:

The mean onset time for the sensory blockade in the ultrasound group was 7.21±2.32 minutes and in the conventional group was 11.16±2.85 minutes.

There was a statistically significant difference of a p value of 0.001(p< 0.05) between the two groups. This can be due to the direct visualization of structures in the ultrasound group.

Gajendra Singh et al.[11] observed that in ultrasound group, mean onset of sensory blockade was 10.83 ±2.94 minutes, in conventional group was 11.60±3.48 minutes; however, this slight difference was not statistically significant.

Veeresham et al. [16] discovered that the onset of sensory blockade was nearly identical in ultrasound (11±2.97) and conventional procedures (11.27±3.48 minutes) and contradicts the findings of present study.

Mithun Duncan et al.[17]found that the onset of the sensory block was 5.47 minutes in the ultrasound and 5.90 minutes in the nerve stimulator group.

The onset of motor blockade:

In the conventional technique, the onset of motor block was with a mean value of 13.98±2.29 minutes, while in the ultrasound group, a mean value of 9.49±3.52 minutes was achieved. The motor block in the ultrasound group was achieved earlier than in the conventional group, as proven by a significant p-value of 0.007.

Gajendra Singh et al. [11], in the ultrasound group, the motor blockade was achieved in 14.56±4.49 minutes and 16.8±3.43 minutes in the conventional group (p-value = 0.02(statistically significant)).

Mithun Duncan et al. [17]also found that motor block was achieved in the ultrasound-guided technique before the nerve stimulation technique.

Raizada et al. [9] , found that the time taken for the motor block in by eliciting paresthesia was 14.07±7.4 minutes.

Above three studies concordant with present study.

Duration of sensory blockade:

For sensory blockade in the ultrasound group, a mean value of 6.45±0.97 hours, and 5.41±0.89 hours in group conventional, were obtained. The p-value 0.001(p<0.05) was significant.

Gajendra Singh et al[11], found that sensory blockade lasted longer in the ultrasound group(397.93 +/-67.32 minutes.) compared to the conventional group (352.22 +/-87.50 minutes).

Veeresham et al. [16], observed that sensory block was prolonged in the ultrasound group (444.16±116 minutes) than the conventional group(393.2±95.33 minutes).

It was evident from these studies that the duration of analgesia in the ultrasound-guided supraclavicular block was more compared to conventional technique.

Duration of Motor blockade

The motor blockade obtained in group U.S. was a mean value of 5.90 ±0.83 hours, and in group C was 4.93 ±0.86 hours. p-value of 0.001 ($p < 0.05$) was significant statistically.

Gajendra Singh et al. [11], in their study with the same drug combination, found that the duration of motor blockade was significantly prolonged in the U.S. group (343.45 +/- 60.84 minutes) than paresthesia group (305.19 +/- 60.08 minutes).

The overall effectiveness of the block:

Out of the ultrasound group 30 cases , 29 blocks were complete, and one block was inadequate with sparing of the ulnar nerve segment. None of the patients had failed block. Thus 97% of patients attained complete block, 3% had partial blockade and 0% failure.

Out of the 30 cases studied under the conventional approach, 22 blocks were complete, 6 were partial and 2 failed blocks. Thus statistically, 73% of patients attained complete block, 20% had partial blockade and 7% failure. The p-value was 0.038 ($p<0.05$). Thus ultrasound-guided technique had a significantly higher success rate than the conventional paresthesia eliciting method.

According to **Gajendra Singh et al.** [11] , the ultrasound-guided technique provided more effective blocks than the paresthesia eliciting technique which is similar to present study.

Complications:

Among the 30 cases in the ultrasound group, only one patient had a vascular puncture of the subclavian artery and among the 30 patients in the conventional group, four patients had a vascular puncture, which resolved immediately with compression for 15 minutes.

Both groups had no incidence of pneumothorax, nerve injury or local anesthetic toxicity.

Gajendra Singh et al.[11]and **Veeresham et al.**[16] also observed a significant reduction in vessel puncture incidence in ultrasound-guided technique compared to conventional paresthesia technique.

The complications were statistically insignificant between the conventional and ultrasound group probably due to using a short 5 cm Huber-point needle and the drug injected immediately after eliciting paresthesia in conventional group.

Limitations of the study:

1.Conventional landmark guided technique without a nerve stimulator.
2.Small group of the study
3.Ultrasound -expensive equipment
4.Learning curve needed for ultrasound blocks.

CONCLUSION

It can be concluded that Ultrasound-guided supraclavicular block for upper limb surgeries had rapid motor & sensory onset, prolonged blockade, reduced intra and postoperative requirements of analgesic and more success rate with lesser complications than conventional technique.

The only limitation of the ultrasound-guided technique is it takes a little longer time to perform than the conventional technique.

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