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Research Article

Comparison between Conventional Technique and Ultrasound Guided Supraclavicular Brachial Plexus Block in Upper Limb Surgeries: A Randomized Double-blind Prospective Study

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ABSTRACT

Background and Objectives: Landmark technique has been traditionally used for performing the supraclavicular block, popularly known as the "spinal of the upper limb". This technique is associated with numerous complications and increased failure rates. Ultrasound guidance was introduced as a remedy to the ill effects of the conventional landmark technique. However, a need was appreciated to comprehensively evaluate the safety and usefulness of ultrasound over landmark based technique. Hence a study was planned comparing various characteristics of both blocks. Our principle objective was to ascertain qualitatively and quantitatively the benefit of ultrasound guidance for supraclavicular blocks.

Materials and Methods: A prospective double blinded randomized study was carried out which included 100 adult patients between the ages of 18 and 60 years (of ASA I/II grade) who underwent upper limb orthopedic surgeries. Patients were randomly allocated into two groups; Group C: patients receiving supraclavicular block by conventional technique and Group USG: using ultrasound technique, comprising of 50 patients each. Parameters compared included - time taken for the procedure, onset of sensory blockade, onset of motor blockade, duration of analgesia, quality of operative conditions, incidence of complications such as vessel puncture, pneumothorax, nerve injuries and incidence of incomplete and failed blocks.

Results: We concluded that compared with conventional technique for supraclavicular block, ultrasound technique provides- (1) Faster onset of sensory block (2) Faster onset of motor block (3) Increased duration of analgesia (4) Better quality of operative conditions (5) Decreased incidence of incomplete blocks/block failure (6) Decreased incidence of complications Also, the average block execution time was found to be shorter in USG group than the C group (p value<0.001). The difference was statistically highly significant.

Conclusion: Ultrasound guided block not only provides superior block characteristics but also greatly reduces patient discomfort. Thus, the use of ultrasound proves to be more beneficial and is advocated.

Keywords: Ultrasound; Landmark technique; Supraclavicular block

INTRODUCTION

Peripheral nerve blocks are revolutionary procedures that have changed the way anesthesia is provided. Supreme analgesia, minimal hemodynamic alteration and simplicity are some of the virtues of peripheral nerve blocks [1]. They involve injection of local anesthetic solutions with or without additives around nerves or within sheaths enclosing a nerve plexus. Detailed knowledge of dermatomal distribution in the body has allowed us to virtually provide spot specific anesthesia. Benefits of peripheral nerve blocks can be especially appreciated in high risk patient populations such as those with ischemic heart disease, geriatric, obstructive sleep apnea etc.

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The unique feature of brachial plexus which is it's compactness has enabled anesthetizing the upper limb with ease. It is formed from the nerve roots C5- T1. It can be approached from multiple locations, each with their own advantages and disadvantages [2].

Kulenkampff performed the first supraclavicular brachial plexus block in 1912. Common techniques for performing the block include [3]-

- Conventional/Landmark technique using paraesthesia
- Peripheral nerve stimulator technique
- Ultrasound guidance technique

The conventional approach using paraesthesia technique is a relatively blind technique relying on anatomical landmarks [4].In developing countries like India, ultrasound is a relatively new technique and is increasingly being used for performing nerve blocks for acute as well as chronic pain procedures. Although the benefits of ultrasound guidance are evident prima facie, a need was appreciated to understand the magnitude of the safety and usefulness of it for supraclavicularbrachial plexus blocks. Hence a detailed study was planned for comparison of efficacy of block by supraclavicular approach using conventional technique and ultrasound based technique.

A myriad of complications may accompany supraclavicular block. The most commonly feared being pneumothorax. The prevalence of pneumothorax after supraclavicular block has been described as 0.5% to 6%. Numerous factors affect this prevalence – technique used and experience being the important ones.

Other complications include vessel puncture, hematoma formation, neuropathies, frequent phrenic nerve block (40% to 60%), Horner's syndrome. The incidence of these and also severity is expected to be significantly circumvented using ultrasound guidance owing to direct visualization.

MATERIALS AND METHODS

The study conducted was a double-blind randomized prospective clinical study. It was carried out in operation theatres (OT) of our hospital on patients undergoing various surgeries on the upper limb under supraclavicular block. 100 patients satisfying the inclusion and exclusion criteria and undergoing upper limb surgery, after obtaining the ethical committee clearance and written informed consent were included in the study.

Most of previous studies included 30 patients in each group for better validation of results. However, we included 50 patients in each group for better validation of results.All patients were explained the concept of Numeric Rating Scale. They were informed about development of paraesthesia. Participation in this study was voluntary. Patients admitted to our hospital and fulfilling the inclusion criteria were involved.

Inclusion criteria

- American Society of Anesthesiologist (ASA) Grade I and II patients
- Male or female
- Aged 18-60 years
- Patients undergoing various orthopedic surgeries on the upper limb

Exclusion criteria

- Patient refusal
- Infection at the site of block
- Patients on adrenoreceptor agonist or antagonist therapy
- Patients with known hypersensitivity to local anesthetic drugs
- Patients with bleeding disorders
- Uncontrolled diabetes mellitus
- Pregnant women
- Patients with pre-existing neurodeficit
- Ischemic Heart disease
- Valvular Heart disease
- COPD
- Morbid obesity

On arrival in OT, standard monitors like ECG, NIBP, and pulse oximetry were attached and baseline values were noted. A 20-gauge IV cannula was inserted; Ringer's lactate infusion started at a rate of 5 mL/kg per hour, and a face mask providing supplemental oxygen (5 L/min) was applied. No sedative or analgesic medications were administered.

Group C: Patients receiving supraclavicular block by conventional technique

(Inj. Bupivacaine 0.5% 2 mg/kg + Inj. Lignocaine with Adrenaline 2% 5 mg/kg + Normal Saline making a total volume of 30 ml.)

In Group C, conventional supraclavicular brachial plexus block was given by eliciting paraesthesia. The point of entry was approximately 1 cm above the midpoint of clavicle, lateral to pulsations of subclavian artery. A 4 cm needle was directed in a caudad, slightly medial, and posterior direction until paraesthesia was elicited. When paraesthesia was confirmed, the drug was injected after gentle aspiration (Figure 1).

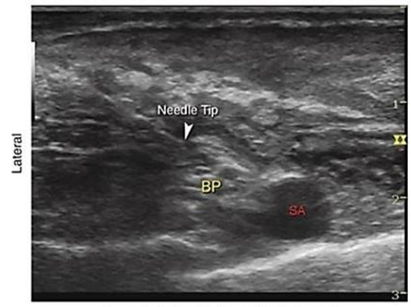

Figure 1: Ultrasonographic view of brachial plexus in supraclavicular view (BP – Brachial plexus, SA- Sub-clavian artery).

Group US: Patients receiving supraclavicular block using ultrasound technique

(Inj. Bupivacaine 0.5% 2 mg/kg + Inj. Lignocaine with Adrenaline 2% 5 mg/kg + Normal Saline to make a total volume of 30 ml.)

We used a high frequency linear ultrasound transducer (10-13 MHz) to conduct the block. All aseptic precautions were adhered to. The probe was placed parallel and just superior to the clavicle. After adjusting the probe in varying directions, the pulsatile circular sub-clavian artery was identified in the short axis. The supraclavicular brachial plexus was identified supero-laterally to the sub-clavian artery. The plexus at this level is described as a "cluster of grapes".

A 5 cm block needle was then inserted using either the "in-plane approach" that is from lateral to medial (parallel to probe) or the out-of-plane approach (perpendicular to the probe). The supraclavicular plexus can be visualized enclosed within an interscalene fascial sheath. Different operators have varying techniques of proceeding from this point viz. whether the fascial sheath should be pierced or not? The technique that proceeds without piercing the fascia has the advantage of avoiding needle to nerve contact; but the disadvantage of increased chances of phrenic nerve blockade as the phrenic nerve lies outside this sheath. We proceeded with piercing the fascia however taking the precaution of continuously visualizing the needle tip to make sure it lies between the nerve roots, to prevent intraneural injection. 30 ml of local anesthetic was injected under vision followed by a 3 minute massage.

Assessment

Assessment of the supraclavicular block was done with a focus on the sensory blockade and motor blockade parameters.For assessment of the block we used the following variables with these definitions:

Sensory blockade

- Technique of assessment: Pin prick method
- Frequency of assessment: At every minute after performing the block
- Areas of assessment: In dermatomes corresponding to median, radial and ulnar nerves
- Onset of sensory block: dull pain sensation on pin prick
- Complete sensory block: complete loss of pain sensation on pin prick

Motor blockade

Technique of assessment: modified Bromage scale on a 3 point scale.

- Grade 0: Normal motor function with full flexion and extension of elbow, wrist and fingers
- Grade 1: Decreased motor strength with ability to move the fingers only
- Grade 2: Complete motor block with inability to move the fingers

Frequency of assessment: At every minute after performing the block

Onset of motor block- grade 1 on 3 point modified Bromage scale

Complete motor block - grade 2 on 3 point modified Bromage scale.

Hemodynamic parameters viz. pulse rate, blood pressure and oxygen saturation were monitored and recorded every half hourly intra operatively and every hourly post operatively until the effect of block wore off.

Incomplete blocks wherein complete sensory and/or complete motor blockade was not achieved were supplemented with intravenous midazolam 0.02 mg/kg and fentanyl 1 μg/kg and/or axillary nerve blockade.

Failed blocks wherein block action was inadequate for surgery to be initiated were treated with general anesthesia.All patients were analyzed for serious complication viz. neuralgias, vessel puncture, pneumothorax, arrythmias or local anesthetic systemic toxicity.Another parameter used for block assessment was the – Quality of block. The following numeric scale was used as described by SS Swami et al. [5].

- Grade 4: (Excellent) No complaint from patient
- Grade 3: (Good) Minor complaint with no need for the supplemental analgesics
- Grade 2: (Moderate) Complaint that required supplemental analgesia
- Grade 1: (Unsuccessful) Patient given general anesthesia

Duration of analgesia was measured post operatively using Numeric Rating Scale of 0 to 10. Rescue analgesia was given in the form of intravenous Diclofenac 1.5 mg/kg when a Numeric Rating Score of 5 or less was obtained.

Statistical analysis

Statistical analysis was done using unpaired 't' test for finding the statistical difference between the means of quantitative data and two sample 't' test for proportions and p value was calculated. A p value of 0.05 was considered as significant, while a p value 0.05 was considered as not significant.

RESULTS

The demographic data is shown in Table 1. Both groups were comparable in terms of age, gender, weight, ASA status (Figure 2 and 3).

Table 1: Comparison of demographic data.

	Group USG (n=50)	Group C (n=50)	p Value
Age (years)	37.26+7.65	37.9+11.61	(0.74) NS
Sex (M/F)	32/18	29/21	NS
Weight (kilograms)	64.32+7.02	62.66+9.20	(0.31) NS
ASA status (1/2)	27/23	30/20	NS

NS: Not significant, M: Male, F: Female

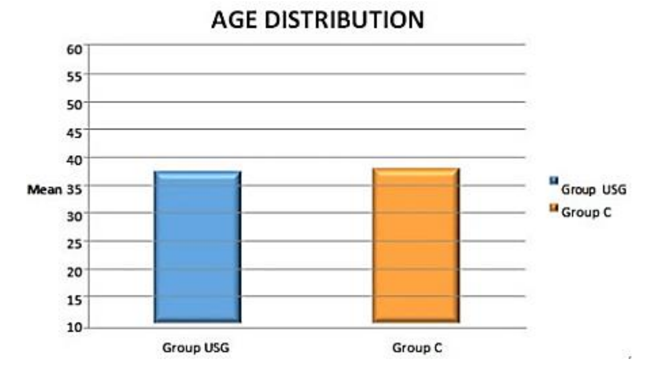

Figure 2: Bar diagram comparing age distribution in Group USG and Group C.

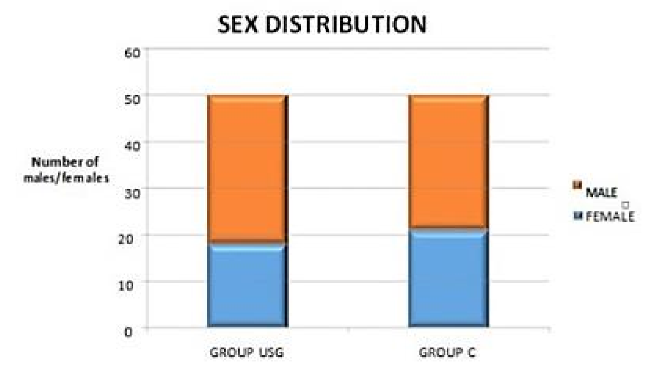

Figure 3: Bar diagram comparing sex distribution in Group USG and Group C.

The baseline hemodynamic parameters were comparable in both groups. Hemodynamic changes are comparable in both groups throughout duration of study.

Table 2: Pulse rate trend comparison between Group USG and Group C.

	Group USG		Group C		p value
Time interval	Mean	SD	Mean	SD	
Baseline	81.94		83	11.86	0.609
30th minute	78.46	13.071	77.24	10.354	0.606
60th minute	71.88	11.076	71.46	11.394	0.852
90th minute	77.74	11.129	77.9	11.699	0.944
120th minute	76.98	11.294	76.68	10.697	0.891
180th minute	77.78	10.562	76.56	9.908	0.552
240th minute	78.28	9.222	78.1	11.498	0.931
360th minute	78.28	9.463	77.84	10.994	0.83

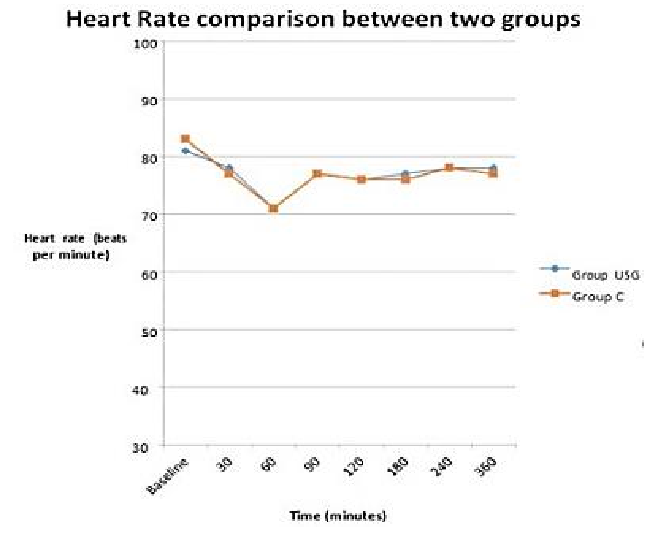

Figure 4: Line diagram showing heart rate trend between Group USG and Group C.

Heart rate pattern was comparable in both groups throughout duration of study (Table 2 and Figure 4).

Table 3: Systolic blood pressure trend comparison between Group USG and Group C.

	Group USG		Group C		p value
Time interval	Mean	SD	Mean	SD	
Baseline	126.52	9.700	126.66	12.286	0.949
30th minute	120.54	9.858	121.36	9.099	0.666
60th minute	113.52	14.158	114.7	12.745	0.662
90th minute	120.12	8.938	121.74	18.04	0.570
120th minute	121.5	11.294	120.3	10.697	0.891
180th minute	122.46	9.114	120.9	17.29	0.573
240th minute	122.94	9.900	122.48	16.676	0.867
360th minute	124.28	9.632	122.52	18.177	0.546

SBP pressure changes are comparable in both groups throughout duration of study. (Table 3 & Figure 5).

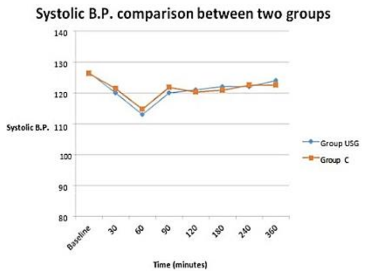

Figure 5: Line diagram showing systolic blood pressure trend between Group USG and Group C.

Table 3: Systolic blood pressure trend comparison between Group USG and Group C.

	Group USG		Group C		p value
Time interval	**Mean**	**SD**	**Mean**	**SD**	
Baseline	81.1	8.35	82.42	12.143	0.527
30th minute	74.56	10.764	73.54	10.797	0.637
60th minute	76.44	8.645	75.48	10.029	0.609
90th minute	75.98	8.529	75.34	9.379	0.721
120th minute	77.2	8.043	76.5	8.533	0.673
180th minute	77.36	8.539	77.44	10.124	0.966
240th minute	79.06	9.296	77.96	11.104	0.592
360th minute	78.38	9.352	77.18	9.364	0.522

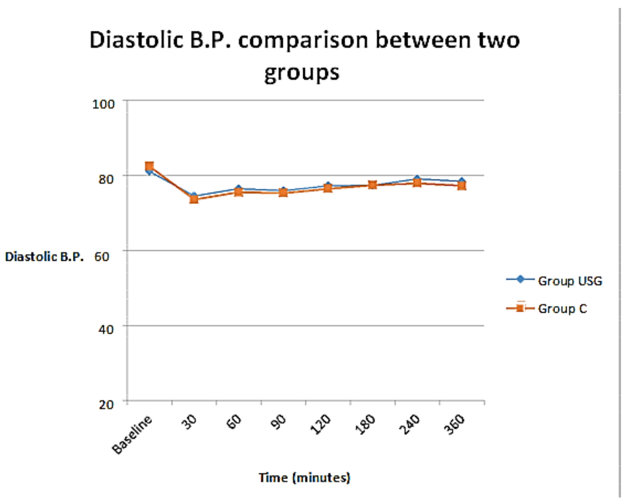

Figure 6: Line diagram showing diastolic blood pressure trend between Group USG and Group C.

Table 4: Diastolic blood pressure trend comparison between Group USG and Group C.

	Group USG		Group C		p value
Time interval	**Mean**	**SD**	**Mean**	**SD**	
Baseline	99.84	0.467	99.78	0.545	0.556
30th minute	99.72	0.701	99.78	0.506	0.624
60th minute	99.84	0.467	99.82	0.437	0.825
90th minute	99.78	0.545	99.84	0.467	0.556
120th minute	99.82	0.481	99.76	0.517	0.549
180th minute	99.84	0.467	99.82	0.481	0.833
240th minute	99.88	0.435	99.84	0.467	0.658
360th minute	99.96	0.197	99.94	0.313	0.703

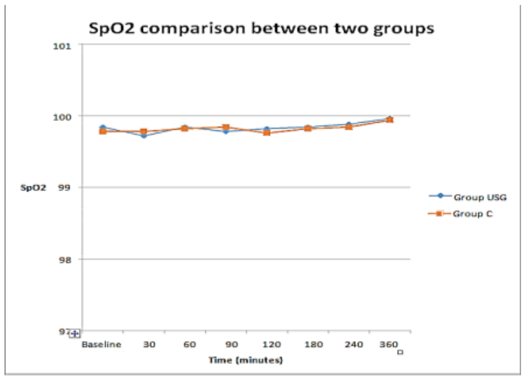

Figure 7: Line diagram showing oxygen saturation trend between Group USG and Group C.

Table 5: Oxygen saturation trend comparison between Group USG and Group C.

	Group USG (Mean ± SD)	Group c (Mean ± SD)	p value
Block execution time (min)	4.88 ± 0.848	9.64 ± 1.289	<0.001
Onset time of sensory block (min)	10.28 ± 0.729	11.06 ± 1.057	<0.001
Onset time of motor block (min)	10.54 ± 1.014	12.04 ± 1.653	<0.001

Duration of analgesia (min)	406.8 ± 67.00	373.12 ± 80.29	0.026

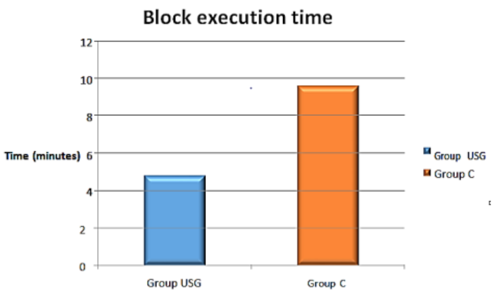

Figure 8: Block execution time comparison between Group USG and Group C

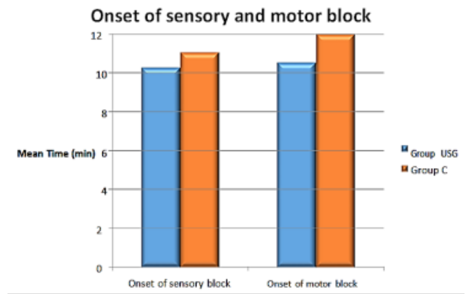

Figure 9: Comparison of onset of sensory block and onset of motor block between Group USG and Group C.

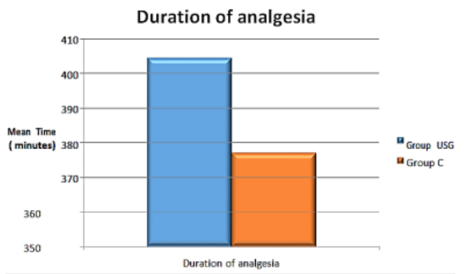

Figure 10: Comparison of duration of analgesia between Group USG and Group C.

Table 6: Block characteristics.

Block grade	Group USG	Group C
1	0	2
2	3	7
3	5	12
4	42	29

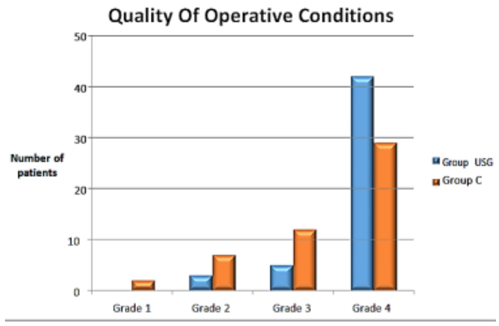

Figure 11: Comparison of quality of operative conditions between Group USG and Group C

Table 7: Quality of block (please add - "number of patients" under Group USG and Group C)

	USG	C
Incomplete	3	7
Failure	0	2
Complication	0	3

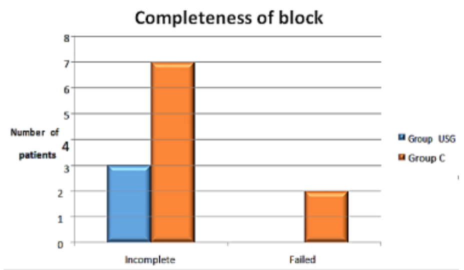

Figure 12: Bar chart showing comparison of completeness of block between Group USG and Group C.

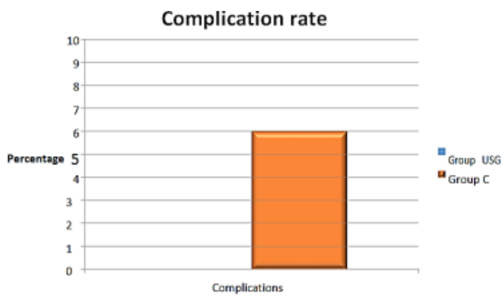

Figure 13: Comparison of complication rate between Group USG and Group C.

DISCUSSION

Peripheral nerve blocks have led to a revolution in anesthesia. Numerous advantages viz. cost effectiveness; supreme analgesia and good quality anesthesia while avoiding tampering with the respiratory system have made them a popular choice. Patient satisfaction has been greater since the advent of regional anesthesia. Lanz et al. [6] demonstrated the technique of paraesthesia technique. Their technique involved locating the first rib, superolateral to the pulsations of subclavian artery. They opined that reliable, uniform, and predictable anesthesia for the upper extremity can be obtained using this technique as it blocks the brachial plexus at the level of trunks and divisions.

Paraesthesia technique carries with it a myriad of drawback the prime one being patient discomfort on eliciting paraesthesia. Patient counseling regarding this is vital. Its success is largely dependent on the cooperation of the patient [7]. Satisfactory use of ultrasound involves a learning curve which is one of drawbacks of this technique. Morros et al. opined that training is required to use the ultrasound technique. Both trainees and anesthesiologists experienced in other techniques such neuro stimulation guidance needs to acquire a new skill set with knowledge [8].

Studies have also been done on the amount of practice required to be successful and confident with supraclavicular blocks. Williams et al. opined that this is an open question. One study says that at least 62 blocks should be performed to achieve a success rate of 87%. This number of blocks is quite difficult to be practiced by most anesthesia trainees. This study is also proof that a significant learning curves needs to undertaken for any technique of giving supraclavicular blocks.

Kiran Abhaya kumar Honnannavar and Mahantesh Shivangouda Mudakanagoudaret al. recorded that the procedure time required for ultrasound technique is greater than that for the conventional technique. Our study contradicts this, with procedure time being significantly shorter for the ultrasound group [9].

Honnannavar et al. observed that the onset of sensory blockade was similar in the conventional and ultrasound groups [9]. Danelli et al. compared nerve stimulation technique with ultrasound guided technique. They observed that while the onset time and complication rates were similar in both techniques, there was a significant difference in the block execution times (ultrasound guidance having a much shorter block execution time.)

Marhofer et al. observed contrasting results wherein onset time was significantly shorter in the US-guided group compared with NS-guided technique. They also recorded that the quality of sensory block was significantly better in ultrasound group [11].

Honnannavar et al. [9] in their study of 60 patients with 30 patients in each group – ultrasound and conventional technique, found 4 incomplete blocks, 6 failed blocks in the conventional group versus they observed 2 incomplete and 4 failed blocks in the ultrasound group.

In our study with 50 patients in each group recorded similar findings, the incidence of incomplete block (7 cases) and block failure requiring general anesthesia (2 cases) were significantly higher in Group C compared to USG Group (3 incomplete, nil failed).

Honnannavar et al. as well as Williams et al. displayed similar findings with regard to onset of motor blockade wherein the onset of motor block was similar in both groups. IN our study, the onset time of sensory and motor blockade was significantly lessusing ultrasound guided technique (10.28 ± 0.729 min and 10.54 ±1.014 min respectively) while the same were significantly higher using conventional blind (11.06 ±1.057 min and 12.04 ±1.653 min respectively). This difference wasstatistically significant.

Kapral et al. found supporting results in their study which compared ultrasound and nerve stimulator-guided supraclavicular brachial plexus block in 160 patients and found that sensory, motor, and extent of blockade was significantly better in the ultrasound group when compared with the nerve stimulation group [13]. Yuan et al. recorded complications and found in their study which compared US and peripheral nerve stimulator guidance that US decreases the risks of complications. Post block neurologic complications have not been recorded by most studies. Further investigation is required regarding this matter. Neurological complications following peripheral nerve blocks [15] for example neuralgias show an incidence of 1.7% up to 12.5% [16]. Most neuralgias tend to be mild to moderate with spontaneous recovery with time. Kaufman et al. observed seven patients suffering from severe chronic pain states after peripheral nerve blocks [17].

Honnannavar et al. recorded one patient in the conventional group who developed neuropathy radial nerve distribution of the blocked arm postoperatively. In our study, no post block neurological complication was observed. Development of pneumothorax is a major fear amongst most anesthesiologists performing the supraclavicular block. This often limits the use of the supraclavicular technique. The incidence of pneumothorax with the classic supraclavicular technique ranges from 0.5% to 6% [18]. No patients in our study showed any clinical evidence of pneumothorax.

Kapral et al. observed no complications such as pneumothorax, vessel puncture, and neuropathy in his study of ultrasound-guided supraclavicular approach brachial plexus blockade [13]. However in our study, vessel puncture was seen in few cases (3 in group C, nil in group USG).

CONCLUSION

We concluded that compared with conventional technique for supraclavicular block, ultrasound technique provides

1. Faster onset of sensory block

2. Faster onset of motor block

3. Increased duration of analgesia

4. Better quality of operative conditions

5. Decreased incidence of incomplete blocks/block failure

6. Decreased incidence of complications Also, the average block execution time was found to be shorter in USG group than the C group (p value <0.001). The difference was statistically highly significant.

LIMITATIONS OF OUR STUDY

We used similar drug volume for both groups. It is known that ultrasound guided blocks require less volume of drug while conventional technique requires greater volume of drug. Hence, block characteristics of conventional technique may be improved with increased drug volume. This remains a factor not considered in our study.

In spite of an intensive search of the published literature, we were unable to identify an ideal scale for assessment of quality of block achieved.

We did not measure the duration of sensory block and duration of motor block separately. We measured duration of analgesia. We admit that further studies with this elaboration are required.

The cost effectiveness and availability of ultrasound is also a concern.

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