

Comparative study of peripheral nerve stimulator versus ultrasound guided supraclavicular brachial plexus block in upper limb surgeries: Open randomized comparative clinical study

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Abstract

Background: The supraclavicular brachial plexus block provides reliable anaesthesia of the entire upper limb with excellent conditions for tourniquet application. Present study was taken up to compare peripheral nerve stimulator versus ultrasound guided supraclavicular brachial plexus block in upper limb surgeries. **Material and Methods:** Present study was hospital based open randomized comparative clinical study which was conducted in patients of age group 18-70 years males and females, ASA physical grading I and II, posted for Elective surgery involving upper limbs, willing to participate in the study. 60 patients were randomly allocated by computer generated tables to either Group A (Ultrasound Guided) or Group B (Nerve stimulator). **Results:** There was no significant association in the study groups regarding age, sex, ASA type, side of the block and the groups were comparable and no any significant variation caused by these variables. Mean time required for the procedure of the block in PNS group was 22.67 ± 0.76 minutes and that for USG group was 15.90 ± 1.58 minutes, difference was statistically highly significant. Mean Block duration PNS group was 6.8 ± 0.89 hours. and that for USG group was 10.83 ± 1.15 hours, difference was statistically highly significant. Mean post-operative analgesia duration in PNS group was 5.77 ± 0.86 hours and 8.83 ± 1.15 hours in the USG group, difference was statistically highly significant. There was 100% success rate of the block in both the study groups. There were no complications noted in any of the study patients. **Conclusion:** Present study conclude that USG-guided supraclavicular block to be significantly better in terms of procedure time and block characteristics during upper limb surgeries compared to the nerve stimulator technique. **Keywords:** supraclavicular brachial plexus block USG-guided supraclavicular, upper limb surgeries nerve stimulator technique.

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Received Date: 04/10/2021 Revised Date: 12/11/2021 Accepted Date: 28/12/2021

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Access this article online

Quick Response Code:	Website: www.medpulse.in
	DOI: https://doi.org/10.26611/10152215

INTRODUCTION

Peripheral nerve blocks have certain advantages over general anaesthesia such as associated analgesia, minimal side effects and more rapid recovery.¹ The supraclavicular brachial plexus block provides reliable anaesthesia of the entire upper limb with excellent conditions for tourniquet application.^{1,2} Traditionally anatomic landmark technique is used in which anatomical landmarks with elicitation of paresthesia are used to identify the nerves of brachial plexus. But this technique had a Drawback of higher

failure rates and complications. A nerve stimulator connected to an appropriate needle allows emission of electric current from needle tip close to or contacts motor nerve with characteristic contraction of innervated muscle.^{2,3} Localization of brachial plexus using nerve stimulator led to more effective and reliable blocks, but the risk of complications remained high.^{4,5} Ultrasound guided peripheral nerve block is performed under an image produced by ultrasound which required essential skill for the performance of block. Observation of spread of drug surrounding the nerves is predictive of a successful block.⁶ Ultrasound guidance provides real time images, thereby in, appropriately trained and experienced hands, has the potential to minimize risk of complications.⁵ Present study was taken up to compare peripheral nerve stimulator versus ultrasound guided supraclavicular brachial plexus block in upper limb surgeries.

MATERIAL AND METHODS

Present study was hospital based open randomized comparative clinical study which was conducted in the Department of Anesthesiology in a Municipal tertiary care Centre and teaching Hospital in Maharashtra, India. Study duration was of 18 months (April 2019 to September 2020). Study was approved by institutional ethical committee.

Inclusion criteria: Patients of age group 18-70 years males and females, ASA physical grading I and II, posted for Elective surgery involving upper limbs, willing to participate in the study.

Exclusion criteria: Patients refusal for procedure. Patients with Neurological deficit, Infection at the site of block and Peripheral neuropathy. Patients with preexisting significant systemic diseases. Patients with History of psychiatric illness. Patients with history of allergy to amide group of local anesthetics. Patients with significant coagulopathies and other C/I FOR Supraclavicular brachial plexus block.

Study was explained and a valid and informed consent was taken for participation. Patients underwent preanesthetic assessment one day prior to surgery. IV cannulation was done on the non-operating hand. Patients were premedicated with Inj. Ondansetron 4mg+ Inj Midazolam 1mg 15 minutes prior to procedure and shifted to operation theatre. Routine monitors such as ECG, Non-Invasive BP, Pulse Oximetry were applied.

All patients were randomly allocated by computer generated tables to either Group A (Ultrasound Guided) or Group B (Nerve stimulator). Local anesthetic solution used was a mixture of 15ml of 0.5% bupivacaine +15ml of 2% Lignocaine to make a total volume of 30 ml.

Group A (USG guided): Ultrasound guided supraclavicular block was performed by senior

Anesthesiologist, using a Samsung ultrasound machine SONOACE R7 With LN 5-12 Linear transducer with a frequency of 5-12 MHz. The patients are placed in a supine position with a shoulder roll under the patient and the head turned away from the side to be blocked and the arm were held downward to depress the Supraclavicular Region. Local anesthetic solution was injected in to the brachial plexus sheath under vision in at least two different needle positions around subclavian artery.

Group B: In this group, Peripheral Nerve stimulated supraclavicular Brachial plexus Block was performed by senior Anesthesiologist. The positive electrode from the PNS is attached to an ECG lead and placed in the ipsilateral shoulder, and the negative electrode was attached to a 21G insulated needle. After skin preparation, the subclavian artery was palpated in the supraclavicular region and skin was infiltrated with 2% lignocaine immediately lateral to the artery. The needle was inserted through the skin in a downward and inward direction with the PNS set to deliver 1.5–2.5 mA current at 1 Hz frequency and 0.1 ms of pulse duration. The needle was slowly advanced until the upper trunk is identified by a muscle twitch of the shoulder muscles. Once the finger twitch was obtained, the current was gradually reduced to 0.5 mA and then the local anesthetic solution will be injected after negative aspiration. During the surgery, mild sedation (IV Midazolam 1–2 mg) was administered. In case of insufficient analgesia, supplementation was given with intravenous fentanyl 1 mcg/kg. If the patient still has pain, then general anesthesia was given and the block was considered as failed. Study parameters measured were time required for the procedure in minutes, onset of sensory block in minutes, onset of motor block in minutes, block duration in hours, post-operative analgesia in hours, rate of success and incidence of the complications Data was collected and compiled using Microsoft Excel, analysed using SPSS 23.0 version. Qualitative data is presented with Frequency and Percentage tables. Charts and diagrams were drawn wherever necessary. Quantitative data was compared with the help of unpaired t test, ANOVA test etc. For the qualitative data statistical tests used were, Chi square test, Fischer exact test, Wilcoxon Sign rank test etc. P value <0.05 was considered as significant value for these tests.

RESULTS

60 patients were randomly allocated by computer generated tables to either Group A (Ultrasound Guided) or Group B (Nerve stimulator). There were 30 patients involved in each of the study groups. In PNS group most common age of presentation was 31-40years with 13(43.33%) patients and 21-30 years (33.33%) was most common age of presentation in US guided group. There

was male preponderance in the study i.e. out of 60, 37(61.67%) were male and 23 (38.33%) were female. Male: Female ratio was 1.61:1. The proportion of ASA type II patients was more in both PNS(56.67%) and US guided (53.33%) groups. Maximum patients 17(56.67%) of PNS group were of right sided block while maximum

17(56.67%) of USG group were of left sided block. There was no significant association in the study groups regarding age, sex, ASA type, side of the block and the groups were comparable and no any significant variation caused by these variables.

Table 1: General Characteristics

Characteristics	PNS	USG	Total
Age in years			
Up to 20	0(0%)	1(3.33%)	1(1.67%)
21-30	6(20%)	10 (33.33%)	16(26.67%)
31-40	13(43.33%)	8(26.67%)	21(35%)
41-50	8(26.67%)	7(23.33%)	15(25%)
51-60	3(10%)	4(13.33%)	7(16.66%)
Sex			
Male	19(63.33%)	18(60%)	37(61.67%)
Female	11(26.67%)	12(40%)	23(38.33%)
ASA type			
I	13(43.33%)	14(46.67%)	27(45%)
II	17(56.67%)	16(53.33%)	33(55%)
Side of the block			
Right	17(56.67%)	13(43.33%)	30(0%)
Left	13(43.33%)	17(56.67%)	30(0%)

Mean time required for the procedure of the block in PNS group was 22.67 ± 0.76 minutes and that for USG group was 15.90 ± 1.58 minutes, difference was statistically highly significant. Mean time required for onset of sensory block in PNS group was 23.00 ± 1.23 minutes and that for USG group was 15.07 ± 1.11 minutes, difference was statistically highly significant. Mean time required for onset of motor block in PNS group was 28.97 ± 1.03 minutes and that for USG group was 19.50 ± 1.17 minutes, difference was statistically highly significant. Mean Block duration PNS group was 6.8 ± 0.89 hours. and that for USG group was 10.83 ± 1.15 hours, difference was statistically highly significant. Mean post-operative analgesia duration in PNS group was 5.77 ± 0.86 hours and 8.83 ± 1.15 hours in the USG group, difference was statistically highly significant. There was 100% success rate of the block in both the study groups. No failure of block was noted in any of the study group. There were no complications noted in any of the study patients.

Table 2: Comparison of the study groups on the basis of anaesthesia characteristics

Characteristics	PNS	USG	P value (Unpaired t test)
Time required for the procedure in minutes	22.67 ± 0.76	15.90 ± 1.58	< 0.0001
Onset of sensory block in minutes	23.00 ± 1.23	15.07 ± 1.11	< 0.0001
Onset of motor block in minutes	28.97 ± 1.03	19.50 ± 1.17	< 0.0001
Block duration in hours	6.80 ± 0.89	10.83 ± 1.15	< 0.0001
Post-operative analgesia in hours.	5.77 ± 0.86	8.83 ± 1.15	< 0.0001
Rate of success	100%	100%	--
Incidence of the complications	0%	0%	--

(< 0.0001 Highly Significant)

DISCUSSION

In recent years peripheral nerve blocks had gained a lot of interest among the anaesthetist community, as it is associated with good regional anaesthesia, lower complication rate and better postoperative analgesia.^{7,8} Efforts were still made to improve upon the technique of these nerve blocks. Mechanical nerve stimulation and electric stimulation were steps in this direction and more recently advances in imaging its wider availability had

made application of USG in PNBs. It is a guided technique which helps in performing PNB by direct visualization. Mean time required for the procedure of the block in PNS group was 22.67 ± 0.76 minutes and that for USG group was 15.90 ± 1.58 minutes. It is clear that time required for process of block in PNS group was far more than that for USG group which was statistically highly significant. The results of our study was well supported by the study done by conducted by Rupera KB *et al.*,⁵ where she quoted the mean procedure time for USG guided group was 4.55 min

and it was 5.71 min for PNS group patients, in another study done by Thomas L *et al.*,⁹ the time taken for performing PNS (mean = 10 mins) was much higher than the USG guided technique (mean = 4.3 mins). Also, these timings were much lower in both the studies when compared to our study for both the study groups. Similarly, Williams *et al.*,¹⁰ and Ratnawat A *et al.*,³ found a significantly shorter time to perform the block with USG than the PNS. However, Duncan *et al.*,¹¹ observed a comparable procedural time with the above two techniques. The procedure time was greater in the nerve stimulator group because of the variability in the relationship between the surface anatomy and nerve location whereas use of USG may minimize this variation. Furthermore, PNS technique took a longer time since the initial response was seen at the shoulder and then the needle position had to be adjusted slightly posteriorly to get finger twitches. With USG guidance, positioning, and any repositioning of the needle is performed under direct vision whereas in the PNS technique, landmark technique is used to locate the plexus requiring repeated needle pricks and needle repositioning ultimately leading to longer procedure time as supported by Vincent W. S. Chan *et al.*,¹² Mean time required for onset of sensory block in PNS group was 23.00±1.23 minutes and that for USG group was 15.07±1.11 minutes. It is clear that time required for onset of sensory block in PNS group was far more than that for USG group which was statistically highly significant. The similar finding was also stated in studies conducted by Leslie C. Thomas *et al.*,⁹ Marhofer P *et al.*,¹³ Kapral S *et al.*,¹⁴ Zencirci B *et al.*,⁶ and Rupera KB *et al.*,⁵ Mean time required for onset of motor block in PNS group was 28.97±1.03 minutes and that for USG group was 19.50±1.17 minutes. Time required for onset of motor block in PNS group was far more than that for USG group which was statistically highly significant. Similar finding were noted in other studies.^{5,6,9,13,14} These results of sensory and motor blockade were similar to the study done by Ratnawat *et al.*,³ in which the mean onset time of sensory and motor block was significantly shorter in USG group (6.46 ± 1.02 min and 8.10 ± 1.02 min, respectively) compared to the PNS group (7.68 ± 1.33 min and 9.94 ± 1.28 min, respectively). However, our findings were in contrary to the study done by Duncan *et al.*,¹¹ in which the onset time of sensory and motor block was comparable between the USG and PNS groups. Mean Block duration PNS group was 6.8±0.89 hours. and that for USG group was 10.83±1.15 hours. Mean Block duration was more in USG group was far more than that for PNS group which was statistically highly significant. There were 100% success rate of the block in both the study groups. No failure of block was noted in any of the study group. These results were in contrast with previous studies. Singh *et*

al.,¹⁵ have observed that out of 102 patients, 45 out of 50 (90%) patients had developed successful block with USG, compared to 38 of 52 (73.1%) in Group PNS requiring additional nerve blocks (P = 0.028). In a study done by Zencirci B *et al.*,⁶ 86.67% of the cases in PNS group developed complete sensory block and only 76.67% of these formed a complete motor block within the first half an hour, whereas among the USG guided group complete sensory and motor block was achieved in 100% of the cases. Similar results were obtained from the study by Karthi VM *et al.*,¹⁶ also in which complete motor blockade could not be achieved in 6.67% (2 out of 30) of patients belonging to group B in whom sensory block was successful and completed the surgery by giving supplemental analgesics (inj. fentanyl 2 mcg /kg I.V and inj. midazolam 0.05mg/kg I.V) in those patients. Mean post-operative analgesia duration in PNS group was 5.77±0.86 hours and 8.83±1.15 hours in the USG group. Thus it was >1.5 times more and better in USG group than in PNS group and was statistically highly significant. There was no incidence of complications such as arterial puncture, pneumothorax and nerve injury in both groups in our study similar to Duncan *et al.*,¹¹. Singh *et al.*,¹⁵ reported seven vascular punctures in the PNS group, while only one in the USG group during check aspiration. Several studies have shown nil or lesser incidence of complications with the use of USG as it helps in direct visualization of the needle with relation to the cervical pleura thereby avoiding the puncture of pleura and development of pneumothorax.^{14,17} Further studies with large sample size are required to assess and compare the incidence of complications with these techniques.

CONCLUSION

Present study conclude that USG-guided supraclavicular block to be significantly better in terms of procedure time and block characteristics during upper limb surgeries compared to the nerve stimulator technique. Furthermore, nerve stimulator can be safely used in situations when USG machine availability is limited.

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Source of Support: None Declared
Conflict of Interest: None Declared