

## Original Research Article

# Evaluation of ultrasound guided verses nerve stimulator technique of interscalene brachial plexus block: insights from Indian multi-specialty hospital

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**Received:** 08 April 2018

**Revised:** 10 May 2018

**Accepted:** 14 May 2018

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## ABSTRACT

**Background:** To provide adequate intraoperative anaesthesia and postoperative analgesia for orthopaedic surgery continues to be a procedural challenge. The administration of brachial plexus anaesthesia can be facilitated through nerve stimulation or by ultrasound guidance. Hence study was conducted to compare differences in these techniques in patients undergoing interscalene brachial plexus block (ISSB).

**Methods:** In this prospective, randomized, observer-blinded study, 60 patients (Male=41, Female=19) were scheduled for orthopaedic shoulder and upper arm surgeries matching inclusion and exclusion criteria. Patients were randomly allocated to either Ultrasound (US, n=30) group or Nerve Stimulator (NS, n=30) group through a computer-generated randomization.

**Results:** There was significant difference between US and NS group with respect to average number of attempts taken, block performance time (BPT), onset of sensory and motor block, duration of motor block and patient satisfaction score. Whereas not much significant difference was observed in duration of sensory block, block success rate and incidence of post operative side effects.

**Conclusions:** The results suggest that US guided ISSB is significantly superior to NS guided block in terms of faster onset of action; lower number of attempts to locate Interscalene brachial plexus; longer duration of block and overall success rate with favourable tolerability at real-life scenario.

**Keywords:** Interscalene brachial plexus block, Nerve stimulator equipment, Regional anaesthetic technique, Ropivacaine, Ultrasound equipment

## INTRODUCTION

Effective pain management and improved patient outcome makes regional anaesthesia suitable for ambulatory cost effective surgeries.<sup>1</sup> For surgeries of shoulder and upper limb interscalene brachial plexus

block is recommended in the perioperative management.<sup>2-5</sup> The administration of brachial plexus anaesthesia can be facilitated through nerve stimulation (NS) or by ultrasound (US) guidance. Peripheral nerve stimulator (PNS) is the 'gold standard' for performing peripheral nerve blocks, and it is highly effective

technique for determining adequate needle position to produce regional anaesthesia/analgesia.<sup>6-9</sup> The advantages of using a NS are high incidence of success rate and low cost when compared to US. Although nerve stimulator guidance is the current technique of choice, it may have suboptimal ability to detect intraneural placement.<sup>10-12</sup> In addition, at standard local anaesthetic dose of 20-30ml, Interscalene block (ISB) is associated with numerous technical complications and adverse effects like phrenic nerve palsy, recurrent laryngeal nerve block, stellate ganglion block (Horner's syndrome), spinal and epidural anaesthesia and even convulsions.<sup>13</sup> With the recent developments in high-frequency imaging, the scope of using ultrasound (US) imaging guidance for regional anaesthesia is growing rapidly. As US guidance provides real-time view of the block needle, the brachial plexus, and its spatial relationship to the surrounding vital structures; it not only can improve block success rate but also decrease complications.<sup>14</sup> US use may enable the reduction in volume of local anaesthetic and reduces the incidence of toxicity and phrenic nerve palsy.<sup>15</sup> Other additional advantages - are reduced duration of procedure, avoidance of intraneural/intravascular injection, faster onset times, improved block quality, prolonged postoperative analgesia, and decreased need for rescue analgesics.<sup>16-19</sup> Recent studies with US suggest high success rates and decreased procedural times, but less is known about the comparison of these procedural times in training programs.<sup>20</sup> The objective of present study was to compare the efficacy and safety of US and NS guided Interscalene brachial plexus block (ISBB) in patients undergoing shoulder and upper arm surgeries at real-life scenario.

## METHODS

This was a prospective, randomized, observer blinded study conducted at routine clinical practice at multi-specialty hospital in Secunderabad, India.

Adult patients with age of 18-60 years; undergoing shoulder and upper limb surgeries classified as American society of anaesthesiologists (ASA) grade I and II and provided valid informed consent for participating in study were included. Patients with history of allergy to local anaesthetics; severe cardiopulmonary disease; clinically significant coagulopathy; infection at the injection site; body mass index  $>35\text{kg/m}^2$ ; pregnancy; diabetes mellitus; known neuropathies and receiving opioid for chronic analgesia were excluded.

In the operating theatre, injection midazolam (0.03mg/kg, IV) was used as pre-medication and I-V fentanyl (upto 100 $\mu\text{g}$ ) was titrated to maintain constant verbal communication with the patient. Standard monitoring with Pulse oximetry, Non-invasive blood pressure monitor on the opposite upper limb, respiratory rate, electrocardiography was used throughout the procedure.

Patients were randomly allocated to either Ultrasound (US) group or Nerve Stimulator (NS) group through a computer-generated randomization. ISBB was performed by resident doctors in anaesthesiology, under supervision of regional anaesthesia specialist. All patients were placed in the supine position with the 30 degree elevation of the bed from the head side. Head was turned opposite to side of intended block and arm adducted and pulled down gently. A small pillow or folded sheet was used under the shoulder for the field to be more prominent. All blocks were performed with 20 ml Ropivacaine (0.75%).

In US Group, the lateral neck was examined by using a high-frequency US probe (SonoSiteMicroMaxx 3.0 Ultrasound System with L25e/13.6 MHz probe, Bothell, WA). In the interscalene region, the cervical roots forming the brachial plexus were located between the anterior and middle scalene muscles.

A 2-inch, 22-gauge Stimuplex insulated needle (B. Braun Medical) was placed into the interscalene groove via an in-plane approach to enable visualization of the entire needle. In total, 20mL of the local anesthetic mixture was injected in 5-10mL aliquots, with continuous monitoring for early symptoms or signs of intravenous injection. The needle position will be redirected multiple times to improve homogeneity of local anesthetic spread, at the discretion of the attending regional specialist.

In NS Group, the nerve location was performed using stimulating needle (2-inch, 22-gauge Stimuplex insulated needle; B. Braun Medical) and it was connected to a nerve stimulator (Stimuplex-DIG Stim-300, B. Braun) at an initial current intensity of 1 mA and advanced until it elicited motor responses in the distribution of the axillary, musculocutaneous, ulnar, radial, or median nerves. The current was gradually decreased to a range of 0.3 to 0.4 mA, with a persistent acceptable motor response. In total, 20mL of the local anesthetic mixture will be injected in 5mL aliquots, with frequent aspirations to assess intravascular needle migration.

Data was collected after the ISB was administered. Data collection was done by a qualified nurse, having prior experience of sensory and motor anaesthesia assessment and was blinded for randomization.

Number of attempts (NoA) was defined as number of times skin was pierced to reposition needle to locate brachial plexus.

Time taken for the procedure [Block Performance Time (BPT)] was defined as the interval between preparations of the injection site to the administration of total dose of local anaesthetic. Sensory block was assessed as loss of sensation to pinprick in region of distribution of each nerve. Sensation was graded as follows: Normal sensation no block; touch sensation, but no pain partial block; total loss of sensation complete block.

Motor block was evaluated by flexion of arm (Musculocutaneous musculocutaneous nerve); extending the flexed arm and wrist (Radial nerve), flexion of wrist and also opposing the thumb to 2<sup>nd</sup> and 3<sup>rd</sup> fingers (Median nerve), flexion of 4<sup>th</sup> and 5<sup>th</sup> fingers (Ulnar nerve). Motor block was scored as follows: No loss of force no block; reduced force as compared with contralateral arm partial block; incapacity to overcome gravity complete motor block. Inadequate or patchy analgesia even after 30 minutes (mins) of the drug administration and required more than 100 mcg fentanyl to complete surgery was considered as an insufficient block. In case of complete failure general anaesthesia was administered.

Safety and tolerability was assessed continuously during the study period and adverse events were recorded.

Data collection was done for every 3 min for first 15 min; every 5 min for next 15 min; every 10 min for next 30 min and finally every 15 min till end of the surgery. At 24 hours of assessment of complete recovery of sensory and motor blockade was performed.

The study was done in compliance with the principles of Declaration of Helsinki, the International Conference of Harmonization of Technical Requirements for Registration of Pharmaceuticals for Human Use and local regulatory guidelines. Informed and written consent was obtained from each patient before pre-anaesthetic evaluation on the day prior to surgery. Patients were well informed about procedure and development of paresthesia. The study was approved by institutional ethics committee.

Data analysis was carried out using Microsoft Excel and Statistical Package for Social Science (SPSS) software. Data were expressed as mean±standard deviation/standard error, percentages (%), and numbers (n). The statistical analysis was performed by using student t test. Discrete variables like patient satisfaction were analysed using Chi-square test. Power calculations were based on the SD reported in previous studies of ISB, 'p' value of less than 0.05 was considered statistical significance.

## RESULTS

The present study was prospective, randomized, observer-blinded conducted during the period of October 2015 to December 2015 at multi-super specialty hospital in Secunderabad, India. Total 78 patients were screened and 60 patients matching inclusion and exclusion criteria were recruited. The patients in this study group were comparable with respect to Age, Weight, Height, Sex and ASA eliminating bias (if any) which can occur due to these factors (Table 1).

There was significant difference between US and NS group with respect to average number of attempts taken, block performance time (BPT), onset of sensory and

motor block, and patient satisfaction score. From the above results authors also observed that there was not much difference in duration of sensory block whereas duration of motor block was statistically significant in US group. The Block Success rate for both techniques was high and it was not statistically different. When we compared postoperative side effects which was also similar in both the groups (Table 2).

**Table 1: Demographic data.**

Number of subjects	60
Mean Age (years)	36.65±12.71
Male	41
female	19
Mean weight (Kg)	61.21±10.93
Men Height (cm)	163.53±5.89

**Table 2: Various parameters studied in US and NS Brachial plexus block.**

Group	US	NS	P value
Number of attempts taken to locate Interscalene brachial plexus; mean±SD	1.33±0.54	5.56±1.19	<0.001
The mean block performance time (BPT), min; mean±SD	4.8±1	10.3±1.5	<0.001
Time for the onset of sensory block, min; mean±SD	5.16±1.06	9.83±2.79	<0.001
Time for the onset of motor block, min; mean±SD	7.56±1.19	11.23±3.17	<0.001
Duration of sensory block, hours; mean±SD	13.8±1.42	12.10±3.55	0.04
Duration of motor block, hours; mean±SD	13.00±1.68	11.53±1.47	<0.001
Block Success rate, %; mean±SD	100%	93.3%	0.15
The patients' satisfaction scores, mean±SD	1.43±0.67	2.33±0.97	<0.001
Incidence of postoperative side effects, %	1	8	0.002

p<0.05 was considered statistical significance, Chi square test; SD-Standard Deviation; US-Ultrasound; NS-Nerve Stimulator.

## DISCUSSION

The practice of regional anaesthesia still remains an "art" for many practitioners, and with constant success these

techniques often appears to be limited to anaesthesiologists who are regional anaesthesia enthusiasts. In current scenario, there has been a growing attention in the practice of regional techniques especially peripheral nerve blocks for surgical and postoperative analgesia. This shift is due to the development of local anaesthetic agents with efficacy, favourable tolerability and long duration of action.<sup>21</sup> Compared with general anaesthesia, regional anaesthesia is associated with multiple benefits including reduced morbidity and mortality, superior postoperative analgesia, cost-effectiveness and a lower rate of serious complications.<sup>22-28</sup>

Currently bupivacaine is regularly used for brachial plexus block for upper limb orthopaedic surgeries in most of the hospitals. In present study ropivacaine, another local anaesthetic with structural similarity to bupivacaine without its cardiotoxic effects has been used for brachial plexus block. Ropivacaine 0.75% reported as effective as bupivacaine 0.5% for brachial plexus block.<sup>29,30</sup> Therefore we selected 0.75 % Ropivacaine in present study.

Authors compared US with NS technique of ISBB in patients undergoing shoulder and upper arm surgeries.

In present study authors observed that ISBB under US guidance has significantly better than NS block in terms of faster onset of action for both sensory (5.16 min vs. 9.83 min,  $p < 0.001$ ) and motor (7.56 min vs. 11.23 min,  $p < 0.001$ ) block; lower number of attempts to locate Interscalene brachial plexus (1.33 vs. 5.56,  $p < 0.001$ ); longer duration of motor (13 hrs vs. 11.53 hrs,  $p < 0.001$ ) and sensory block (13.8 hrs vs. 12.10 hrs,  $p = 0.04$ ). Overall block success rate for US and NS guided ISBB was 100% and 93.3% respectively. More favourable tolerability was reported with US guided block compared to NS guided block. Overall patients' satisfaction score was favouring to US guided block.

The steps for success in regional anesthesia includes direct visualization of nerve structures, needle, adjacent anatomic structures, precise placement of local anesthetic around nerves and its dispersion in real time. Thus, more effective blocks reduces dependency on anatomic references, decreases aesthetic volume, and increases safety.

Neurostimulation is very specific in identifying nerves, but it cannot execute all other requirements. Whereas, ultrasound is capable of disseminating the teaching of regional anesthesia as it is easy to learn and to supervise, with an excellent safety profile and success rate, encouraging anaesthesiologists with little experience in regional blocks to choose this technique.<sup>31</sup>

Authors have seen analysis of reduction in nonsurgical times lends support to the acquisition of US equipment and monitoring of personnel in teaching institutions. The benefits of ultrasonography were clearly realized.

This study highlights that US guided block is easy to perform, do not require highly skilled personnel involvement, cost effective and provides superior ISBB with favourable tolerability.

The findings of this study need to be considered cautiously due to small sample, single centre study. Additionally, data for post-operative follow-up and rescue analgesic is missing. Findings of this study needs to be replicated in large, multicentre randomized clinical trial.

## CONCLUSION

This study highlighted that US guided ISBB is significantly superior to NS guided block in terms of faster onset of action; lower number of attempts to locate Interscalene brachial plexus; longer duration of block and overall success rate with favourable tolerability at real-life scenario.

## ACKNOWLEDGEMENTS

The authors gratefully acknowledge and thank to all resident Anaesthetologist (apart from the authors) of Yashoda hospital Secunderabad, who participated in this study.

*Funding: No funding sources*

*Conflict of interest: None declared*

*Ethical approval: The study was approved by the Institutional Ethics Committee*

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**Cite this article as:** Kumar KGV, Gurrām R, Fultambkar G, Gupta AO, Swami OC. Evaluation of ultrasound guided verses nerve stimulator technique of interscalene brachial plexus block: insights from Indian multi-super specialty hospital. *Int J Res Med Sci* 2018;6:2503-7.