ORIGINAL ARTICLE

Comparative evaluation of nerve stimulator guided supraclavicular brachial plexus block with or without ultrasound: An observational study

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Abstract

Background: Supraclavicular block is a popular technique for upper limb surgeries. It can be performed with landmark, nerve stimulator (NS), ultrasound (US) guidance or a combination of techniques. NS can be an invaluable tool even in low resource set up. There are limited studies to compare NS guided supraclavicular block with (dual technique; Group NS+US) and without (Group NS) US guidance. Although US is gaining popularity, its availability at all times can be limited. Whenever available, the combination of two technique can improve the success rate. *Material and Methods:* Thirty patients (n=30) were included each in group NS and NS+US in the study. Both groups received 30 ml of 1:1 mixture of 2% adrenalized lignocaine and 0.5% bupivacaine. Both techniques were assessed in terms of ease of block execution (block execution time, number of skin punctures and needle redirections), block success rates and patient satisfaction. Onset and duration of block as well as complications were noted. *Results:* Both the groups were comparable in terms of age, gender, and mean weight. The block execution times were comparable but the dual technique group had significantly lower number of skin punctures and needle redirections. Both groups had similar success rates. The dual technique group had significantly earlier onset of motor and sensory blockade. No statistically significant difference in the incidence of complications was noted. The dual technique group had better patient satisfaction. *Conclusion:* A successful supraclavicular block can be performed with NS with or without US safely. The combination of two techniques eases the block execution, hastens the onset and provides better patient satisfaction.

Keywords: Nerve Stimulator, Lignocaine, Bupivacaine, Patient Satisfaction

Introduction

The supraclavicular approach of brachial plexus block, initially described by Kulenkampff is now popularly called the *spinal anaesthesia of upper limb* as it provides dense motor and sensory blockade of the limb. The landmark technique had risks such as pleural puncture and intravascular injection of drugs with limited success rates. Later, Nerve Stimulators (NS) to identify the plexus were extensively used to achieve successful blockade. More recently, with the availability of ultrasound machine, the safety of performing successful supraclavicular block has improved. Ultrasonography (US) enables the direct visualization of the brachial plexus and real-time drug spread around it while performing the block. However, placing the needle tip reliably just outside the perineurium and avoiding intra-neural injections, have been shown to be difficult for even experienced anaesthetists when peripheral nerve blockade was done using US guidance [1]. Peripheral nerve stimulation with motor response to currents of 0.2 mA or less reliably indicates intraneural placement of the

needle when confirmed with US [1].

The combined technique with US + NS has proven to be effective in avoiding nerve injury and has shown sensitivity [2-3]. Most of the studies that compared US with NS have shown mixed results regarding success rate and time taken for the block [4-5]. Data regarding efficacy & safety of combined US with NS technique vs NS is limited [3]. NS remains an easily accessible and cost-effective tool for regional anaesthesia and hence is helpful for practicing anesthesiologist even in low resource set up. Hence, we compared NS with combined NS and US technique for supraclavicular brachial plexus block in terms of ease of execution, block success and patient satisfaction. The aim of the study was to compare the success rate of the dual technique with NS technique alone. To the best of our knowledge only one such study compared the block execution time and success rates in the two groups [2].

Material and Methods

After approval from the Institutional Ethics Committee in September 2017, 60 consecutive patients belonging to American Society of Anesthesiologists class 1 and 2, in the age group of 18-65 years, undergoing surgeries in distal arm, forearm and hand, under supraclavicular brachial plexus block, who were able to give their own consent were included in the study. Patients with communication problem and nonconsenting patients were excluded.

Thorough assessment, adequate fasting protocol and standard monitoring were followed for all patients and baseline haemodynamic parameters were noted. All blocks were performed by qualified anesthesiologists with 5-7 years of experience. One group of patients received supra clavicular block under NS guidance and the other using US+NS guidance. All blocks were given with patient lying supine, head turned to the contralateral side by 45° and hands by the side. A rolled towel was placed to make the block site prominent whenever required. Strict aseptic precautions including skin preparation and sterile preparation of the US probe were followed.

All patients were anaesthetized using 30 ml local anaesthetic drug solution containing 1:1 mixture of 2% adrenalized lignocaine (1 in 2,00,000) and 0.5% bupivacaine. A 22G insulated stimuplex needle (B braun) of 50 mm length was attached to the negative electrode of NM-20/ NSML-100 transcutaneous nerve stimulator and its positive electrode was attached to an ECG lead and stuck in the ipsilateral arm of the patient. In group NS, the subclavian artery was palpated lateral to the clavicular head of sternocleidomastoid muscle and the needle insertion was 1 cm superior and lateral to the artery. The needle was advanced in a backward, downward and inward direction looking for a finger flexion response to 1.5 mAmp twitch stimulus at 1Hz frequency ensuring that the depth of insertion is not more than 2.5cm. Once identified, the amplitude was reduced in steps to 0.5 mAmp to elicit the lowest twitch response. A lack of response at 0.2 mAmp was ensured to exclude intra-neural injection. The drug was injected after confirming negative aspiration of air and blood.

For the dual technique (US+NS), Samsung, SONO ACE R7 machine was used with a 6-12 Mhz linear probe placed in transverse plane immediately superior to the clavicle to identify the subclavian artery, pleura and first rib. Brachial plexus was identified as "A bunch of grapes" like structure above the subclavian artery. The brachial plexus was approached by in-plane technique visualizing

the plexus, pleura, and the needle throughout the procedure. Finger flexion response at 1mAmp and 0.5 mAmp at 1 Hz frequency and absence of response at 0.2 mAmp was ensured before drug deposition and the spread of the drug was visualized using ultrasound.

Our primary objective was to compare the success rate in both the groups. The block execution time, number of pricks, onset and duration of motor and sensory blocks were observed as secondary objectives. The block execution time was calculated from the time of needle insertion in group NS and from the time of scanning in group NS+US till the time of needle removal after injecting the drug in both the groups [4]. The number of skin punctures and the number of redirections with more than 1 cm needle withdrawal were noted during the performance of the block. The vital parameters were noted immediately after block and every 5 minutes thereafter. The onset of motor and sensory blocks was assessed every 2 minutes and the graded at 30 minutes. Quality of sensory block was graded using the scales adapted from Koscielniak-Nielsen *et al*., (2009) as follows [6]:

Grade 0 - Sharp pain

Grade 1 - Touch sensation only

Grade 2 - No sensation

Quality of motor block was graded using modified Bromage scale for upper limb adapted by Lavoie *et al.,* (1992) and Lahori *et al.,* (2011) [7-8].

Grade 0 - Flexion and extension in hand and arm against resistance

Grade 1 - Flexion and extension in hand and arm against gravity but not against resistance

Grade 2 - Flexion and extension in hand but not in the arm

Grade 3 - No movement in the entire upper limb.

Time for the onset of grade 1 sensory blockade in at least one dermatome and grade 1 motor blockade were assessed starting immediately after needle withdrawal. A grade 3 motor block and grade 2 sensory block in all the dermatomes at 30 minutes was considered as successful block. The absence of full sensory block in at least one dermatome was considered as block failure. The duration of sensory and motor blocks were noted by following up the patient till complete recovery of the block. After the block assessment, all patients were sedated with dexmedetomidine with a loading dose of 1 mcg/kg over 10 minutes infusion followed by a continuous infusion at 0.5 mcg/kg/hr till the beginning of skin closure. Patients expressed their satisfaction with anaesthesia in terms of excellent, good, fair or poor experience at the end of surgery. All patients were monitored for complications like local anaesthetic systemic toxicity, pneumothorax, diaphragmatic palsy, and Horner's syndrome.

Statistical analysis

Sample size calculation was based on previous study [9]. With a confidence interval of 95% and power of 80%, a sample size of 27 was needed in each group. To allow a possible dropout of 10%, thirty patients were included in each group.

$$n = (Z_{\alpha/2}+Z_{\beta})^2 * (p_1 (1-p_1)+ p_2 (1-p_2)) / (p_1-p_2)^2$$

$Z_{\alpha/2}$ is the critical value (1.96) for a confidence interval 95% and for a power of 80% Z_{β} is 0.84.

Analysis was done using the Statistical Package for Social Sciences (SPSS) for Windows software (version 22.0; SPSS Inc, Chicago). Descriptive statistics such as mean and Standard Deviation (SD) for continuous variables were determined. Frequencies and percentages were calculated for

categorical variables. Association between variables was analysed using Chi-Square test for categorical variables and unpaired t-test for quantitative variables. Level of significance was set at 0.05.

Results

Thirty patients were included in each group (NS and NS+US). All the patients were followed up and included in the statistical analysis. Both the groups were comparable in terms of patient demography (Figure 1).

Block success and failure

The block success rate at 30 minutes was 26 (86.7%) patients in Group NS and 29 (96.7%) patients in group NS+ US with value of *P* is 0.161. One patient in group NS had grade 1 blockade at C5 dermatome and required additional local anaesthetic infiltration. Three patients in group NS and one patient in group NS+US had grade 1 sensory blockade in C8 and T1 dermatomes and grade 2 motor blockade requiring conversion to general anaesthesia. They were all included in statistical analysis as "block failure".

Block execution time, skin punctures and needle redirections

The average block execution time ($p = 0.066$) was similar in both groups, but the number of skin punctures and needle redirections were significantly lower in group NS+US ($p = 0.001$) (Table 1 and Figure 2).

Onset and duration of sensory and motor block

The mean onset time of sensory and motor block and the average time to achieve complete sensory and motor block was sooner in Group NS+US which was statistically significant ($p = 0.032$, 0.006, 0.001 and 0.008 respectively) (Table 1). The average duration of sensory, motor block and the duration of analgesia were comparable in both groups (Table 1). One patient in group NS developed hoarseness of voice after the block, associated with flushing and sweating of face on the side of block. Unilateral recurrent laryngeal nerve palsy was suspected which resolved before the end of surgery, warranting no further investigations. No other complications were noted in either groups. There was no statistically significant difference in the incidence of complications in both the groups.

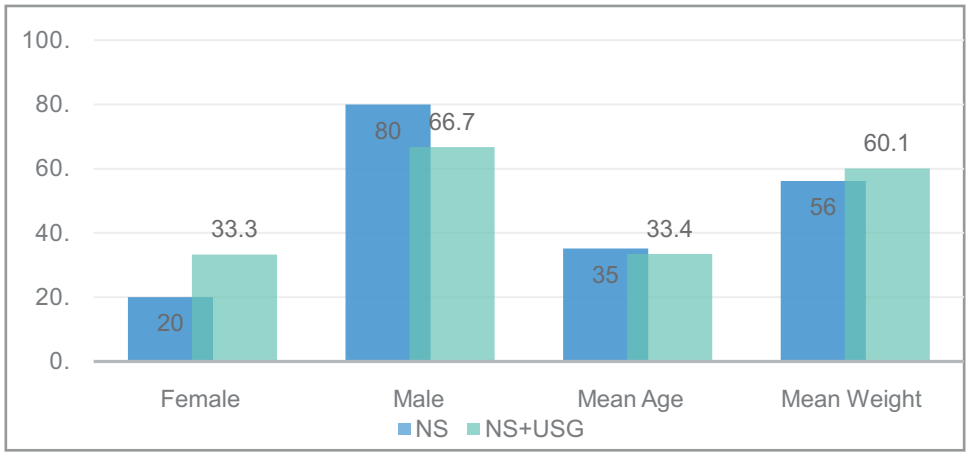

Figure 1: Comparison of demographics

The Group NS+US had better patient satisfaction rates when compared to Group NS, which was statistically significant ($p = 0.043$). Eighty percent in Group NS+US and 63.3% in Group NS rated their experience as excellent, while 23.3% in Group NS and 16.7% in Group NS+US had a good experience with the anaesthesia. Only 13.3% in Group NS and 3.3% in Group NS+US rated the experience as fair and none had dissatisfaction.

Table 1: Comparison of block characteristics

Parameters	Group (NS)	Group (NS+US)	*p*
Block execution time (minutes)	14.6 ± 6.19	11.81 ± 5.50	0.066
Number of skin punctures (mean)	2.9	1.57	**< 0.001**
Number of needle redirections (mean)	5.83	3.17	**< 0.001**
Onset of sensory block (minutes)	5.90 ± 3.80	4.10 ± 2.36	0.032
Onset of motor block (minutes)	8.98 ± 6.02	5.43 ± 3.25	0.006
Time for complete sensory block (minutes)	17.63 ± 11.08	10.17 ± 4.36	0.001
Time for complete motor block (minutes)	19.52 ± 11.40	13.00 ± 5.51	0.008
Block success rate	86.70%	96.70%	0.161
Duration of motor block (hours)	7.63 ± 1.93	7.51 ± 1.52	0.809
Duration of analgesia (hours)	8.61 ± 2.34	8.48 ± 1.96	0.812

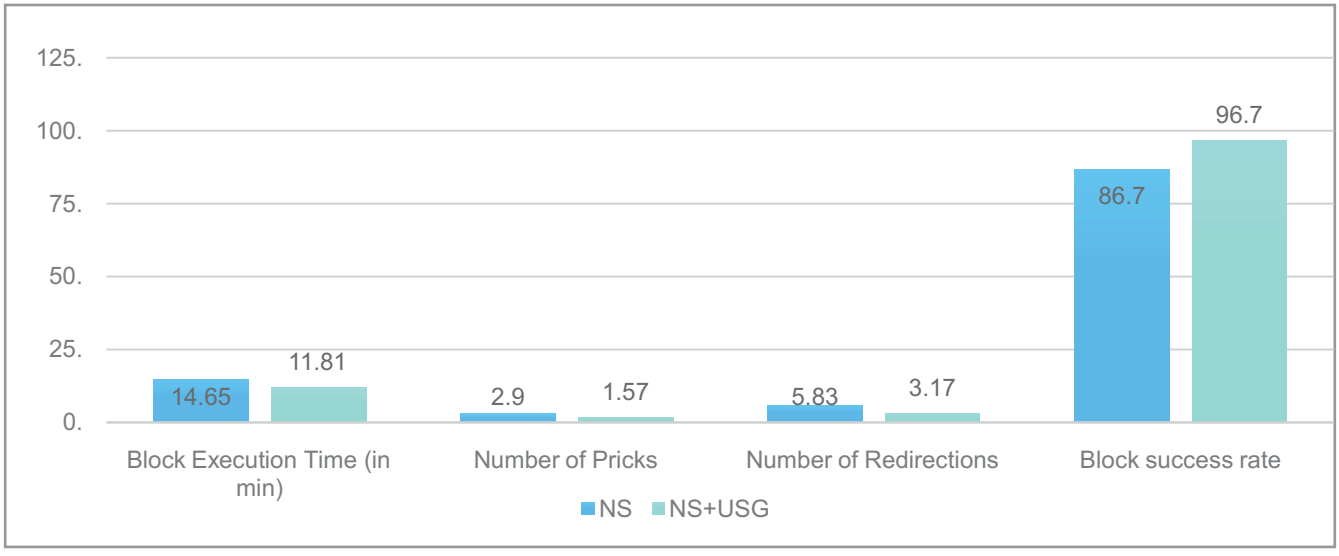

Figure 2: Comparison of ease of block execution and success rates

Discussion

Our study aimed at determining the usefulness of combination of US+NS for supraclavicular brachial plexus block in comparison with only NS. *Franco et al.*, (2004), demonstrated a 100% success rate in NS guided supraclavicular block with injection at an initial motor response of 0.9 mAmp as well as 0.5 mAmp [10]. While in the retrospective study by Tsui *et al.*, (2008), 104 patients who received supraclavicular block by the combined technique demonstrated an overall 94.2% block success with 88.8% and 100% success rates in obese and morbidly obese patients respectively [11]. William *et al.*, (2003) compared the NS guided technique with the dual technique for supraclavicular block and obtained similar success rates but shorter block execution time in the combined technique group [2]. In their study, the blocks were given by a senior resident who had an experience of 11 blocks by each technique and taken over by experienced staff anesthetist only if 20 minutes elapsed [2]. Duncan *et al.*, (2013) also observed comparable block execution times with either US or NS guided [4]. However, when Luo *et al.*, (2017) used the dual injection technique for supraclavicular block, they observed a significantly longer block execution time when combined technique was used to locate the inferior trunk compared to when only US was used [12]. In our study, in addition to a comparable block success rates, similar block execution times were obtained in both the groups when all the blocks were performed by consultant anesthesiologists.

Additionally, we observed the number of skin punctures and needle redirections to assess the ease of block execution. The dual technique was easier to execute with significantly lesser number of skin punctures and needle redirections. William *et al.*, (2003) observed similar findings and quoted that this may be directly attributed to the visualization of the nerve plexus with US and the inherent variability of the plexus with landmark guidance [2]. While the NS technique is prone to physiological variability and is dependent on needle-tissue interface, US imaging is subjected to the skill and interpretation of the operator [11]. Perlas *et al.*, (2006) found that paraesthesia was less sensitive compared to motor response in US guided axillary block [13].

In our study, we found that in experienced hands the supraclavicular block can be successfully performed by either technique, however the combined technique improved the ease of block execution. The dual technique group had hastened onset and achievement of complete block compared to group NS. Although a desirable motor response was confirmed before injection of local anaesthetic agent in both the groups, minor needle readjustments were made under US guidance after the visualization of drug spread in the dual technique group. However, there was no needle repositioning during injection in Group NS. By ensuring the real time visualization of drug spread and enabling needle adjustments around the plexus, US aided the hastening of block onset. In addition, various adjuvants can be added to prolong the block duration [15-16]. Although, the NS is an easily accessible tool even in a low resource set up, US guided technique is gaining popularity; however, its availability may be limited [17].

Our study demonstrated the complementary nature of combining US with NS in supraclavicular brachial plexus block. This contrasts with the study

by Beach *et al.*, (2006) who compared the US guided supraclavicular brachial plexus block with and without neurostimulation and concluded that a positive motor response is not a gold standard for successful US guided block [14]. However, in difficult visualization scenario, such as obesity, confirmation with NS in identifying the plexus can be invaluable [10, 13]. Limitation of the study is inability to monitor injection opening pressure.

Conclusion

This study demonstrates the complementary nature of US and NS in locating the nerve plexus. Whenever available combination of these two techniques improves ease of block execution, patient satisfaction, hastens block onset and minimizes complications.

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