

Comparative Evaluation of Techniques in Supraclavicular Brachial Plexus Block: Conventional Blind, Nerve Stimulator Guided, and Ultrasound Guided

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Abstract

Introduction: In recent years, real-time ultrasonographic guidance has been introduced for peripheral nerve blocks, which is rapidly evolving and becoming increasingly more useful in the field of regional anesthesia.

Objective: The aim of this study was to compare the three techniques of brachial plexus block. Trial design: This was a prospective, randomized clinical trial.

Materials and Methods: About ninety patients of either sex, aged 18–60 years, ASA physical status I and II, and posted for elective surgery of upper limb were included. Brachial plexus was blocked by conventional blind in Group I (CB), Group II nerve stimulator (NS) technique whereas Group III by ultrasound (US)-guided technique. All the three groups were injected 2% xylocaine with adrenaline 1:200,000 in a dose of 7 mg/kg body weight. The drug solution was diluted with normal saline to make a final concentration of 1.5%.

Results: Comparison of blockade characteristics between the CB, NS, and US-guided groups revealed that the procedural time and number of skin puncture were nonsignificant in all the three groups. The onset of sensory and motor blockade was significantly less in US group compared to other groups. The mean duration of analgesia was significantly higher in both NS and US groups compared to CB group. The incidence of patchy effect and blockade failure requiring general anesthesia was significantly higher in CB group (13.3%) compared to NS group (10%) and US group (3.3%).

Conclusion: The success rate and effective quality of the block were more satisfactory with US technique than the NS or CB technique. The onset time of sensory and motor blockade was significantly less in US group, while the incidence of complications such as vessel puncture was seen only in CB group.

Key words: Brachial plexus, Forearm fracture, Supraclavicular block, Ultrasound guidance

INTRODUCTION

Supraclavicular approach is an easy and effective method of brachial plexus block. It is used to perform surgeries

on the distal half of arm, forearm, and hand as a safe alternative to general anesthesia. The conventional blind (CB) technique depends on subjective response and is associated with significant failure rate, injury to nerves, and vascular structures.¹ In the nerve stimulator (NS) technique, nerve plexus is located by eliciting motor response, which is associated with patient discomfort, patchy block, failure of block, injury to nerves, and vascular structures. Nowadays, the ultrasound (US) technique is being used to locate the nerve plexus and its spatial relationship with other surrounding tissues as it provides the real-time view. US guidance not only determines the size, depth, and exact

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location of the plexus, but also its neighboring structures and achieves a satisfactory and dense blockade, but due to variable user experience, the results may vary.²

The primary aim of the study was to compare the three techniques of supraclavicular approach of brachial plexus block in terms of time taken for block, time of onset, quality of sensory and motor blockade, duration of analgesia, and failure rates. As a secondary objective, we studied the occurrence of complications such as nausea, vomiting, hypotension, arrhythmias, and convulsions.

MATERIALS AND METHODS

After taking Institutional Ethical Board's approval and patient's informed consent, 90 cases of ASA I, II, and III grading of both sexes between age 18 and 60 years, and posted for elective surgery of upper limb of <90 min duration were enrolled in this prospective, comparative, and randomized study. Exclusion criteria included patient's refusal, ASA IV status, infection at the site of block, coagulopathy, allergy to local anesthetic, pulmonary pathology, and pre-existing neurological deficit in the upper limbs. All patients were randomly divided into three different groups using closed envelope method. Group I was CB technique, where the block was administered following eliciting of paresthesia or hitting first rib as end point. Group II was peripheral NS-guided technique where motor twitches were elicited using current strength of 0.6 mA as end point. Group III used US-guided technique in real-time view for locating the brachial plexus as end point for injecting the drug mixture. A SonoSite Micromaxx-HFL linear 38 probe (6-13 MHz) was used for conducting the block in every case. The probe was covered with tegaderm so as to maintain sterility. It was then placed in the coronal oblique plane in the supraclavicular fossa. The subclavian artery, vein, and the brachial plexus were visualized. The brachial plexus and its spatial relationship to the surrounding structures were scanned. The plexus was identified superolateral to the subclavian artery, consistently in all the cases.

Patients in all the three groups were injected 2% xylocaine with adrenaline 1:200,000 in a dose of 7 mg/kg body weight. The drug solution was diluted with normal saline to make a final concentration of 1.5%. The observed parameters included time of procedure, number of skin puncture, onset of sensory and motor blocked, quality of sensory and motor blocked, duration of analgesia, and for any post block complications.

The sensory and motor blocks were then assessed by an independent observer who was not aware of the technique

used for every 2 min till the onset of block and every 5 min thereafter for 30 min. Any failure in establishing the block was converted to general anesthesia.

The procedural time was defined as the time spent between the insertion of needle using any technique and its removal following the administration of full volume of anesthetic solution. The sensory block was assessed by pinprick and cold application every 2 min until the onset of sensory block. The time from the removal of block needle to the time when the patient first says he/she has reduced sensation when compared to the opposite limb was taken as the time of onset of sensory block. Similarly, the time of removal of the block needle to the time when the patient had weakness of any of the three joints, i.e., shoulder, elbow, or wrist upon trying to perform active movements was taken as the time of onset of motor block.

The quality of sensory block was assessed every 5 min after the onset was established using pinprick method. At the end of 30 min, the sensory block in each dermatome was graded as follows; blocked: Complete absence of sensation; patchy: reduced sensation when compared to the opposite limb; no block: normal sensation. Postoperatively, the patients were supplemented with analgesics when they complained of pain or had a visual analog scale score of more than 4, and the duration of analgesia was recorded.

Statistical Analysis

The data were analyzed using the SPSS (version 19) software. The demographic characteristics, hemodynamics, duration of analgesia, and blockade failures were compared using one-way ANOVA test. Variables such as time of motor, sensory blockade and total duration of analgesia between all the three groups were compared using Chi-square tests and Fisher's exact test, whichever appropriate. *Post hoc* intergroup comparisons were made using Bonferroni's correction. $P < 0.05$ was considered significant.

RESULTS

A total of 96 cases were enrolled during the study period, with 32 cases in each group. Due to protocol violation in 4 cases (i.e., delay in surgery for more than 90 min) and patient's refusal to participate in the study, 2 cases were excluded from the study, leaving a total of 90 cases in the study and 30 cases in each group. There were no significant differences between the three groups with regards to demographic data such as age, sex, weight, ASA grading, and pre-operative vitals parameters (Table 1).

Comparison of blockade characteristics between the CB, NS, and US-guided groups revealed that the procedural

time and number of skin punctures were comparable in all the three groups. On comparison, the onset of sensory and motor blockade was significantly less in US group, whereas they were comparable in NS and CB groups (Table 2). The average duration of surgery was comparable in all the three groups. The mean duration of analgesia too was significantly higher in both NS and US group (3 h 21 min and 3 h 25 min, respectively), whereas it was nonsignificant in CB group (2 h 33 min). The incidence of patchy effect (5 cases) and blockade failure requiring general anesthesia (7 cases) were significantly higher in CB group compared to NS group (3 cases each) and US group (1 case each) (Table 2). No incidence of serious side effects or life-threatening complications such as pneumothorax, arrhythmias, hemodynamic instability, or local anesthetic toxicity was observed in any of the groups.

DISCUSSION

This prospective randomized study was aimed at comparing the efficacy of various brachial plexus blockade techniques. A successful brachial plexus block depends not only on the technique used, but also on the experience of the anesthetist, patient's body habitus, and the amount and type of drug injected.

In recent years, real-time ultrasonographic guidance has been introduced for peripheral nerve blocks, which is rapidly evolving and becoming increasingly more useful in the field of regional anesthesia. It has also resulted in improved success rate of supraclavicular brachial plexus block due to ability to visualize plexus, subclavian artery, first

rib, and pleura.³ This study compared different parameters between CB, NS, and USG-guided supraclavicular block.

The average number of needle pricks required to perform the procedure did not vary in any of the three groups, owing to the user experience in performing the procedures through any of these techniques. Similarly, the average procedure time in this study did not show any significant difference in any of the three groups, with 7 min ± 26 s in blind technique, 6 min ± 32 s in NS group, and 7 min ± 3 s in USG-guided group. It is well known that the learning curve of US-guided blocks may require 15–20 procedures, following which the performance time improves for all inexperienced users. As all the investigators in this study were well versed and in routine use of these techniques, it took comparable time to perform the block in all the three groups.

The onset time of sensory and motor blockade was significantly less using US-guided technique (9 min ± 33 s and 14 min ± 3 s, respectively) while the same were significantly higher using CB (11 min ± 31 s and 17 min ± 1 s, respectively) and NS-guided techniques (20 min ± 1 s and 22 min ± 06 s, respectively). In the earlier studies, the reason for delay in the onset of action in supraclavicular blocks has been attributed to distant spread of injected drugs away from the perineural tissues. This distant spread of injectate not only delays the onset of action, but also shown to limit the duration of action of the local anesthetics. Kapral *et al.*,⁴ Casati *et al.*,⁵ and Soeding *et al.*⁶ compared US- and NS-guided techniques in supraclavicular block and found that the extent of sensory and motor blockade was significantly better in the US group when compared with the nerve stimulation group. Hence, the results in our study are comparable with other researchers.

We observed a higher duration of analgesia in both NS- and US-guided groups compared to CB group. This could be explained by more precise delivery of drug closer to the brachial plexus. Similar findings have been observed by Abrahams *et al.*⁷ where they observed a combined mean increase in block duration of 25% as compared with NS group. A higher incidence of patchy effect requiring

Table 1: Comparison of demographic data between different groups

Demographic data	CB group	NS group	US group	Significance
Age (years)	36.4±12.3	31.5±9.8	34.3±13.1	ns
Weight (kg)	57.6±7.8	51.4±13.2	50.6±9.5	ns
Gender (M:F)	17:13	19:11	14:16	ns
ASA grading (I:II:III)	21:7:2	24:5:1	23:4:3	ns

ns: Non-significant, CB: Conventional blind, NS: Nerve stimulator, US: Ultrasound

Table 2: Comparison of blockade characteristics between different groups

Block characteristics	CB group	NS group	US group	Standard deviation	Significance CB:NS:US (P value)
Procedural time (s)	446.0333	392.8000	423.7000	137.19083	1.00:0.48:1.00
Number of skin punctures	2.4000	2.3000	1.8333	1.10746	1.00:0.42:0.304
Onset of sensory blockade (s)	679.6667	1207.7391	572.9310	401.89227	0.548:0.001:0.001
Onset of motor blockade (s)	1031.93	1324.09	842.97	400.462	0.12:0.135:0.001
Mean duration of analgesia (min)	153.4783	203.3448	205.8333	57.43618	0.74:0.019:0.026
Patchy effect	5	3	1		0.75:0.14:0.045
Failure	4	3	1		1.00:0.004:0.002
Vessel puncture	4	1	0		0.018:0.342:1.000

CB: Conventional blind, NS: Nerve stimulator, US: Ultrasound

intravenous anesthetic supplementation was observed using CB technique (5 cases) compared to NS (3 cases) or US-guided techniques (1 case). Not only the CB technique which relies on eliciting paresthesia, even the peripheral NS technique can result in inadequate blockade owing to anatomical variation and thus sparing of peripheral nerves. Again, these spared nerves have been shown to be more effectively blocked using multiple point paresthesia technique, either by CB or NS-guided technique that points toward the merits of nerve bundle visualization using ultrasonography. Owing to the real-time visualization of injected drug spreading around the nerve sheaths, the failure rate of supraclavicular blocks requiring conversion to general anesthesia was least in US group (3.3%) compared to CB (13.3%) and NS groups (10%). These results correlate with the studies done by Liu *et al.*,⁸ Duncan *et al.*,⁹ Chan *et al.*,¹⁰ and Kapral *et al.*⁴

CONCLUSION

From the present study, it was concluded that the success rate and effective quality of the block were more satisfactory with US technique than the NS or CB technique. Moreover, the incidence of complications such as vessel puncture was seen only in CB group.

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