ORIGINAL ARTICLE

Comparison of ultrasound and electrical neurostimulation guidance in axillary brachial plexus block

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ABSTRACT

Objectives: To compare ultrasound guidance (USG) and electrical neurostimulation guidance (ENSG) in axillary brachial plexus block in terms of block performing time, sensory and motor block quality, and patient satisfaction.

Methodology: 200 patients undergoing elective carpal tunnel syndrome surgery were randomly assigned to one of two groups equally; the USG group or the ENSG group. Axillary blocks were performed with a mixture of 15 ml of lidocaine 2% and 15 ml of bupivacaine 0.5% (a total of 30 ml solution). Sensory block was evaluated with a pinprick test and motor block was evaluated via the Bromage scale by a blinded observer.

Results: Block performing time was significantly shorter in the USG group than in the ENSG group (P<0.001). The sensory and motor block onset times were significantly shorter and the additional analgesic requirements were significantly lower in the USG group than in the ENSG group (P<0.001).

Conclusion: USG is better than ENSG in axillary brachial plexus block in terms of block performing time, block quality and patient satisfaction.

Key words: Anesthesia; Anesthesia, Conduction; Brachial Plexus Block; Ultrasonography; Ultrasonography, Interventional; ultrasonography; Ultrasound; Percutaneous Electric Nerve Stimulation; Neurostimulation

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INTRODUCTION

Axillary block, an effective method of regional anesthesia for hand and distal arm surgery, may be performed by the artery palpation method, electrical neurostimulation guidance (ENSG), or ultrasound guidance (USG).[1,2] Although ENSG is the standard technique for peripheral nerve blocks, it is a blind technique because the anesthesiologist cannot view the needle, target nerve, or adjacent important tissues, such as arteries and veins.[3,4]

The most important advantage of USG is the protection of the target nerve and its adjacent tissue because USG allows the practitioner to watch the needle being advanced; and be able to view the drug being spread, helping to lower the required dose of local anesthetic and thus decreases local anesthetic toxicity risk, as well as increasing the success of the block.[7,8,9]

The aim of present study was comparison of the two main neuroaxial nerve block technique with US guidance and ENS guidance in terms of nerve block performing time, block onset time, block success rate, quality of the motor block, complication rate, patient satisfaction ratio.

METHODOLOGY

After obtaining the institutional research ethics board's approval and the written informed consent of the patients, two hundred patients scheduled to undergo elective carpal tunnel surgery with axillary brachial plexus block (18-85 years of age, ASA physical status I-III) took part in this randomized, controlled clinical trial. A priori analysis was performed using a 2-tailed t-test where the power 0.80, and significance level (α) = 0.05. The number of patients for this trial would be 100 in each group. All patients were informed about the study a day before the study and written informed consent was taken. Randomization to two groups was established by sealed envelope technique.

In first group (Group ENS) axillary block was performed with electrical neurostimulation guidance, in second group (Group US) axillary block was performed with electrical neurostimulation guidance.

The exclusion criteria were: local anesthetic allergy, local infection, coagulopathy, a history of significant neuropsychiatric disorders, a history of peripheral neuropathy, or a history of substance abuse.

Routine, non-invasive monitoring (electrocardiogram, non-invasive blood pressure, and pulse oximetry) was applied before the block procedure and continued throughout the perioperative period. After IV access was established, midazolam 0.05 mg/kg was administered before the procedure. All axillary block procedures were performed by one staff anesthesiologist and all post-procedural parameters regarding block onset were evaluated by another anesthesiologist who was blinded to the results. Randomisation was done by the unmasked anaesthesiologist, who used a list of two numbers (a block) provided in a sealed envelope. A web-based randomisation number generator was used to generate the full list of randomisation numbers that was split up in blocks of two numbers.

A standardized 30 ml of local anesthetic solution (15 ml of 2% lidocaine and 15 ml of 0.5% bupivacaine) was administered to all patients. Three nerves (median, ulnar, and radial nerves) were surrounded by 10 ml of local anesthetic solution. A 50-mm peripheral block needle was used for the block procedure in both groups.

For the ENSG group, a nerve stimulator (Braun Stimuplex™ HNS 12, Germany) with a stimulating frequency of 2 Hz and a pulse width of 100 μsec was used for axillary block. When the distal motor response for each nerve was observed, the stimulator current was decreased to 0.4 mA or less. If the patient reported paresthesia or pain during local anesthetic injection, the needle was pulled back slightly to void intraneural injection.

In the USG group, axillary block was performed using linear 10-18 MHz probe covered with sterile dressing. The radial nerve, ulnar nerve, median nerve, and adjacent tissues were identified in a transverse view. A 50-mm block needle was advanced in line with the ultrasound beam. Local anesthetic solution was injected to surround the nerve circumferentially.

The age, weight, gender, comorbidity, ASA physical status, and block sides were recorded for all patients. Block performing time, block success rate, sensory and motor block quality, procedure complication ratio, patient satisfaction ratio were recorded. During the procedure, arterial punction, needle injection count, additional analgesic requirements were recorded. Patients' heart rate, mean arterial blood pressures, oxygen saturation values were recorded. Block performing time was defined as the time between needle injection into the skin and drug administration for all three nerves. Motor block was evaluated by the Bromage scale (0: No movement, 1: Finger movement, 2: Flexion of wrist against gravity, 3: Extension of elbow against gravity).[10] Sensory block onset time was defined as the time between the drug injection and the disappearance of sharp pain as assessed by a pinprick test. If additional analgesic was needed, inj. fentanyl 0.5 μg/kg was administered IV.

Patient satisfaction ratio was assessed by three graded scale (Bad: 0, Mild: 1, Good: 2, Excellent: 3).

Data were analyzed using SPSS v.15.0 for Windows (SPSS, Inc., Chicago, IL). All values are expressed as mean ± SD. Demographic variables (age, weight, and height) were compared using Student's t-test. Qualitative data were analyzed using the Pearson, Mann-Whitney U, and Fisher chi-square tests. The level of statistical significance was set at $P \leq 0.05$.

RESULTS

The demographic variables were similar between the groups (Table1). Block performing time was significantly shorter in the USG group than in the ENSG group ($p<0.05$) (Table 1).

Table 1: Demographic variables, and block sides and performing time

Variable		ENSG Group	USG Group	P value
Mean age (years)		46.28	47.08	0,688
Gender [n (%)]	Female	75 (75.8)	79 (78.2)	0,679
	Male	24 (24.2)	22 (21.8)	
Block Side [n (%)]	Right	43 (43.4)	40 (39.6)	0,583
	Left	56 (56.6)	61 (60.4)	
Block performing time (min) (Mean ± SD)		5.40 ±1.60	4.17 ± 1.21	<0,001

Needle injection count during the block procedure, arterial puncture, and additional analgesic requirements intraoperatively were significantly lower in the USG group than in the ENSG group (Table 2).

Table 2: Needle injection counts, arterial puncture and additional analgesic requirements [n (%)]

Parameter		ENSG	USG	p-value
Needle injection counts	1 time	78 (78.8)	97 (96)	**0.001**
	2 times	17 (17,2)	4 (4)	
	3 times	3 (3)	0	
	4 times	1 (1)	0	
Arterial puncture		15 (15.2)	3 (3)	**0.003**
additional analgesic requirements		15 (15.2)	5 (5)	**<0.001**

Sensory block and motor block onset time were significantly shorter in the USG group than in the ENSG group (p<0.05; Table 3).

Table 3: Sensory and motor block onset time. Data given as mean ± SD

Block	USG Group	ENSG Group	p
Sensory block on-set time (min)	6.99 ± 1.43	8.47 ± 2.33	<0.001
Motor block onset time (min)	9.03 ± 1.64	10.57 ± 2.55	<0.001

Patient satisfaction ratio was significantly higher in the USG group than in the ENSG group. Neither local anesthetic toxicity nor any peripheral nerve damage symptoms were observed in either group (Table 4).

Table 4: Patient satisfaction scores in groups. Data given as n (%).

Patient satisfaction scores	ENSG	USG	P value
0	14 (14.1)	2 (2)	<0.001
1	32 (32.3)	11 (10.9)	
2	30 (30.3)	49 (48.5)	
3	23 (23.2)	39 (38.6)	

DISCUSSION

The success of peripheral nerve block depends on the true localization of the target nerve and deposition of adequate dosage of local anesthetics. The nerves might be located with electrical nerve stimulation or watching for paresthesiae. Although neurostimulation is widely in practice, complications and block failure may still be seen with both neurostimulation as well as eliciting the paresthesiae; additionally, the sensitivity for the true nerve location is low for both techniques.[10] In contrast, USG helps to locate the nerve, and anesthetic spread can be readily observed.[11,12] USG also has the advantage of protecting adjacent tissues by viewing the needle during its advancement, and thus USG increases block quality and decreases block performing time and local anesthetic requirements.[11,13]

Previous studies showed that USG is more successful than the trans-arterial technique or ENSG in terms of block quality.[16,17,18] Another study showed that, secondary to low needle manipulation rates, patient satisfaction was higher in the USG group than in the ENSG group[19]. The disadvantages of USG may be the time required for machine preparation or the cost on the equipment; with increasing experience, however, the expertise required to use USG rises exponentially.[20] The present study reports that needle injection counts and arterial puncture were significantly lower in the USG group than in the ENSG group, indicating that USG helps protect tissue and suggesting that USG's low needle injection rate increases patient satisfaction. Patient satisfaction was higher in the USG group in our study; in contrast, Kumar et al reported that USG and ENSG had similar success and complication rates and that needle manipulations and pain secondary to the procedure were lower with USG than ENSG.[21]

In the present study, both sensory and motor block onset times were significantly shorter and additional analgesic requirements were lower in the USG group than in the ENSG group. We hypothesize that being able to view the spread of local anesthetic is important for both early block onset and block quality. Because by visualization of drug injection, the anaesthesiologist try to spread the drug all around the nerve homogenously to ensure better block quality. Luyal et al reported that USG decreased the local anesthetic requirement and increased patient satisfaction, as we report here.[22] In the present study, patient satisfaction was statistically higher in the USG group than in the ENSG group; this was likely due to the absence of electric current and short procedure times.

CONCLUSION

The results of our study conclude that ultrasound guidance (USG) is better than electrical neurostimulation guidance for axillary brachial plexus block in terms of block performing time, sensory and motor block quality, and patient satisfaction.

Conflict of interest: None declared by the authors

Author contribution: All of the authors took part in the conduct of the study and preparation of this manuscript.

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