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Supraclavicular Versus Infraclavicular Brachial Plexus Block Using Two Different Techniques: Comparative Study

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ABSTRACT

Background: A perfectly conducted regional anesthetic guided by ultrasound offers much to anesthesiologists.

Objective: This study was aimed to compare supraclavicular block with infraclavicular brachial plexus block for anesthesia in the forearm, hand surgery using two different methods: ultrasound alone or ultrasound together with a nerve stimulator. **Patients and Methods**: This prospective randomized study was performed on 80 adult patients, aged from 20 to 60 years, with ASA (American Society of Anesthesiology) physical status I and II. Patients were randomized in one of four groups: Supraclavicular block used Ultrasound (n =20), Supraclavicular block used ultrasound with nerve stimulator (n =20), Infraclavicular block used Ultrasound (n =20), Infraclavicular block used ultrasound with nerve stimulator (n =20). The local anesthetic solution used consisted of a 1:1 volume of 0.5 % bupivacaine and 2% lidocaine with 1:200.000 adrenaline. This solution was injected in a dose of 0.5 ml/kg to maximal 40 ml.

The Measured parameters were: Demographic values, the scanning time, the block performance time, the onset time, the degree of pain during block performance, evaluation of sensory and motor block, and complications.

Result: There were no significant differences between groups as regards all measured parameters. **Conclusion**: It could be concluded that the supraclavicular nerve block showed no significant difference from infraclavicular ultrasound-guided with or without nerve stimulator. It remains controversial whether the adding of the nerve stimulation to the ultrasound is more beneficial in ensuring rapid onset, longer duration of action, and avoiding complications.

Keywords: Supraclavicular, Infraclavicular, Brachial Plexus, Ultrasound-guided, Nerve stimulator with Ultrasound.

INTRODUCTION

Indications for a supraclavicular block are operations on the elbow, forearm, and hand [(1)]. General contraindications to supraclavicular block are those to whichever regional block, such as injection site's local infection, coagulopathy [(2)]. Due to the risk of pneumothorax, or phrenic nerve block, bilateral supraclavicular block is avoided in patients with respiratory compromise [(1)]. Infraclavicular approaches to the brachial plexus provides reliable anesthesia for the forearm and the hand [(3)]. Probable complications may include: Infection, Vascular puncture, paresthesia, Nerve injury, Local Anesthetic Systemic Toxicity (LAST), Horner syndrome, Hemi diaphragmatic paralysis, and Pneumothorax [(3)]. The aim of the current work was to compare supraclavicular block with infraclavicular brachial plexus block for anesthesia in the forearm, hand surgery using two different methods: ultrasound alone or ultrasound together with a nerve stimulator.

PATIENTS AND METHODS

This prospective randomized study included a total of 80 adult patients planned for hand, and distal arm surgery, attending at Zagazig University Hospital, Egypt.

Ethical Consideration:

This study was ethically approved by the Research Ethics Committee of Zagazig University Hospital. All included participants gave a written well-informed consent before being in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Patients were enrolled and randomized into one of four groups, 20 each:

- **Group (I):** Supraclavicular block (SC BPB) performed using Ultrasound.
- **Group (II):** Supraclavicular block (SC BPB) performed using ultrasound together with nerve stimulator.
- **Group (III):** Infraclavicular block (IC BPB) performed using Ultrasound.
- **Group (IV):** Infraclavicular block (IC BPB) performed using ultrasound together with nerve stimulator.

Inclusion Criteria: The study involved 80 adult patients of both sexes, aged between 20 and 60 years, and with ASA I and II physical status.

Exclusion Criteria: Patients under the age of 20 or above the age of 60, severe form of chronic restrictive or obstructive lung diseases, skin infection in injection's site, local anesthetics's allergy, sensory or motor deficit in the operated upper limb, Or patient's refusal.

Withdrawal cases:

Six patients were discounted due to the block's failure. Block failure was stated as a partial or absent nerve block in more than one nerve territory, the block was not repeated, and these patients received GA.

Three patients were not sticking to inclusive criteria due to a local skin infection, and below 20 years. Seven

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patients changed their minds on arrival to OT, despite giving the consent for the block in the ward.

In all groups the block was performed using a 22-gauge 50-mm Teflon-coated insulated needle (Pajunk, Geisingen, Germany). Patients lay supine with the head rotated to the non-operative side. ECG, pulse oximetry, and blood pressure monitoring were regularly used.

Under complete aseptic circumstances, a high-frequency linear array transducer (13e6 MHz, my lab one, SL3235 apple probe Vascular, Anesthesiology Wideband Linear Array) was used. A frequency of 10–13 Hz was used. In the groups using ultrasound with a nerve stimulator; only distal motor response was accepted with a 1-Hz 0. 1-ms stimulation current between 0. 2 mA and 0. 5 mA. The local anesthetic solution consisted of 1:1 volume of 0. 5% bupivacaine and 2% lidocaine with 1:200.000 adrenaline was used in all groups, in a dose of 0. 5 ml/kg to maximal 40 ml. Local anesthetic solution was administered gradually with 5 ml each time and aspiration done before each injection. Mostly premedication was avoided to keep the patient's full collaboration during block's performance. Midazolam was offered as required to anxious patients. Sedation score was evaluated according to the modified Ramsay Sedation scale, the patient was kept around grade 2.

For the performance of the supraclavicular block, the probe was placed in the transverse plane posterior to clavicular's midpoint, pointing caudally and moved in lateral and medial directions to get a short-axis view of the subclavian artery and the brachial plexus. Color Doppler was used to confirm the subclavian artery position. The first rib was detected inferior to the artery, and the pleura was validated by its characteristic sliding movement during respiration. The plexus with a ''honeycomb'' appearance was found mostly lateral and superficial to the subclavian artery and above the first rib.

After subcutaneous infiltration of the skin with lidocaine 1%, the needle was inserted using in-plane approach in the direction from lateral to medial, until the needle tip reached the junction of the first rib and subclavian artery (the corner pocket), 50% of the local anesthetic was injected at this point, then the needle was withdrawn and directed to a point superior and less than 1 cm lateral to the subclavian artery where the remaining 50% was injected. If any patient has sensation of electric shock in the arm or if the needle touches the first rib, the needle was withdrawn and repositioned. For the USNS group, nerve stimulation (0.5 mA, 0.1 msec) coupled with a motor response of the arm, forearm, or hand usually obtained before local anesthetics' injection.

The performance of Infraclavicular block was done while patients were lying supine with head faced the contralateral side. In a parasagittal plane, the probe was sited medial to the coracoid process below the clavicle. Then probe was moved to obtain the optimum image of the middle third of the axillary artery and the brachial plexus's cords which are hyperechoic and recognize their relation to the axillary artery, typically at a depth of 3–5 cm.

Using in plane approach, the needle was advanced caudally and posteriorly with the bevel facing dorsally to a location posterior to the axillary artery. Firstly, injection of 50% of the local anesthetic was done just posterior to the axillary artery. The other 50% was injected in a U-shaped pattern posterior and to either side of the axillary artery.

In USNS group, injection of local anesthetic was done after achieving a distal motor response (hand or finger movement).

The Measured parameters were:

- Demographic values: age, sex, body mass index (BMI, kg/m^2), operation time.
- The scanning time: the time starting from placing the probe on the skin until a clear image was gained.
- Block performance time: the time between the first needle insertion and its removal after finishing the block.
- The onset time: the time from the needle's withdrawal till full motor and sensory loss.
- Block performance-related pain was assessed by asking the patient to enumerate the level of pain vocally passing through a Visual Analogue Score (VAS) score from 0 to 10; with 0 means no pain while 10 means agonizing pain.
- Evaluation of sensory and motor block in the median, ulnar, musculocutaneous, and radial nerve territories after 30-min of the withdrawn of the needle.
- Sensory block was evaluated by judging the cold sensation sparked by ice in each nerve's sensory area against the cold sensation by the identical stimulus applied to the contralateral side. The block of median nerve was assessed on the skin of the palmar edge of the lateral three digits. Confirmation of the ulnar nerve's block was done by examining the skin of medial side of the wrist and the medial one digit. Review the lateral side of the forearm's skin was used to ensure the Musculo-cutaneous nerve block. The radial nerve block was approved by testing the posterior region of the forearm's skin.

The sensory block was sorted as follows: 0 = same degree of sensation as the unblocked limb, 1 = less cold than the unblocked limb, 2= total loss of cold sensation. Motor block was tested for the musculocutaneous nerve using elbow flexion, the radial nerve using thumb abduction or wrist extension, thumb opposition for the median nerve, and thumb adduction for the ulnar nerve. The motor block was graded as follows: 0 = maintain same power, 1= decreased power judged against the unblocked extremity, 2= inability to defeat gravity.

- The complications, such as hematomas, numbness, LAST, dyspnea, Horner's syndrome, and pneumothorax, were reported.

Surgeons, nurses from recovery room or ward, the statistics's person were blind to the technique used.

At 12 and 24 after surgery, we visited the patients in the ward to record any complications. Home discharge occurred at the next morning.

The outcomes were divided into a block related and pain related outcomes. Block-related outcomes included scanning time, block performance time, the onset time and the incident of complication. Pain-related outcomes

represented by pain score during block performance (VAS score). A chest X-ray was obtained before shifting the patient to the ward. If a patient suffered from any respiratory discomfort or signs of pneumothorax, a chest radiograph was repeated immediately.

Statistical Analysis

The collected data was organized, tabulated, and statistically analyzed using SPSS software statistical computer package version 22 (SPSS Inc, USA). Quantitative data was described as mean and standard deviation. Difference between study groups regarding quantitative variables was tested using one–way ANOVA followed by Tukey test as a post hoc test. For qualitative data, the number and percent distribution were calculated, chi square (χ^2) was used as a test of significance. For interpretation of results of tests of significance, significance was adopted at $P < 0.05$.

RESULTS

Study was conducted on 80 adult patients male and female, aged between 20 to 60 years, and with ASA physical status I and II. (**Figure 1)** showed Flow Chart of the Study Population. There were no significant different in the onset time between SC groups and IC groups (P<0. 0001) although infraclavicular has relatively shorter time of onset than supraclavicular, (22. 9 and 23. 8) min for IC groups and (24. 8 and 26. 8) min for SC groups ultrasound guided and ultrasound with nerve stimulator respectively but not significantly different (**Table 1**).

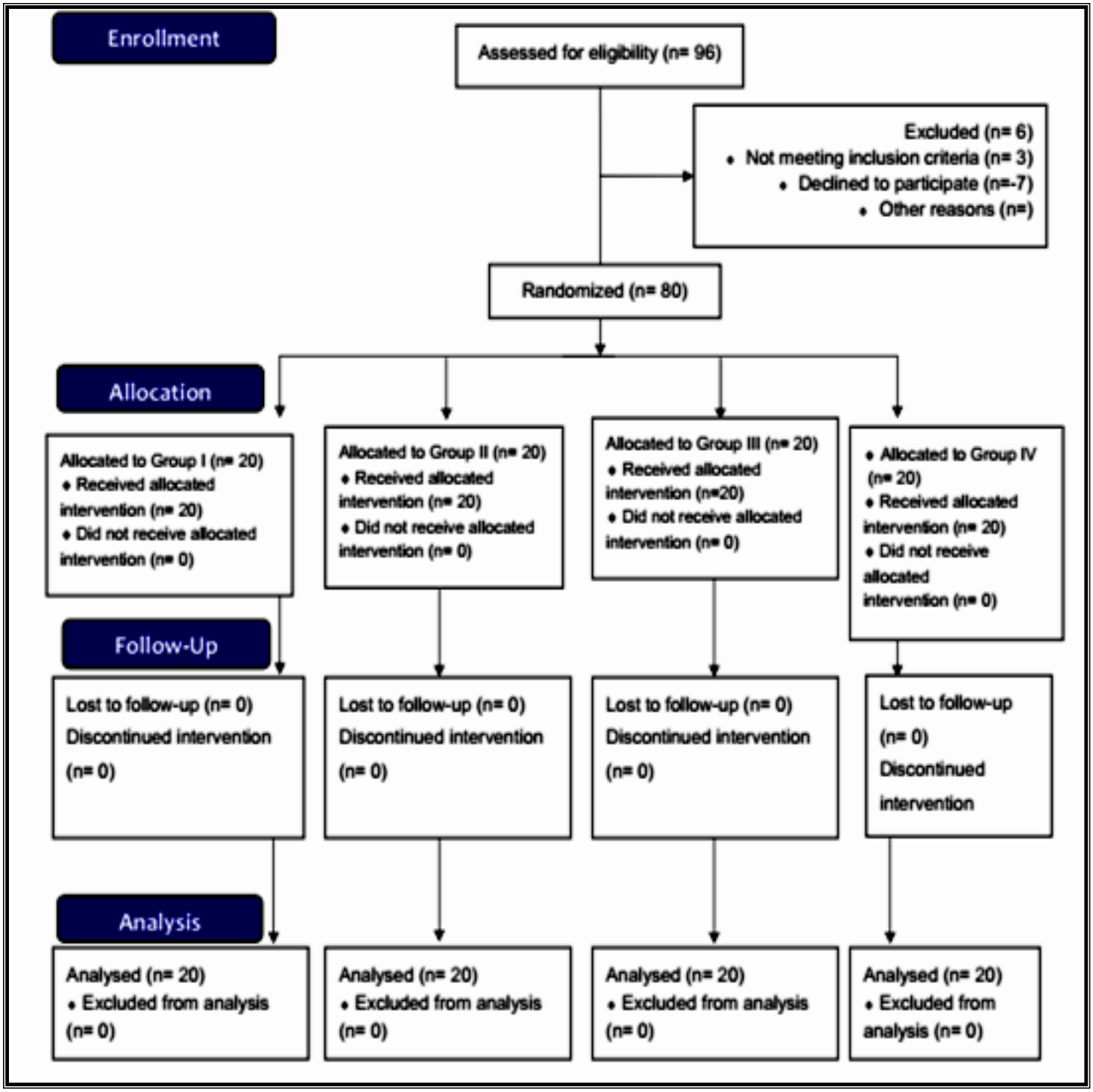

Figure (1): Flow Chart of the Study Population.

Table (1): The block onset time

Variable	Supraclavicular US (N=20)	Supraclavicular US/NS (N=20)	Infraclavicular US (N=20)	Infraclavicular US/NS (N=20)	P-value#
	Mean± SD	Mean± SD	Mean± SD	Mean± SD	
Onset (min)	24.8±3. 1	26. 8±2. 1	22.9±3. 2	23. 8±2. 8	-1 vs. 2 <0. 0001 (S). -2 vs. 3 0. 007 (S).

 # One way ANOVA

Our study showed longer performance time for groups of USNS for IC and SC, (9. 7±1. 72 and 10. 4 ±1. 52) min respectively than groups of US alone (9. 5±1. 45 and 10±1. 46) min but without significant differences (**Table 2**).

Table (2): The block performance time and scanning time in minutes.

	Supraclavicular US (N=20)	Supraclavicular US/NS (N=20)	Infraclavicular US (N=20)	Infraclavicular US/NS (N=20)	P-value#
	Mean± SD	Mean± SD	Mean± SD	Mean± SD	
Scanning time(min)	6. 4±3. 3	6.6±2. 7	6. 7±2. 7	7±2. 7	0. 94 (NS)
time of performance(min)	11.2±2. 9	11. 7±3. 3	11. 7±3	11. 9±3. 5	0. 913 (NS)

 # One way ANOVA

Pain during injection was slightly more with USNS groups SC and IC (2. 3 ± 1. 1 and 2. 6 ±1. 1) vs. (1. 9 ± 0. 8 and 2. 1 ± 1. 1) than US alone groups this may be explained by discomfort experience of the electrical stimulation. As regard terminal branches block , partial radial spare occurred in 2 of our patient in IC groups (US and USNS) one in each group but there were no significant different with SC groups . It was compensated by local anesthetic infiltration as required. Although the difference between groups in the block quality in the terminals braches had no significant difference. Still, radial incomplete block was seen with the infraclavicular technique and not with the supraclavicular technique **(Table 3).**

Table (3): The terminal branches block between groups

	Supraclavicular US (N=20)		Supraclavicular US/NS (N=20)		Infraclavicular US (N=20)		Infraclavicular US/NS (N=20)		P-value#
	N	%	N	%	N	%	N	%	
nerve block test									
Radial N block	20	100%	20	100. 0%	19	95. 0%	19	95. 0%	
Ulnar N block	20	100%	20	100%	20	100%	20	100%	0. 562
Median N block	20	100%	20	100%	20	100%	20	100%	(NS).
Musculocutaneous N block	20	100%	20	100%	20	100%	20	100%	

 # One way ANOVA

We didn't get any local hematoma or accidental intravascular injection in our patients. One of our patients in the ultrasound guided supraclavicular group developed pneumothorax. One patient in supraclavicular USNS and one in infraclavicular USNS group developed numbness spontaneously resolved within 24 hrs. After one week, the follow up visit didn't report any dysesthesia or weakness in the limb operated. Our study showed no significant different between groups as regard complications **(Table 4).**

Table (4): The complication between groups

	Supraclavicular US (N=20).		Supraclavicular US/NS (N=20).		Infraclavicular US (N=20).		Infraclavicular US/NS (N=20).		P-value#
	N	%	N	%	N	%	N	%	
Complications									
No	19	95. 0%	19	95. 0%	20	100%	19	95. 0%	0. 792 (NS)
Yes	1	5. 0%	1	5. 0%	0	0. 0%	1	5. 0%	0.386 (NS)
minimal pneumothorax	1	5. 0%	0	0. 0%	0	0. 0%	0	0. 0%	0.562 (NS)
numbness	0	0. 0%	1	5. 0%	0	0. 0%	1	5. 0%	
ptosis	0	0. 0%	0	0. 0%	0	0. 0%	0	0. 0%	

DISCUSSION

Multiple previous studies comparing SC BPB and IC BPB ultrasound guided found that there were no significant differences in performance time [4-6]. **Arcand *et al.*** [7] study recorded that although ultrasonic visualization in the infraclavicular block was more rapid than in the supraclavicular region, both blocks had same block performance times, same result was reported by other studies (8-9-10). Our result showed the performance time was longer for IC BPB groups (11.7±3 and 11.9±3.5) min VS (11.2±2.9 and 11.7±3.3) min for supraclavicular groups with no significant difference; this may be due to more experience by performers for SC BPB than IC BPB in our institute.

Our study concluded similar result as previous studies [5,6] that showed no significant different in the onset time of ultrasound supraclavicular VS ultrasound infraclavicular. Although in our study infraclavicular has relatively shorter time of onset than supraclavicular (22. 9 and 23. 8) min for IC groups and (24. 8 and 26. 8) min for SC groups ultrasound guided and ultrasound with nerve stimulator respectively but not significantly. In opposite to our results a study by **Koscielniak *et al.*** [8] who stated that infraclavicular block had a faster onset.

In study of **Elsawy *et al.*** [9] compared SC BPB and IC BPB, the results showed that statistically, no significant differences in the sensory or the motor block grades between the two groups. Studies of **Arcand *et al.*** [7] and **Park *et al.*** [6] showed a better block quality in the supraclavicular group than in the infraclavicular group due to radial sparing in the infraclavicular group. Their explanation to these results was the deepest position of the radial nerve which made it more difficult to be blocked. Our results match results of other studies [6,7] showed partial radial spare as we have incomplete radial block occurred in 2 of our patients in IC groups (US and USNS) one in each group but there were no significant different with SC groups. It was compensated by local anesthetic infiltration as required. Although difference between groups had no significant difference, still radial incomplete block was seen with the infraclavicular technique and not with the supraclavicular technique.

Different result from our study was found by **Koscielniak *et al.*** [8] who got better motor block with infraclavicular approach, he explained his result by the lesser experience with the supraclavicular approach in their institute. Another study by **Fredrickson *et al.*** [10] stated that incomplete ulnar nerve was more frequently in the supraclavicular group than in the infraclavicular group, but we didn't got ulnar spare in our patients.

Concerning the block related pain; this study found no statics difference between the groups concerning the discomfort feeling during the block's performance, similar results was found by many previous studies [4, 5, 8, 11].

Many other Studies [4, 12-17] demonstrated that using the ultrasound reduces the frequency of vascular injury, local anesthetic systemic toxicity, pneumothorax, and phrenic nerve block.

In our study, only one patient in the US-guided supraclavicular block group developed minimal pneumothorax. The patient complained of mild chest pain 2 hours after shifting to the ward postoperatively. Immediate x-ray chest was done showed minimal pneumothorax. The patient did not need a chest tube but was kept for observation for 72 hours then discharged home unevenly. No other patient had pneumothorax in the whole four groups.

Ultrasound guided block versus dual ultrasound guidance with nerve stimulation: In **previous** studies [14, 18--24] results showed that USNS guidance had a longer performance time than US alone in both upper or lower limb nerve blocks.

Bayar *et al.* [24] findings showed performance times for Group US and Group USNS with no significant differences between groups; this study is consistent with our study, which showed longer performance time for groups of USNS for IC and SC, respectively (9. 7±1. 72 and 10. 4 ±1. 52) min than groups of US alone (9. 5±1. 45 and 10±1. 46) min but without significant differences.

In this study, onset time of the groups of USNS (22. 9 ±2. 1 and 23. 8±2. 8) min were shorter than that with groups of US alone (24. 8±3. 2 and 26. 8±3. 1) min but without significant different consistent with the result of many other studies (18-20-24-25-26)

Patients' satisfaction during injection was acceptable in our four groups. Pain during injection was slightly more with USNS groups SC and IC (2. 3 ± 1. 1 and 2. 6 ±1. 1) vs. (1. 9 ± 0. 8 and 2. 1 ± 1. 1) for US alone groups these results matches other studies (18-20-24-25-26). These findings may be explained by discomfort experience of the electrical stimulation.

In **Bomberg *et al.* [(25)]** study, the combination of ultrasound with nerve stimulation showed a lower rate of unintentional paresthesia than ultrasound alone, without differing significantly. **Zhang *et al.* [(26)]** concluded higher incidence of LAST using ultrasound alone comparing with dual guidance in lower limb blocks. In other hand, **Zhu *et al.* [(27)]** showed increase vascular puncture significantly in USNS group again ultrasound alone. Our study showed no significant different between groups as regard complications

Limitations of the study: The degree of experience of the performer may play a rule in increasing the performance time. Our results should be interpreted cautiously due to the small sample size. While using neurostimulation in the block at the cord level, achieving motor responses distally may be difficult.

CONCLUSION

It could be concluded that the supraclavicular nerve block showed no significant difference from infraclavicular ultrasound-guided with or without nerve stimulator. It remains controversial whether the adding of the nerve stimulation to the ultrasound is more beneficial in ensuring rapid onset, longer duration of action, and avoiding complications.

Conflicts of interest: No conflicts of interest were recorded.

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