



AN ASSESSMENT BETWEEN ULTRASOUND AND NEUROSTIMULATION GUIDED AXILLARY BRACHIAL PLEXUS BLOCK IN A TERTIARY CARE TEACHING INSTITUTE

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ABSTRACT **BACKGROUND AND OBJECTIVES:** Ultrasound in Regional Blocks is increasingly more frequent. Very few studies comparing ultrasound and neurostimulation have been conducted. The objective of this study was to compare neurostimulation-guided axillary brachial plexus block with double injection and ultrasound-guided axillary plexus block for hand surgeries. The time to perform the technique, success rate, and complications were compared.
METHODS: After approval by the Ethics on Research Committee 40 patients scheduled for elective Forearm surgeries under axillary plexus block were selected. Patients were randomly divided into two groups with 20 patients each: Neurostimulation (NE) and Ultrasound (US) groups. The time to perform the technique, success rate, and complication rate were compared.
RESULTS: Complete blockade, partial failure, and total failure rates did not show statistically significant differences between the US and NE groups. The mean time to perform the technique in the US group (354 seconds) was not statistically different than that of the NE group (381 seconds). Patients in the NE group had a higher incidence of vascular punctures (40%) when compared with those in the US group (10%, $p < 0.05$). The rate of paresthesia during the blockade was similar in both groups (15%).
CONCLUSIONS: The success rate and time to perform the blockade were similar in ultrasound- and neurostimulation-guided axillary plexus block for hand surgeries.

KEYWORDS : Axillary Plexus Block , Neurostimulator, Ultrasound.

INTRODUCTION

Axillary plexus block is one of the most popular techniques in upper limb surgeries. Different methods can be used to identify the branches of the brachial plexus: loss of resistance, transarterial injection, presence of paresthesia, neurostimulation, and ultrasound^{1,2}. Neurostimulation is the technique used more often in peripheral nerve blocks. Surgeries in areas of the forearms and hands that are not innervated by the musculocutaneous nerve can be successfully done under axillary brachial plexus block with double stimuli and double injection³.

The use of the ultrasound to guide regional blocks is becoming increasingly popular^{4,5}. It allows the anatomical evaluation of the region before the blockade to correctly identify the structures of the brachial plexus^{6,7}. This can avoid lesions of the blood vessels and pleura, and the local anesthetic can be deposited around the nerves under real time direct visualization⁸.

A systematic review compared the use of the ultrasound with neurostimulation in peripheral nerve blocks and it concluded that the ultrasound was associated with a lower risk of failure of the blockade, reduced the time to perform the technique and the latency, and it increased the duration of the blockade. Besides, the use of the ultrasound also decreased the risk of vascular puncture⁹.

A systematic qualitative review concluded that there is not enough evidence that the use of the ultrasound increases the success rate of regional blocks when compared to other techniques because of the limited number of studies in the literature¹⁰. The same authors concluded that randomized controlled studies and series of cases should be encouraged to allow future comparison¹⁰.

Three variables have been identified as relevant when comparing ultrasound and neurostimulation in peripheral nerve blocks: time to perform the procedure, success rate, and complications¹³. The objective of the present study was to compare those three variables in neurostimulation with double injection and ultrasound-guided axillary brachial plexus block for hand surgeries.

METHODOLOGY

After approval by the Ethics on Research Committee 40 patients scheduled for elective hand surgeries under axillary brachial plexus block were selected. To participate in the study, patients agreed to sign an informed consent.

Inclusion criteria were as follows: ages between 18 and 65 years, physical status (ASA) I or II, and body mass index (BMI) ≤ 40 . Exclusion criteria included: absolute contraindication of regional block, diabetes mellitus, or any other neurological disorder of the upper extremity.

Chan et al.¹² reported a success rate of 62.5% in neurostimulation-guided axillary plexus block. Success rates of ultrasound-guided peripheral nerve blocks range from 95 to 100%. To calculate the size of the study population, the hypothesis of the present study was that ultrasound increased to at least 95% the success rate of axillary brachial plexus block. Assuming a probability of a type I error of 5% and type II error of 20%, 18 patients in each group would be necessary for one-tailed comparisons and 23 for two-tailed comparisons.

Patients were divided into two groups according to randomly numbers generated electronically: in the NE group (n = 20) neurostimulation was used to identify the terminal branches of the brachial plexus, and in the US group (n = 20) the ultrasound was used. All patients were monitored with pulse oximeter, non-invasive blood pressure, and electrocardiogram. A 20G Teflon catheter was used for venipuncture, NS was infused, and Midazolam (1 to 3 mg) was administered 3 to 5 minutes before the blockade.

In the NE group, a 5 cm long 22G electrically isolated needle (Stimuplex[®], B-Braun, Germany) guided by a neurostimulator (Stimuplex Dig[®], B-Braun, Germany) was used for the axillary brachial plexus block. The arm was abducted 90° in relation to the trunk, and the forearm was flexed 90° in relation to the arm. The motor response of the hand corresponding to the territories of the motor innervation of two terminal nerves of the brachial plexus (median + ulnar, median + radial, or ulnar + radial) to a current lower than 0.5 mA and greater than 0.2 mA was considered an adequate response. Extension of the fingers or wrist was considered an adequate response for the radial nerve; flexion of the wrist or of the second and third fingers was considered an adequate response for the median nerve; and for the ulnar nerve, flexion of the fourth and fifth fingers or adduction of the thumb was considered an adequate response.

In the US group, patients underwent ultrasound-guided axillary nerve block with a 4 cm linear transducer with a frequency of 5 to 10 MHz (SonoAce 8000 SE[®], Medison, South Korea) and a 5 cm, 22G electrically isolated needle (Stimuplex[®], B-Braun, Germany). For the blockade, the arm was placed in 90° abduction in relation to the trunk,

and the forearm was flexed 90° in relation to the arm. After the identification of the median, ulnar, and radial nerves, along with the biceps and triceps muscles, and axillary artery and vein, the needle was introduced longitudinally to the transducer and the local anesthetic solution was injected around each of the terminal branches of the brachial plexus (median, ulnar, and radial).

In all patients, 0.5% ropivacaine was the local anesthetic used. It has been demonstrated that 40 mL is the volume of local anesthetic associated with greater dispersion in the axillary sheath and greater success rate in axillary brachial plexus block¹⁴, and, therefore, this was the volume used in the present study. In the NE group, 20 mL of the solution were injected on the first nerve and 20 mL on the second, for a total of 40 mL. In the US group, 20 mL of the anesthetic solution were injected in the region of the radial nerve, 10 mL in the region of the ulnar nerve, and 10 mL in the region of the median nerve, for a total of 40 mL.

The time necessary to perform the blockade was recorded. In the NE group, the time was counted from the palpation of the axillary artery on, and in the US group from the time the transducer was placed on the skin. Complications, such as vascular puncture, pain with the injection, and paresthesia were recorded.

The surgery started 30 minutes after the blockade, just after the lack of sensitivity to pin prick at the site of the incision was confirmed. Afterwards, all patients were sedated with target-controlled infusion of propofol (Diprifusor, AstraZeneca, Sweden) with an initial target-controlled concentration in the effector compartment of 1 to 1.5 ng/mL. Patients remained somnolent, but easily aroused during the procedure. Changes were made in the target-concentration of propofol to guarantee this level of sedation¹⁵. The blockade was considered complete when opioid supplementation was not necessary to complete the surgery, partial failure when 50 to 100 µg of fentanyl were necessary to guarantee analgesia, and total failure when general anesthesia was necessary⁹. The Student t test for independent samples was used to compare continuous parameters between both groups. The Chi-square test was used to compare categorical parameters between both groups. A $p < 0.05$ was considered significant.

RESULTS

The demographic data was similar in both groups. The rate of complete and partial blockades and total failure, as well as the time to perform the blockade did not show statistically significant differences between the groups.

The frequency of vascular puncture was greater in the NE group (40%) than in the US group (10%) ($p < 0.05$). The incidence of paresthesias did not differ.

In the present study, we compared neurostimulation-guided axillary brachial plexus block with double stimuli with the ultrasound-guided technique for hand surgeries. This approach did not allow to evaluate the rate of musculocutaneous nerve block, which has a high failure rate in neurostimulation guided axillary brachial plexus block with double stimuli³.

DISCUSSION

The use of ultrasound to guide regional blocks has been increasing over the past few years⁴. Besides the evaluation of the anatomy before the blockade, its use allows depositing the local anesthetic around the nerves and avoiding damaging blood vessels, pleura, and muscles^{4,5}.

Despite those advantages, very few studies comparing this technique with neurostimulation-guided peripheral nerve blocks, currently the standard technique to locate nerves in regional peripheral blocks, are found in the literature^{9,10}.

Three nerves are involved in the innervation of the hands: the median, ulnar, and radial nerves. The success rate of the axillary brachial plexus block with double stimuli is similar to that of three or four stimuli in hand surgeries³, which is associated with a lower complication rate.

Chan et al.¹², using 42 mL of a standard solution, compared the ultrasound-guided to the neurostimulation-guided axillary brachial plexus block with three stimuli for hand surgeries and found a higher success rate and smaller time to perform the technique in the ultrasound group.

The results of the present study were different. The success rate and the time to perform the technique did not differ between the study groups. However, different methods were used to evaluate the success rate in both studies. In the present study, surgical anesthesia was the parameter for a successful block while in the study of Chan et al. the lack of skin sensitivity to pin prick and loss of muscle strength in the territory of the three terminal branches of the brachial plexus were the criteria used. Besides, Chan et al. used the three-stimulus technique, which might explain the longer time necessary to perform the technique.

In the study of Chan et al., intravascular injection, evaluated by the presence or absence of systemic complications, was not seen in the study groups. In the present study, we evaluated the rate of vascular puncture during the procedure, which was greater in the NE group.

Casati et al.¹¹ compared ultrasound-guided with neurostimulation-guided axillary brachial plexus block with multiple stimuli in upper limb surgeries and found similar success rates for both techniques, similar to the results of the present study. However, the authors did not evaluate the time of the blockade or the rate of vascular puncture and paresthesia.

CONCLUSION:

We concluded that the success rate and time to perform the procedure are similar in ultrasound-guided and neurostimulation-guided axillary plexus block with double stimuli for hand surgeries. However, ultrasound-guided nerve blocks were associated with a lower incidence of vascular punctures.

ACKNOWLEDGEMENTS

We would like to thank Professor & Head, Dept. of Anesthesiology, for his always available guidance to us.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Ethics Committee

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