

COMPARISON OF AXILLARY BRACHIAL PLEXUS BLOCK- ULTRASOUND GUIDED VS PERIPHERAL NERVE STIMULATOR USING 0.25 % BUPIVACAINE

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Received : 09/01/2023
 Received in revised form : 03/02/2023
 Accepted : 14/02/2023

Keywords:

Anaesthesia; Brachial plexus block; Bupivacaine; Peripheral nerve stimulator; Ultrasonography.

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DOI: 10.47009/jamp.2023.5.2.149

Source of Support: Nil,

Conflict of Interest: None declared

Int J Acad Med Pharm
 2023; 5 (2); 708-712



Abstract

Background: The brachial plexus blockade is an efficient means of administering anaesthesia to the upper limb from the shoulder to the fingertips. Success rates and safety margins of such surgeries have been enhanced by the use of ultrasound sonography guidance and peripheral nerve stimulators. The purpose of this research was to compare the effectiveness and safety of brachial plexus nerve blocks performed under the guidance of a nerve locator with those performed under ultrasound (US) guidance. **Materials and Methods:** A total of 60 patients were recruited on the basis of eligibility criteria for this study purpose and were randomly divided into two groups of 30 each. Group U and P received 40 ml of 0.25% bupivacaine using an ultrasound guided technique and a peripheral nerve stimulator, respectively. Time taken to perform block, onset of block (motor and sensory), time to achieve complete block and duration of block along with various hemodynamic parameters were recorded. **Result:** On comparison, the difference in the mean executing time and onset of the block in both the groups was statistically non-significant, whereas the difference in the meantime taken to complete the block and the duration of the block in both the groups were statistically significant, with better results in group U. Also, in group P, out of 30 patients, 3 of them required rescue analgesia for the surgery to be continued, out of which 2 were considered failed blocks, and on the other hand, none of the subjects in group U needed rescue analgesia. **Conclusion:** Our study demonstrates that ultrasound guided axillary brachial plexus block is more effective than the peripheral nerve stimulator technique using 0.25% bupivacaine.

INTRODUCTION

Brachial plexus block is a common anaesthetic method for upper limb surgeries. Upper extremity surgery frequently makes use of axillary brachial plexus anaesthesia.^[1] Axillary brachial plexus block with numerous injections of nerve stimulation has been shown to be more successful than either double or single injection in providing anaesthesia for nerve localization.^[2] These approaches allow a precise needle placement and accurate monitoring of the distribution of local anaesthetic, which improves the quality of nerve block and reduces the amount of anaesthetic necessary for a successful nerve block, as well as shortening the time it takes for a nerve block.^[3,4] Researchers found that ultrasonography (USG) provided better onset and completion of sensory and motor blocks than an immobile needle single injection procedure with nerve simulator when testing it for interscalene and axillary brachial plexus

blocks.^[5] The overall success rate of axillary block with ultrasound guidance is significantly higher than the success rate using a peripheral nerve stimulator.^[6] Bupivacaine is used for local infiltration, peripheral nerve blocks, sympathetic nerve blocks, and epidural and caudal blockades as it belongs to the amino-amide category of local anaesthetics.^[7,8] It is injected into the affected area, into the epidural space of the spinal canal, or around a nerve that supplies the area. Analgesic bupivacaine limits sodium input into nerve cells by binding to intracellular portions of voltage-gated sodium channels, which stops nerve cells from depolarizing. Without depolarization, there is no initiation or transmission of pain signals.^[9]

Thus, the aim of the present research investigation was to compare axillary brachial plexus block - ultrasound guided versus peripheral nerve stimulator using 0.25% bupivacaine. We attempted to assess accuracy and reliability of peripheral nerve stimulator guided peripheral nerve block versus USG guided peripheral nerve block of upper limb using

0.25% bupivacaine along with any possibility of side effects.

MATERIALS AND METHODS

Study Design

The present prospective randomized case-controlled study was executed in the Department of Anesthesiology at the School of Medicine and Hospital, D. Y. Patil Deemed to be University, Navi Mumbai. The study was approved by Institutional Ethic Committee of the University and Departmental Review Board (PDDYPMC/ Ethics/PG Dissert/ 2015; Dated 28-10-2015). A valid informed written consent was obtained from each participant who met the eligibility criteria. Patients and their relatives were given all the details of the study before signing the informed consent. A detailed history of the patients was recorded and relevant examinations and investigations as per the case record form was performed.

Subject Size and Eligibility Criteria

60 patients who are scheduled to undergo upper limb surgeries under general anesthesia were selected as study population. As per the inclusion criteria, all subjects in the age group of 18 – 60 years, either sex with indication for brachial plexus block (anesthesia and analgesia) for elective upper limb (fore arm and hand) surgeries lasting less than 2 hours and with ASA physical status I or II according to the American Society of Anesthesiologists were enrolled in the study. Any non-consenting patients or pregnant and lactating women or hemodynamically compromised subjects or emergency cases or patients with associated uncontrolled systemic diseases and ASA physical status class III and IV or patients with basal pulse rate <55 beats/min or subjects with having difficult stature and in whom bony and muscular landmarks were not visible or patients with peripheral neuropathies, clinically significant coagulopathy, infection at the injection site, history of allergy to local anesthetics, severe cardiopulmonary disease, body mass index >35 kg/m², diabetes mellitus or any case involving surgical procedures for upper arm and shoulder were excluded from the study.

Preparation of Drugs and Study Procedure

Bupivacaine was prepared by diluting 20 ml of 0.5 % bupivacaine upto 40 ml with normal saline to yield 40 ml of 0.25 % bupivacaine.

Sixty (60) patients were divided at random into two groups using a computer-generated sequence of random numbers and received the drugs as follows:

Group U (n = 30): 40 ml of 0.25% bupivacaine using ultrasound guided technique –10ml per nerve.

Group P (n = 30): 40 ml of 0.25% bupivacaine using peripheral nerve stimulator – 10 ml per nerve.

On arrival of all the patients in the operation theatre, ECG, heart rate (HR), respiratory rate (RR), SpO₂ and non-invasive recording of systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial blood pressure (MAP) and preoperative baseline

parameters were recorded. After establishment of intravenous line, ringer lactate solution was given at 4ml/kg/hr. Patient were oxygenated with nasal prongs throughout the procedure and pre-induction heart rate, non-invasive blood pressure, SPO₂ and ECG monitoring was performed. Patients were given with 0.2 mg IV Glycopyrrolate, 4 mg IV Ondansetron and 1mg IV Midazolam

Peripheral Nerve Stimulation

After thorough skin preparation, the pulse of the axillary artery was palpated high in the axilla. Once pulse was felt, artery was fixed between the index and middle fingers and firmly pressed against the humerus. The index and middle fingers of the palpating hand was pressed firmly against the arm, straddling the pulse of the axillary artery immediately distal to the insertion of the pectoralis major muscle. Local anesthetic was infiltrated subcutaneously at the determined needle insertion site. Axillary brachial plexus blocks were also accomplished using multiple injections after electro location of each nerve. A needle connected to the nerve stimulator (0.5-1.0 mA, 2 Hz, 0.1-0.3 ms) was inserted at an angle of 45° cephalad. Once through the skin, the needle was slowly advanced directly below the pulse until stimulation of the brachial plexus was obtained. After eliciting appropriate twitches of the nerves, 10 ml of 0.25 % bupivacaine was infiltrated around each nerve after negative aspiration.

Ultrasound Guided Block

With the patient in proper position, the skin was disinfected and the transducer was positioned in the short axis orientation to identify the axillary artery. Once the artery was identified, an attempt was made to identify the hyperechoic median, ulnar, and radial nerves. Local anesthetic was deposited posterior to the artery first. 10 ml of 0.25% bupivacaine was administered around radial nerve, the needle was withdrawn almost to the level of the skin, redirected toward the median and ulnar nerves, and a further 10 ml per nerve was injected in these areas to complete the circle around the artery. Finally, the needle was once again withdrawn to the biceps and redirected toward the musculocutaneous nerve. Once adjacent to the nerve, 10 ml of local anesthetic was deposited.

Sensory Block, Motor Block and Rescue Analgesia

Sensory block was assessed as loss of pinprick sensation in the central sensory region of each nerve with the same stimulus delivered to the contralateral side, and scored as normal sensation (no block), touch sensation (no pain-partial block) and total loss of sensation (complete block).

On the other hand, motor block was evaluated using forearm with wrist flexion/extension, thumb with second digit pinch, thumb with fifth digit pinch, and were scored as, no loss of force (no block), reduced force as compared with contralateral arm (partial block) and incapacity to overcome gravity (complete motor block). The 0th time for the onset of sensory and motor blocks was completion of local anesthetic injection. Time to readiness for surgery was

considered upon complete sensory block and complete motor block in at least three of the four nerves, with partial motor block in the fourth remaining nerve.

In case of pain, supplementary analgesia with 1 mcg/kg boluses of intravenous fentanyl was given. The need for more than 100 mcg fentanyl to complete surgery was considered as an insufficient block. Patients were then shifted to the recovery room and duration of motor and sensory block were monitored at regular intervals along with vital parameters.

Statistical Evaluation

The data presented in the figures and tables represent mean $\pm$ standard deviation (SD). All the statistical analysis was performed using Statistical Package for Social Sciences (SPSS), unpaired t test. The significance threshold of p value was set at <0.05 and p values less than that threshold were considered to be statistically significant.

RESULTS

A total of 60 patients were enrolled in the study and randomly divided into two groups, i.e., group U and group P, which received 40 ml of 0.25% bupivacaine using an ultrasound guided technique and a peripheral nerve stimulator (10 ml per nerve) respectively. Demographic data shows that group U had 16 (53.3%) male and 14 (46.6%) female subjects involved in the study, whereas group P had 18 (60%) male and 12 (40%) female patients (Table 1). The mean age did not differ much amongst the group and, upon comparison, was found to be statistically insignificant ($p = 0.855$). The mean weight and height of subjects enrolled in group U were found to be 58.43 ± 8.65 kg and 161.07 ± 6.97 cm, respectively. Likewise, the mean weight and height of subjects enrolled in group P were revealed to be 63.3 ± 10.16 kg and 163 ± 6.12 cm, respectively. Upon

comparison, the mean weight and height of the patients in both groups were found to be statistically non-significant [Table 1].

Furthermore, various other parameters were compared between both groups to achieve axillary brachial plexus block. The mean executing time of the block in group P was found to be slightly greater, i.e., 16.2 minutes in comparison to group U (15.9 mins), albeit the difference in the executing time between both the groups was found to be statistically insignificant ($p < 0.79$). The mean onset of sensory and motor blocks was also monitored in both groups. Following the previous trend, the mean onset of sensory and motor block was found to be non-significantly higher in group P patients when compared to group U subjects [Table 2]. Also, the time taken to attain a complete sensory block was revealed to be 7.4 ± 2.39 mins in group U as against 13.1 ± 5.62 mins in group P. This difference in the meantime taken to complete sensory block was found to be statistically significant ($p < 0.001$). Similarly, the time required to achieve a complete motor block was measured and found to be 10.7 ± 2.58 mins in group U and 17.2 ± 5.15 mins in group P. This difference was found to be statistically significant ($p < 0.01$) clearly indicating a better response in group U patients (Table 2). On the other hand, the total duration of sensory and motor block was found to be significantly higher in group U in comparison to group P, which reflects that ultrasound guided axillary brachial plexus block is more effective than the peripheral nerve stimulator technique using 0.25 % bupivacaine (Table 2). Out of 30 patients studied in group U, rescue analgesia for inadequate block or partial block was not needed in any patient. Also, in group P, out of 30 patients, 3 of them required rescue analgesia for the surgery to be continued, out of which 2 were considered failed blocks and were converted to general anaesthesia, while in group U, the success rate was 100% with no block failure.

Table 1: Demography of Patients.

Parameters	Group U	Group P	p value
No. of patients	30	30	
Gender			
Male, N (%)	16 (53.3%)	18 (60%)	
Female, N (%)	14 (46.6)	12 (40%)	
Mean age (years)	35.83 ± 12.60	35.3 ± 9.64	0.855
Mean weight (kgs)	58.43 ± 8.65	63.5 ± 10.16	0.42
Mean height (cm)	161.07 ± 6.97	163 ± 6.12	0.258

The data present in the table is expressed as Mean $\pm$ SD.

Table 2: Various parameters compared between both the groups to achieve axillary brachial plexus block.

Parameters	Group U	Group P	p value
Mean executing time of the block (mins)	15.9 ± 5.8	16.2 ± 2.12	0.79
Mean onset of sensory block (mins)	3.1 ± 1.84	4.1 ± 2.46	0.08
Mean onset of motor block (mins)	5.7 ± 3.49	6.9 ± 2.42	0.12
Time for complete sensory block (mins)	7.4 ± 2.39	13.1 ± 5.62	0.0001
Time for complete motor block (mins)	10.7 ± 2.58	17.2 ± 5.15	0.0001
Duration of sensory block (hours)	4.8 ± 1.23	3.5 ± 0.81	0.0001
Duration of motor block (hours)	5.1 ± 1.23	3.5 ± 0.62	0.0001
Rescue analgesia	0	3 (10%)	-

The data present in the table is expressed as Mean $\pm$ SD.

DISCUSSION

One of the most important components of a successful peripheral nerve block is being able to accurately identify the many nerves that will be impacted by the procedure and administer the appropriate amount of local anaesthesia to each one. Established methods of nerve localization were used based on either elicitation of paraesthesia or the appropriate nerve stimulation response. The paraesthesia and perivascular techniques for the axillary approach of brachial plexus block are not free from complications and failure. In the past few years, there has been a shift in established methods of nerve location from elicitation of paraesthesia to identification of the proper motor response to nerve stimulation. Both of these techniques have been reported to have low sensitivity for detecting needle to nerve contact.^[10] Ultrasound guidance introduced into clinical practise to identify peripheral nerves offers the potential benefit of optimising the spread of the local anaesthetic solution around the nerves under sonographic vision.^[3,4,11–13] The ultrasound imaging technique not only allows for an accurate needle position, but it also allows for real-time monitoring of the distribution of the local anaesthetic, which has the potential to improve the quality of the nerve block, shorten the latency of the block, and reduce the minimum volume required to obtain a successful nerve block.^[6,14–16] When compared to the peripheral nerve stimulation approach, the use of ultrasound guidance improves the onset and completeness of sensory and motor blocks,^[4,14] and has a higher overall success rate for axillary brachial plexus block.^[17]

In our study, the mean executing time of block, mean onset of sensory and motor block were found to be less in group U than in group P, albeit the differences between the groups were non-significant. Furthermore, the time required to complete sensory and motor blocks was significantly less in group U, which reflected the superior potential of the ultrasound guided method of axillary brachial plexus block. Schwemmer et al. stated that the ultrasonography application significantly increases the success rate of axillary blocks and that starting time of operation following the block is much earlier.^[18,19] Another study reported that sensory block started earlier in the ultrasonography-applied group, although this was not significant statistically. On the other hand, motor block rate in this group was significantly higher in comparison with the peripheral nerve stimulated group.^[20] Our results corroborate with previously published literature that mentions ultrasonography application can significantly reduce the starting time of sensory and motor block.^[5,21]

The total duration of sensory block in our study was found to be longer in group U than in group P. This indicates a longer duration of action of the block in the ultrasound group. Similar results are presented by

other researchers who found that the ultrasound group had a combined mean increase in block duration of 25% as compared with the nerve stimulated group.^[22] This could be ascribed to the more precise delivery of drugs closer to the brachial plexus. According to Liu et al., ultrasonography application provides more accomplished sensory and motor blocks.^[23] Soeding et al. also observed that the ultrasound technique significantly increased the block quality.^[5]

In our study, there was no evident adverse drug reaction or any complication witnessed during the procedure, therefore no subject withdrew from the study. Fanelli et al. reported a rate of 1.7% transient neurological complications using a multiple injection technique for peripheral nerve blockade.^[24] Liu et al also reported that, through ultrasonography they managed to provide a highly sufficient analgesia without any complications in sixteen axillary-block applied cases of final-stage renal failures.^[23]

CONCLUSION

Our study demonstrates that ultrasound guided axillary brachial plexus block is more effective than the peripheral nerve stimulator technique using 0.25% bupivacaine. Ultrasound guided axillary block significantly reduced the time taken for attaining complete sensory and motor blocks. It also significantly increased the duration of the block. Peripheral nerve stimulator technique of axillary brachial plexus block took longer time to perform, with significantly lesser duration of action of the block. There was no block failure with the ultrasound guided technique and the success rate was 100%.

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