

Research Article

A randomized prospective comparative study of nerve stimulator and ultrasonogram in popliteal sciatic nerve block for ankle and foot surgeries

Ramamoorthi Panneerselvam, Vijay Kanna*, Rajamanoharan Akkayan

Department of Anesthesiology, Chennai Medical College & Research Centre, Irungalur, Trichy, Tamil Nadu, India

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***Correspondence:**

Dr. Vijay Kanna,

E-mail: drvijaykanna@gmail.com

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ABSTRACT

Background: Regional blocks in the field of anaesthesia were done traditionally with paraesthesia technique. To overcome the demerits with paraesthesia technique, nerve locator was applied for nerve blocks. Later, the application of ultrasonogram for regional blocks got the real time imaging of the nerves and drug administration. This resulted in publications of numerous studies with variable results. Therefore we planned to compare ultrasonogram and nerve locator in popliteal sciatic nerve block in our population.

Methods: A prospective, randomized, observer blinded study was planned to compare the nerve stimulator (Group N) and ultrasound (Group U) on duration of 'block technique', number of needle reinsertions in popliteal sciatic nerve block for ankle and foot surgeries. We included all consented patients aged ≥ 18 years of both genders belonging to ASA I to III and excluded pregnant mothers, diabetes mellitus, neuropathy, chronic opioid use, positioning difficulty, coagulopathy, nerve block contraindications, local anaesthetic allergic patients.

Results: The duration of block technique in Group U = 262.00 ± 108.36 Seconds and Group N = 715.16 ± 234.66 Seconds with statistically significant P value = 0.0001. The average number of needle reinsertions in Group N = 6.05 ± 2.31 and Group U = 2.46 ± 1.11 with statistically significant p value of 0.0001. Therefore the time taken to perform the block and the number of needle reinsertions in Group U is shorter than the Group N.

Conclusion: The duration of block technique and number of needle reinsertions are better with ultrasound. Though the onset of motor and sensory blockade were better with ultrasound success rate is not significantly different.

Keywords: Regional anesthesia, Nerve blocks, Ultrasonogram, Motor blockade, Sensory blockade

INTRODUCTION

The nerve blocks were performed initially with paraesthesia elicitation which is a landmark based technique. This ensures definite proximity of the needle to the nerve and therefore a higher success of blockade. As paraesthesia is a subjective response, cooperation of the patient is definitely indicated. In addition, this technique causes neurovascular injury. The nerve damage may become permanent rarely. In order to decrease the

complications while maintaining the same success rate an objective response tool, nerve stimulator was invented. The introduction of nerve stimulator used objective response of muscular contraction for administration of drug to block the nerves. The needle displacement was minimal with nerve stimulator guided technique thus ensuring a better blockade than the paraesthesia guided technique. Since this is also a landmark based technique neurovascular injuries are possible and may lead to permanent nerve injury.

Working further on, the real time imaging radiological tool ultrasonogram was introduced. As this helped in direct visualization of nerves and vessels ultrasonogram gained importance over the earlier methods done with paraesthesia and peripheral nerve stimulator guidance. Though it is real time imaging tool the success of blockade and other parameters has to be studied in detail before employing it into the daily practice. The lack of availability of suitable instruments and their high cost are the causes for the delay in their usage in day to day practice till the last decade. Nowadays the technology has improved so much that the more economical and portable machines are available enabling to perform the regional nerve blocks with ultrasonogram guidance.

Customarily, the peripheral nerve blocks are done by either paraesthesia elicitation or under peripheral nerve stimulator guidance. The introduction of ultrasonogram has created a dilemma of identifying the better technique among ultrasound or peripheral nerve stimulator. As a result, wide number of studies are being published worldwide for upper limb blocks where the nerves are located superficially. But only fewer studies are available for lower limb blocks where the nerves are deeper. Therefore we planned to design a study comparing the ultrasound and nerve stimulator in posterior popliteal sciatic nerve block.

Aim

‘Comparison of the efficiency of ultrasound and nerve stimulator in posterior popliteal sciatic nerve block on the time taken to perform the block, number of needle reinsertions and success of blockade.’

METHODS

This is a prospective, randomized, observer blinded, study planned to compare the nerve stimulator and ultrasound on various parameters to identify the effectiveness of their use in posterior popliteal sciatic nerve blocks. The study was designed and ethical committee approval was obtained.

Inclusion criteria

All consented patients aged ± 18 years of both genders belonging to ASA I to III posted for ankle and foot surgeries.

Exclusion criteria

1. Pregnancy
2. Diabetes mellitus
3. Neuropathy
4. Chronic opioid use

5. Unable To Position
6. Coagulopathy
7. Contraindication to nerve block such as local infection, history of local anaesthetic allergy.

Anthropometry measurements

As the patients selected were lower limb surgery patients and immobile the anthropometric measurements were difficult. Hence a nomogram was used to calculate the body weight from the basic measurements like height, waist circumference, and hip circumference.

Sample size and randomization

The sample size was calculated to be 100 based on the pilot study.

They were randomly allocated to 50 in each group and named as Group U (ultrasound) and Group N (Nerve stimulator). The investigator prepared 100 lots numbered serially from 1-100. A coding sheet was also simultaneously prepared that allotted each number randomly to a group. The observer was allowed to take a lot and the selected number was marked in the proforma. Then the observer is blinded for the block being performed. The investigator performs the procedure and then the observer was allowed to make the readings. At the end of the study coding sheet was revealed.

Procedure

Description of procedural parameters

1. Duration of “Block technique”

GROUP U:

The interval of time between the probe placement for scanning to the removal of needle at the end of the block.

GROUP N:

The interval of time between the muscular landmark palpation to the removal of needle at the end of the block.

In both of the above groups if the duration of ‘block technique’ exceeds 30 minutes then patient is provided general/regional anaesthesia as suitable and excluded from the study.

2. Needle reinsertion

Needle reinsertion is done as any withdrawal of needle for a minimum of 10 mm followed by forward movement. The number of such reinsertions required to achieve the correct needle placement are recorded by an

assistant. If the number of needle reinsertions exceeds 20 then the technique is abandoned and converted to general/regional anaesthesia and excluded from the study.

Materials

GROUP N:

1. Sterile towels and 4"x4" gauze packs
2. Two 20-mL syringes with local anaesthetic
3. Sterile gloves, marking pen, and surface electrode
4. One 1½" 25-gauge needle for skin infiltration, povidone iodine.
5. Peripheral nerve stimulator used is IN-MED
6. The needle used is a stimulating, 10cm long, 21 G, shortbevelled, teflon-coated needle (Braun).37.

GROUP U:

1. Sterile towels and 4"x4" gauze packs.
2. Two 20-mL syringes with local anaesthetic.
3. Sterile gloves, marking pen.
4. One 1½" 25-gauge needle for skin infiltration.
5. A 38 mm long, 7-11 MHz linear probe (L&T India) is used to localise the sciatic nerve at the popliteal level.
6. The needle used is 18 G intravenous disposable needle
7. 10 cm extension with three way adapter (to be attached to needle).

Both the groups were given popliteal sciatic nerve block with classical posterior approach under sterile aseptic precaution in prone position.

Sterility during the technique was ensured with proper sterile drape and gloves. Acoustic coupling was achieved by applying sterile jelly over the footprint followed by applying sterile glove and banding it to the probe. Then the gloved probe is drenched with povidone iodine along its foot print to achieve acoustic coupling between the gloved probe and skin interface.

RESULTS

This is a prospective, randomized, observer blinded, study performed comparing the nerve stimulator and ultrasound on the duration of block technique, number of

needle reinsertion, and success of block in the posterior popliteal sciatic nerve blocks. After completing the study, the data were compiled and analysed.

All the variables are examined for outliers and non-normal distributions. The categorical variables are expressed as frequency and percentage. The quantitative variables are expressed as mean and standard deviation. Descriptive statistics are used to evaluate baseline characteristics.

The group comparison for the categorical variables are analysed using Chi square test and for quantity variables are analysed using student t test.

The P value of less than 0.05 was considered as statistically significant. The statistical analysis was carried out using statistical software package SPSS 19.0.

Gender comparison between Group U & Group N

On analysing the distribution of gender among Group N and Group U the p value is 0.517 (i.e. $P > 0.05$), stating that there is no significance difference between the two groups hence they are comparable.

Comparison of mean of age, height and weight between Group N and Group U

On analysing the data statistically, the p value was calculated as $P = 0.226$, $P = 0.990$, $P = 0.871$ for age, height and weight respectively. All these values are > 0.05 , hence the difference is statistically insignificant between the two groups in terms of age, height and weight and the two groups are therefore comparable.

Comparison of duration of "Block technique" in Group N and Group U

The duration of technique in Group U = 262 seconds and Group N = 715.16 seconds. The calculated P value = 0.0001 which is < 0.05 , hence the difference is statistically significant. Therefore the time taken to perform the block in Group U is significantly shorter than the Group N.

Comparison of number of needle reinsertions among Group N and Group U

Average number of needle reinsertion in Group N = 6.05 ± 2.31 , Group U = 2.46 ± 1.11 . The P value is calculated to be 0.0001 i.e., < 0.05 , hence difference is statistically significant. Therefore number of needle reinsertion in Group U is significantly shorter than Group N.

Comparison of onset of sensory and motor blockade between Group N and Group U

The onset of sensory blockade in Group N = 19.35 ± 9.86 minutes Group U = 12.92 ± 3.55 minutes, whose P value

is 0.001, which is statistically significant. Therefore the onset of the sensory blockade is significantly faster in Group U than Group N.

The onset of motor blockade in Group N = 21.28 ± 5.01 minutes Group U = 16.25 ± 4.55 minutes, whose p value is 0.001, which is statistically significant. Therefore the onset of the motor blockade is significantly faster in Group U than Group N.

Comparison of success rate of Group N and Group U

The success rate in Group N = 86% and Group U = 96% reporting a numerical difference. But on statistical analysis, the calculated P value = 0.081 i.e. (P >0.05) which is not statistically significant.

Complications observed among Group N and Group U

Though the incidence of vascular puncture and paraesthesia are numerically higher in Group N than Group U, the statistical analysis reported that the incidence is insignificant as the P values are 0.167 and 0.093 respectively. Supporting this, the overall the incidence of complications shows no difference between the Group N and Group U, since statistically P value is 0.025.

Anaesthetic supplements required among Group N and Group U

The statistical difference between the Group N and Group U for patients administered fentanyl 50 mcg and proceeded with surgery is insignificant, as the P value = 0.655.

The statistical difference between the Group N and Group U who required fentanyl 100 mcg and hence converted to General anaesthesia is insignificant, as the P value = 0.238.

The statistical difference between the Group N and Group U who had no blockade and hence surgery done under general anaesthesia is insignificant, as the P value = 0.315. The statistical difference between the Group N and Group U who had no blockade and hence surgery done under regional anaesthesia is insignificant, as the P value = 0.315.

DISCUSSION

The usage of ultrasonogram, a radiation free radiological tool to perform various anaesthetic procedure like peripheral nerve blocks, central venous cannulation, epidural catheter insertion etc., is relatively a newer technical advancement. It is rapidly gaining in popularity over the conventional techniques of nerve blockade employing peripheral nerve stimulator and paraesthesia. But the lack of suitable ultrasound machines for

anaesthetic procedures delayed their utility till the end of last decade in the field of anaesthesiology.

But technological advances rose dramatically and made available a lot of ultrasound machines with wide range of flexibility in its application that are portable, inexpensive with the features necessary to perform ultrasound guided cannulation, regional anaesthesia etc. Subsequently, this has become an interesting tool for analysts and promoted a lot of comparative studies with the traditional techniques like paraesthesia, nerve stimulator in various combinations resulting in multiple conclusions favouring for and against the ultrasonogram guided technique. So we planned a randomized, prospective, observer blinded study to compare the conventionally used technique of peripheral nerve stimulator with ultrasonogram in popliteal sciatic nerve block.

With all these considerations popliteal block was performed and observations were recorded. The demographic variables like age, gender were equally distributed in both the groups. The physical measurements such as weight and height were equally distributed in both the groups. The American Society of anaesthesiologist physical status is also equally distributed ruling out any influence of pathologic states affecting specifically the ultrasound or nerve stimulator group. The surgical indications are also equally distributed between the two groups.

The primary study parameter, duration of block techniques is significantly shorter in Group U (262 ± 108.26 secs) than Group N (715.16 ± 234.66). As well as the variability in timing is much higher in Group N than Group U. Danelli et al. had reported similar results with his study [2 min(U) vs. 5 min(N)]. Conversely, Perlas et al. demonstrated that block procedure time was similar between ultrasound and nerve stimulator guided blocks. Dufour et al. reported that combined ultrasound and nerve stimulator guidance does not reduce block time of posterior popliteal sciatic block vs. neurostimulation alone. But we had shorter block procedure time that may be due to real time visualisation of the nerve in spite of slight anatomical variations as visualization has overcome this demerit. But that was not possible with nerve stimulator where the needle puncture site is constant in relation to external anatomy howsoever the internal anatomy varies. When it is located exactly as per the defined anatomy then the time taken was shorter. When there is variability in the nerve course then block procedure time is prolonged on searching for evoked motor response on various angles and depths.

The number of needle reinsertion is also significantly shorter in ultrasound group (n=2) than nerve stimulator (n=6) group. The variability in ultrasound is also smaller (n=1-5) compared to nerve stimulator (n=1-12). On further analysing the data 100% of the patients in ultrasound group had less than 5 needle reinsertion while it was only 22 patients in nerve locator group had less

than 5 needle reinsertion. It could be due to measurement of depth of nerve from the skin on the ultrasound image and placing the entry point of the needle at that depth from the skin. This places the needle along the in plane orientation with the probe and in straight line to the plane of nerve. Therefore the changes in direction of the needle are kept minimal. Orebaugh et al. showed consistently lesser needle reinsertions in ultrasound group than nerve stimulator group. Danelli et al. also reported significantly lesser needle reinsertion in ultrasound [Group U (n=1-7) vs. N (n=1-20)]. This might have been due to real time imaging of the movements of the needle.

The onset of sensory blockade in ultrasound group (12.92 ± 3.55 min) is significantly shorter than nerve stimulator group (19.35 ± 9.86 min) $P = 0.001$. The onset of motor blockade is also significantly shorter in ultrasound group (16.12 ± 4.55 minutes) than nerve stimulator group (21.28 ± 5.01 minutes) $P = 0.001$. Danelli et al. had reported a significantly shorter onset time with sensory and motor blockade in ultrasound group than nerve stimulator group. This might have been due to visualization of distribution of local anaesthetics in ultrasound while injection, which helps in depositing the drug around the nerve in various planes in close proximity to the nerve. The same reason is attributed to the shorter onset time in my study as well. But in contrast to my study, Danelli et al. reported no significant difference in either sensory or motor blockade in the two groups.

The success rate between ultrasound (96%) and nerve stimulator (86%) though numerically different does not report significant difference statistically. Therefore with lesser block performance time and needle reinsertions the success rate remains equal in ultrasound group than nerve stimulator group. This shows that although the block performance time and needle reinsertion are higher in nerve stimulator group, if the nerve is identified then the success rate is not significantly different from ultrasound group. Danelli et al. reported no significant difference in success rate [Group U (100%) vs. Group N (82%)] between the two groups though numerical difference exists.

We had 4 patients in nerve stimulator and 1 patient in ultrasound experiencing paraesthesia, $P = 0.167$, hence statistically insignificant. 5 patients in nerve stimulator and 1 patient in ultrasound had vascular puncture but $P = 0.093$, hence statistically insignificant. Danelli et al. though had 22% incidence of vascular puncture and paraesthesia in nerve stimulator group, the incidence is not statistically significant.

8 patients in nerve stimulator group and 4 patients in ultrasound group had incomplete blockade. 3 patients in Group N and 2 in Group U were supplemented 50 mcg and proceeded to surgery. 5 patients in Group N and 2 in Group U who had discomfort during surgery even after the maximum dose of fentanyl (100 mcg) were

administered general anaesthesia and proceeded to surgery. 2 patients in nerve stimulator group had no blockade hence alternate anaesthesia was administered. One patient was administered spinal neuraxial blockade as the clinical status was stable (ASA PS-I) while the other patient who presented with infected and reoccluded femoropopliteal artery bypass with ischemic heart disease of ASA PS-II posted for below knee amputation was administered general anaesthesia. There were no significant difference between any of these anaesthetic supplements as the P values are 0.238, 0.655, 0.315, 0.315 respectively for general anaesthesia after 100 mcg fentanyl, fentanyl 50 mcg and proceeded with block for surgery, general anaesthesia without supplementation, regional anaesthesia respectively. Danelli et al., reported 18% patients in nerve stimulator group and none in ultrasound group required general anaesthesia to complete surgery. 27% patients in ultrasound and 18% in nerve stimulator required Fentanyl 100mcgs to complete surgery.

CONCLUSION

To conclude, block technique time and number of needle reinsertions are significantly lesser in ultrasound groups. The onset times for sensory and motor blocks are also significantly shorter in ultrasound group. However, the success rate and complications did not significantly differ between the two groups.

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