



ORIGINAL ARTICLE

Combined Femoral and Sciatic Nerve Blockade for Lower Limb Surgeries: Ultrasound Guidance versus Nerve Stimulation

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ABSTRACT

Background: Comparison between nerve stimulator guided and ultrasound guided femoral-sciatic nerve block, to find out the method of best outcome and least side effects. **Methods:** The study was performed in Zagazig University Hospital (ZUH), eighty ASA classes I and II adult cooperative patients of both sexes were scheduled for below or at knee level surgery. They anesthetized under femoral-sciatic nerve block. They were randomly allocated into two equal groups, ultrasound guided nerve block (US) group and nerve stimulator group (NS) group (40 patients each) according to the used method for nerve localization. **Results:** It was found that there was a statistically significant difference between US and NS groups ($P=0.001$) regarding the "performance": technique time, the number of attempts of skin puncture, the onset time for complete motor and sensory block, incidence of hematoma formation and the incidence of painful paresthesia during nerve localization. **Conclusion:** The ultrasound guided lower limb block was superior to nerve stimulator guided for localization of femoral and sciatic nerve with less performance time, accurate needle placement, less failure rate and less incidence of complications.

Key word: Ultrasound, Nerve stimulator, sciatic femoral block.

INTRODUCTION

Peripheral nerve block provides surgical anesthesia with cardiorespiratory stability as compared to central neuro-axial anesthesia which had side effects of hypotension, bradycardia, postdural puncture, headache, etc... [1].

With development of ultrasound and peripheral nerve stimulator, the scope of anesthesia has shifted from general anesthesia and central neuroaxial blockade of isolated limb surgery to peripheral nerve blocks [2].

Nowadays, nerve stimulator and ultrasonography guided methods of block have increased the safety level of procedure.

Ultrasonography allows direct vision of the nerve so that, the needle can be kept away from sensitive organs and distribution of regional anesthesia can be monitored. Also, using transcutaneous electric nerve stimulation could be helpful in localizing the nerve and increasing the effectiveness of block [3].

Ultrasound allows direct visualization of peripheral nerve block. This imaging modality has proven highly useful to guide targeted drug injections and catheter placement. The last several years has witnessed a tremendous increase in use of

ultrasound guidance for regional anesthesia [4].

The aim of this study was to compare between nerve stimulator guided and ultrasound guided femoral-sciatic nerve block to find out the method of best outcome and least side effects.

METHODS

After approval of the Institutional-Review Board [IRB], this comparative prospective study was carried out in Zagazig University Hospitals in Egypt.

Sample size was taken as effect size and difference from previous paper which was 12.5% so it's size was 80 patients (40 in each group) with power 80% and confidence level 95% [5].

In the study, 80 patients were allocated randomly into two groups: Ultrasound guided group (US), combined femoral sciatic nerve block (n = 40). Nerve stimulator guided group (NS), combined femoral sciatic nerve block (n = 40).

Inclusion criteria:

Patients who admitted to the hospital for elective lower limb procedures fulfilling the following criteria:

- Operations not extending more than 2 hours.
- Limb surgeries below Knee or at knee level.

- American Society of Anesthesiologists (ASA) I, II.
 - Age group between 21 and 65 years.
- Exclusion criteria:
- Patient refusal.
 - Uncooperative patient.
 - Coagulopathies.
 - Infection at the site of application.
 - Urgent cases.

(1) Preoperative preparation:

Written informed consent was obtained from all participants. The work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

The instructions about the fasting period were also done.

Premeditations with intravenous injection of 0.02 mg/kg midazolam was given. Standard monitoring and basal readings were recorded. Large bore (18 or 16) gauge cannula was inserted.

(2) Patient position:

At first sciatic nerve block is done via the Labat (classic) approach [6]. The patient was positioned into sim's position (Fig. 1). Regarding femoral nerve block, patient was positioned into the supine position.



Figure 1. Sciatic nerve block in Sim's position [7]

(3) Nerve stimulator guided (NS) combined sciatic-femoral nerve block

a. Sciatic nerve block is done first

The blocks were performed with peripheral nerve stimulator and 22 G insulated short beveled electric needle. After

positioning the patient into sim's position a line was drawn between the palpated posterior superior iliac spine (PSIS) and the greater trochanter (GT) of the femur. This line was bisected with a perpendicular line extending approximately 5 cm caudad to cross a

confirmatory line which was drawn between GT of the femur and the sacral hiatus. This represents the point of needle insertion.

At puncture site lidocaine 1% 3 ml were infiltrated with 27 gauge needle and deeper infiltration with 5 ml lidocaine 1% was done. An insulated needle inserted 10-12 cm to the spherical skin plane. The nerve stimulator was set to deliver current intensity of 1.5-2 mAmp. As the needle was advanced, twitches of gluteal muscles were observed. The needle was advanced further, the gluteal twitches were disappeared, and brisk response of sciatic nerve occurred (Hamstring, calf, foot or toe twitches). The current was reduced gradually. The motor response was evident at 0.2-0.5 mAmp. Twenty ml of 0.5% isobaric bupivacaine with 10 ml 2% lidocaine were injected around the sciatic nerve (Sunny pivacaine® Bupivacaine HCl, Sunny medical group).

b- Femoral nerve block

The next step was the patient positioned supine to perform femoral nerve block. The line representing the inguinal ligament was drawn between palpated anterior superior iliac spine (ASIS) and pubic tubercle. Palpation and marking 2 cm inferior to inguinal ligament and 1 cm lateral to femoral pulsation was the best and exact point of entry.

After skin sterilization an insulated needle 50 mm was introduced and directed cephalad at approximately 30 to 40 degree. When appropriate motor response obtained which was brisk quadriceps contraction patellar snap "dance sign" which should be visible with electric current at 0.2-0.5 mA. At this point injection of Fifteen ml of 0.5% isobaric bupivacaine with 5 ml 2% lidocaine was done with intermittent aspiration to rule out any intravenous injection.

The patient was continuously evaluated for onset of sensory block by pin prick stimulation and motor block by modified Bromage scale. Sensory block was evaluated each 5 minutes till 20 minutes as follow (if no sensation = 2, reduced sensation = 1, normal sensation = 0). While motor block of sciatic nerve was assessed by examination of first toe movement (normal force = 0, reduced force = 1, no ability to move the first toe = 2) [8].

Motor block of entire limb was assessed by using modified Bromage scale [8].

No movement = 3

Movement of ankle only = 2

Movement of knee = 1

Full movement = 0

(4) Ultrasound guided (US) combined sciatic-femoral nerve block group

a. Sciatic nerve block is done at first

Determination of land mark for sciatic nerve block after patient was positioned into sim's position was done by identifying both the bony land mark, greater trochanter (GT) laterally and ischial tuberosity (IT) medially, then skin sterilization was done with povidone iodine solution. We placed a low frequency (2-4.5 MHz) curved ultrasound probe (HFL 38; sonosite M-Turbo, Bothell, USA) to a line connecting (GT) with (IT).

Three ml of 1% lidocaine local anesthetic at site of needle insertion was injected then simplex D® Braun needle was inserted with in plane technique. Twenty ml of 0.5% isobaric bupivacaine with 10 ml 2% lidocaine were injected around the sciatic nerve (Sunny pivacaine® Bupivacaine HCl, Sunny medical group).

b. Ultrasound guided femoral nerve block

The patient was positioned into supine position for the femoral nerve block. Land mark was determined as previously described. Skin sterilization was done, 6-13 MHz linear probe was placed below inguinal crease parallel to inguinal ligament.

Skin sterilization was done. The needle was introduced with an in-plane technique from lateral to medial. Fifteen ml of 0.5% isobaric bupivacaine with 5 ml 2% lidocaine were injected around the nerve at which the femoral nerve injection causing separation of the two fascia iliaca. Assessment of the motor and sensory block was done as previously described.

The following parameters were collected and recorded in each group:

(1) Demographic data including: age per years, sex, weight per kg, height per cm, and ASA classification.

(2) The block technique characteristics of the studied groups including:

- Technique performance time/minutes.
- Number of attempts of skin punctures.

- Number of needle passages.
- (3) Onset of action including:
- Onset of complete sensory block.
- Onset of complete motor block.
- (4) Incidence of side effects during block performance including:
- Subcutaneous hematoma.
- Painful parasthesia during block.
- Postoperative neuropathy (neurological examination was performed in the first day after surgery to assess new transient or permanent nerve damage).
- Local anesthetic toxicity.
- (5) Failure rate.
- (6) Postoperative visual analogue scale (VAS): VAS consists of 10 cm straight line with two ends representing pain dimension, zero = no pain and 10 = worst pain. The distance in cm from zero point to the patient mark was used as numerical index for degree of pain.

Statistical analysis

All data was collected, coded and analyzed using SPSS 20. Data were reported as mean and standard deviation (SD) frequency and percentage. T-test was used to compare means and Chi-square for comparing categorical

variable. P value < 0.05 was considered as significant.

RESULTS

Demographic characteristic, duration of surgery and ASA classification was showing no significant difference between both groups [Table 1].

The technique characteristic into studied group [Table 2] showed highly significant difference into ultrasound group.

The mean value of complete sensory and motor block [Table 3] showed highly significant difference into ultrasound group, the time taken to gain complete sensory and motor block into (US) group was less than (NS) group.

Regarding incidence of side effect during the block performance [Table 4]. There was increased incidence of hematoma formation into (NS) group than into (US) group. No reported cases among US and NS group regarding neuropathy and local anaesthetic toxicity.

Failure rate [Table 5] there was two cases into (US) group while at (NS) group was 3 cases.

Table 1. Demographic characters and ASA and operation time

	US guided group (N = 40)	NS guided group (N = 40)	t	P
Age (Year)	44.75±2.96	43.8±2.69	1.500	0.138
Weight (kg)	68.8±8.6	69.7±7.9	-0.341	0.621
Height (cm)	169.5±6.9	170.6±4.3	-0.732	0.378
BMI (kg/cm ²)	23.75±1.49	24.0±2.01	-0.630	0.530
ASA (I, II)	1.82±0.8	1.81±0.6	0.02	0.98
Operation time (min)	77.4±10.87	78.64±11.87	-0.25	0.63

Data represented as mean ± SD

T-test and P value was used

No significant difference

ASA: American society of anesthesiologist

BMI: Body mass index

Table 2. Technique characters in studied groups

	US guided group (N = 40)	NS guided group (N = 40)	t	P
Performance time (minute)	5.91±0.3*	7.75±0.37	-8.645	0.00
Number of attempts	1.0±0.0*	1.97±0.37	-16.49	0.00
Number of needle passage	1.31±0.24*	2.41±0.65	-9.893	0.00

Data represented as mean ± SD

T-test and P value was used

* P <0.001 = very highly significant, US significantly lower than NS group.

Table 3. The onset time of complete sensory and motor block (minutes) in the studied groups

	US guided group (N = 40)	NS guided group (N = 40)	t	P
The onset time of sensory block (min)	10.67±1.32*	16.68±1.35	-20.062	0.00
The onset time of motor block (min)	14.56±1.05*	21.02±1.21	-25.327	0.00

Data represented as mean ± SD

T-test and P value was used

US significantly lower than NS group

Table 4. Complication distribution among studied groups

		Group		Total	χ^2	P
		US	NS			
Hematoma	Count	0*	17	17	21.58	0.00
	%	0.0	42.5	21.2		
Painful parathesia	Count	0*	8	8	8.88	0.003
	%	0.0	20.0	10.0		
Neuropathy	Count	0	0	0	0.00	1.00
	%	0.0	0.0	0.0		
Toxicity	Count	0	0	0	0.00	1.00
	%	0.0	0.0	0.0		

Data represented as number and percentage

Chi-square test and P value was used

NS group showed significant difference which associated with hematoma and painful parathesia

Table 5. Failure rate

			Group		Total	χ^2	P
			US guided group (N = 40)	NS guided group (N = 40)			
Failure	No.	Count	38	37	75	0.21	0.64
		%	95.0	82.5	96.2		
	Yes	Count	2 SNB 2 FNB 0	3 SNB 2 FNB 1	5		
		%	5.0	7.5	3.8		
		Total	Count	40	40		
%	100	100	100				

Data represented as number and percentage. Chi square and P value was used
 SNB: Sciatic nerve block. FNB: Femoral nerve block

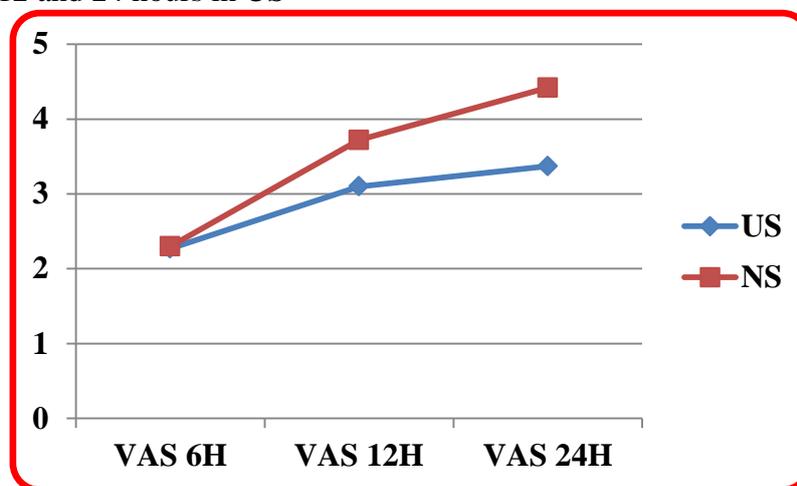
Table 6. VAS distribution in different time

	US	NS	t	P
VAS 6h	2.27±0.45	2.3±0.46	-0.244	0.808
VAS 12h	3.1±0.67*	3.72±0.59	-2.987	0.004
VAS 24h	3.37±0.88**	4.42±0.65	-13.489	0.00

Data represented as mean ± SD

T- test and P value was used

VAS sig lower in 12 and 24 hours in US

**Figure 2.** Mean value of VAS distribution in different times.

The mean value of VAS at 6 hours was nearly the same into US and NS group. At 12 and 14 hour post-operative, it was different which this means that the both group has ascending course of increased pain intensity but with less intensity at US group.

DISCUSSION

Combined femoral-sciatic nerve is an excellent option for lower limb surgery below knee surgery [9].

When compared to general anesthesia, regional anesthesia provides a lot of benefits

such as, superior pain managements, low incidence of cognitive dysfunction, early hospital discharge, greater patient satisfaction, and enhanced cost effectiveness [10].

In this study, it was observed that; in ultrasound-guided group; there were less

mean number of attempts of nerve localization and needle passages when compared with the nerve stimulator guided group. This finding was consistent with the finding of other workers **Wadhwa et al. [11]**. Their study was done using ultrasound versus nerve stimulator for two groups, one of them lumbar plexus block and other was sciatic nerve block and the study proved that ultrasound imaging is an effective tool to localize peripheral nerves and may facilitate block performance. It allow direct visualization of nerve and needle in real time with less number of needle passage if compared with nerve stimulator guided group **Pablo et al. [12]**, approved through their study that the step for successful regional block requires identification of the exact position of the nerves and the precise localization of the needle with less number of needle passages which decrease injuries to adjacent structure and this can be more facilitated with ultrasound technique than nerve stimulator gaudiness. Although neuro-stimulation is very useful in identifying nerve, it does not fulfill all those requirements.

In this study, the block performance times of US group were significantly shorter than those of NS group. This finding was attributed to the associated lower number of attempts of nerve localization to reach intended nerves by the tip of needle due to direct vision with US technique than the blind NS technique. These results were in agreements with the results of other workers **Lam et al. [13]** who conducted systemic review clarifying that ultrasound is the most helpful technique to identifying the target nerve, the study reported faster performance time and decrease in procedural time when it used for lower limb extremity block **Lewis et al. [14]** Also conducted systemic review with meta-analysis of 32 randomized controlled trial that compared ultrasound guided arm or leg nerve block with at least one other method of nerve location and the study approved that ultrasound guided nerve block performance time is shorter than other guidance technique.

Also, regarding procedure time, **Forouzan et al. [3]** was in concordance of our results. However, the ultrasonography guided group had lower procedure time.

In the present study, the onset of both sensory and motor block had significant shorter time in the US group than NS group. This could be attributed to the closer injection of local anesthetic to the intended nerve in US techniques. These finding were in agreement with the reported finding of the following studies **Liu [15]** who conducted a systemic review comparing ultrasound guidance versus other technique for never localization and found that the US guidance provide improvement in block onset of sensory and motor than the traditional technique.

Also, in concordance of our results the finding of **Detelfobal and Ralf [16]** who conducted a systemic review for ultrasound guidance for deep peripheral nerve block such as sciatic compared with nerve stimulator for nerve localization and found that the US guidance provide improvement in block onset, both sensory and motor than traditional technique. Also, **Bansal et al. [2]** found that combined femoral sciatic nerve block show faster onset of sensory and motor block compared with nerve locator.

In this study, we found that US group was associated with decreased incidence of accidental vascular puncture during nerve localization. This attributed to under vision US techniques. This result was concordant with the results reported by other authors. **Lewis et al. [14]** who found that peripheral nerve block performed by ultrasound guidance had less complication such as vascular puncture compared with nerve stimulation. **Bansal et al. [2]** performed a comparative randomized trial comparing the ultrasound versus electrical stimulation block technique for femoral and sciatic nerve block and revealed that the ultrasound guidance were associated with significant decrease in the occurrence of blood vessels puncture compared with electrical stimulation.

Cao et al. [17] approved in their study that ultrasound guidance for sciatic nerve block had more success rate and reduction of the vascular puncture over the nerve stimulator guidance.

Concerning painful parasthesia during the blocks, the present study shows that US group had less incidence of painful parasthesia during block than NS group,

while both groups didn't show significant postoperative neuropathy. These finding may be explained by that; the direct vision US technique decrease the liability of nerve trauma and intraneural injection than blind NS group. **Neal et al. [18]** concluded that the ultrasound guided regional anesthesia technique had shown significantly lesser peripheral nerve injuries than other nerve localization techniques. **Liu et al. [19]** did not show statistically significant difference in postoperative neurologic outcome between electrical stimulation and ultrasound guided technique and this may be attributed to different approaches they used.

In this study there was no detected case of local anesthetic toxicity among the studied groups. These results were in agreement with **Mokin et al. [9]** who compared ultrasound and nerve stimulation and revealed that ultrasound had the potential to decrease the rate of local anesthetic toxicity by avoiding intravascular injections and reducing local anesthetic volumes.

In this study we found that, the failure rates to achieve successful lower limb blocks were significantly higher in NS group than the US group. These findings were in agreement with the reported finding of **Tantry et al. [20]** and **Lam [13]** who revealed that ultrasound guidance improve overall success rate of lower limb nerve block.

In this study, the postoperative VAS at 6 hours were not significantly different among the studied groups while, at 12 and 24 hours US group were significantly less than NS group.

This could be explained by that, the US techniques allow uniform and close local anesthetic injection around the nerve to be blocked with subsequent effective anesthesia. These finding were concordant with finding of other workers; **Bhoi et al. [21]** who reported longer duration of block with ultrasound guided technique with prolonged analgesia.

Liu et al. [22] reported that, ultrasound guided technique were significantly minimizing postoperative pain intensity compared with parasthesia and nerve stimulation technique.

In contrast to results of present study, **Antonakakis et al. [23]**, conducted a comparative study for multiple techniques of blocking the deep proneal nerve reported that, ultrasound-guided technique did not show any significant difference in the postoperative pain intensity and the overall quality of the block compared with parasthesia and nerve stimulator technique, this difference may be attributed to different nerve study.

In this study we found that, the failure rates to achieve lower limb blocks were significantly higher in NS than the US group. These finding were in agreement with previous findings [13] and [20] who revealed that ultrasound guidance improve overall success rate of lower limb nerve block.

CONCLUSION

It could be concluded that the ultrasound guided is superior to nerve stimulation guided femoral sciatic nerve block less performance time, accurate needle placement, less failure rate and less incidence of complications.

Conflict of interest

The authors declare no conflict of interest

Financial disclosure

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