USG versus PNS guided combined femoral and sciatic nerve block for lower limb surgery

Dr Pooja Meena[1], Dr Manisha[2], Dr Jitendra Kumar Meena[*3]

1Assistant Professor Nims Medical College and Hospital Jaipur
2Associate Professor Nims Medical College and Hospital Jaipur
3Professor Nims Medical College and Hospital Jaipur

Corresponding Author: Dr Jitendra Kumar Meena
Professor Nims Medical College and Hospital Jaipur
Email: drjitum@gmail.com

Abstract

Introduction- Combined femoral nerve block (FNB) and sciatic nerve block (SNB) is a popular method for reducing postoperative pain following orthopaedic surgery on the lower limbs because it effectively reduces pain. Avoiding the negative effects of central neuraxial blockage, FNB delivered via the landmark approach, peripheral nerve stimulation (PNS), or ultrasound (USG) produces efficient analgesia. The application of nerve blocks in clinical practice has been transformed by USG-guided blocks. In this study, the effectiveness of peripheral nerve stimulator (PNS)-guided and ultrasonography (USG) guided combined femoral nerve block and sciatic nerve block in knee arthroscopic operations is compared.

Material and method- after ethical approval, the study was carried out on 80 patients, with 40 in each group i.e. group P and group U. Individuals aged between 21-65 years,who were brought to the hospital for elective lower limb operations not extending more than 2 hours, limb surgeries below Knee or at knee level with American Society of Anesthesiologists Physical Status (ASA PS) I, II, and III were included in the study. Statistical analysis: data collected were tabulated and analysed by SPSS software version 20.0.

Result- Mean age of the patients in group P was 38.56±7.56 years while it was 40.32±7.75 years in group U. The number of needle repositioning was found to be significantly less in group. Similarly onset times of sensory and motor block in USG guided patients (10.67±1.32 and 14.56±1.05 minutes respectively) were significantly lower than the PNS guided patients (16.68±1.35 and 21.02±1.21 minutes respectively). In the current study the group U had lower incidence of complications as compared to group P. The postoperative VAS at 6 hours did not differ substantially between the two groups, however at 12 and 24 hours, the group U VAS was considerably lower than the group P.

Conclusion- When it came to femoral and sciatic nerve localisation, the ultrasound-guided lower limb block outperformed the nerve stimulator-guided method in terms of performance time, precise needle insertion, failure rate, and occurrence of complications.

Keywords- Regional anesthesia, Ultrasound, Nerve stimulator, Femoral nerve block, Sciatic nerve block.

Introduction:

Several methods of regional or central neuraxial blocks can be used to provide surgical anaesthesia of the whole lower extremity.[1,2] The regional blocks like femoral nerve block along with sciatic nerve block can be one of the alternative techniques to provide surgical anesthesia. [3,4] Ankle, foot, medial side of calf, knee, and anterior thigh sensory anaesthesia is achieved by blocking the femoral nerve.[2] The sciatic nerve may be utilised to manage postoperative pain after foot and ankle surgery, and it has been blocked using a variety of techniques. [5,6]

The best anaesthetic method for lower limb orthopaedic surgeries is regional anaesthesia because it lowers the need for systemic analgesics, improves perioperative pain management, and permits early ambulation, all of which lessen the risk of deep vein thrombosis.[7] There are several regional anaesthesia procedures for lower limb surgery that offer adequate sensory block with minimum motor block for improved postoperative mobility. One simple block that works well is the femoral nerve block (FNB). Avoiding the negative effects of central neuraxial blockage, FNB delivered via the landmark approach, peripheral nerve stimulation (PNS), or ultrasound (USG) produces efficient analgesia.[8] The scope of anaesthesia has changed now from general anaesthesia and central neuroaxial blockade of isolated limb surgery to peripheral nerve blocks with the advent of ultrasonography and peripheral nerve stimulators.[9] The techniques used to determine the nerve's location are either directed by the determination of a suitable motor response upon nerve stimulation or by the elicitation of paraesthesia.

However, neither approach has a high sensitivity for detecting needle-to-nerve contact.[10] The application of nerve blocks in clinical practice has been transformed by USG-guided blocks. By directly seeing the nerve, ultrasound makes it possible to monitor the distribution of regional anaesthesia and keep the needle away from delicate organs.[11,12] 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. [13]

The goal of the current study was to determine which approach had the greatest results and the fewest adverse effects by comparing femoral-sciatic nerve blocks guided by nerve stimulators and ultrasonography.

Material and methods:

This study was carried out after obtaining ethical approval from institutional ethics committee approval. With a power of 80% and a 95% confidence level, the sample size was 80 patients (40 in each group), calculated as the effect size and difference from the past article, which was 12.5%. [14]

Individuals aged between 21-65 years,who were brought to the hospital for elective lower limb operations not extending more than 2 hours, limb surgeries below Knee or at knee level with American Society of Anesthesiologists Physical Status (ASA PS) I, II, and III were included in the study. Patients who refused to participate, uncooperative patients, patients with co-agulopathies or infection at the site of application and urgent cases were excluded. For every subject, written informed permission was acquired. Additionally, instructions about the fasting time were given.

In both the groups (group P and group U), the sciatic and femoral nerve blocks were achieved using a 25 ml mixture consisting of 10 ml of lignocaine adrenaline, 10 ml of 0.5% bupivacaine, and 5ml of saline (10ml for the femoral and 15 ml for the sciatic nerve block).

Patients in Group P had a nerve block guided by PNS. Initially, the stimulating current intensity was set to provide 1 mA, and the stimulation frequency was set at 1 Hz.Using a 22-gauge insulated Stimuplex needle (B. Braun, Germany), the skin was punctured and the needle was manipulated and repositioned to elicit contraction of the respective muscle. After a gradual reduction in current, the needle's location was carefully adjusted to provide a negative stimulation at less than 0.3 mA. At that moment, the prepared solution was administered gradually following a negative blood aspiration.

In Group U, a 12-7 Hz high-frequency linear array probe (Fujifilm Sonosite M-Turbo Portable Ultrasound Machine) was used. The needle was inserted and if the tissue under the fascia iliaca expanded after receiving a 3 mL injection of the local anaesthetic solution, the placement was considered good. The needle was adjusted until the proper local anaesthetic distribution, including anterolateral spread, was evident. The preferred local anaesthetic was delivered over the course of one to two minutes following negative aspiration. All patients received intravenous (IV) paracetamol (15 mg/kg every 6 hours). If the patient complained of discomfort, an intravenous injection of tramadol (2 mg/kg) was given as a rescue medication.

Time to perform the block (defined as the interval between the initial needle contact with the skin and the needle's removal), the number of needle redirections needed to accomplish a block, and the block's duration (defined as the interval between the drug's deposition and the patient's pain complaint and need for a rescue analgesic) were recorded. Additionally, we evaluated how satisfied patients were with the block overall in the following ways: 0 means inadequate, 1 means satisfactory, 2 means excellent, or 3 means exceptional. Side effects during block performance were also seen in both the groups. Postoperative visual analogue scale was observed in all patients which 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: data collected were tabulated and analysed by SPSS software version 20.0. Frequency and percentage were used to present categorical data. For continuous variable mean±SD was used. The chi-square test was used to see the association between categorical variable. Student’s t-test was used to test the significance of the difference between the two groups. For all tests p-value of ≤0.05 was considered to be significant.

Results:

The study was conducted upon a total of 80 patients (40 in each group). Table 1 shows age, height weight, BMI and duration of surgery of the patients. Table 1 shows the demographic features of study participants. Mean age of the patients in group P was 38.56±7.56 years while it was 40.32±7.75 years in group U. the difference between mean age was not significant. Mean weight of group U (69.26±7.35) was a bit higher than the group P (68.65±8.65 kg) and the difference was not significant. Height of the group U patients was significantly higher than the group P patients but there was no significant difference of BMI between the two groups. As far as duration of surgery is concerned it was 78.64±11.87

minutes in group P and 77.44±10.91 minutes in group U and the difference was non-significant.

Table 1: Demographic characteristics of patients

Variable	Group 'P'	Group 'U'	p-value
Age in years	38.56±7.56	40.32±7.75	0.307
Height in cm	165.45±5.34	168.34±5.53	0.019
Weight in kg	68.65±8.65	69.26±7.35	0.339
BMI in kg/m^2	25.01±1.01	25.21±1.20	0.422
Surgery duration in minutes	78.64±11.87 -	77.44±10.91	0.639

The number of needle repositioning was found to be significantly less in group U patients as can be seen in table 2. It was 5.63±0.689 in group P patients and 3.01±0.564 in group 'U' patients.

Table 2: Number of needle repositioning

Group	Mean	SD	p-value
Group 'P'	5.63	0.689	<0.001
Group 'U'	3.01	0.564	

Similarly onset times of sensory and motor block in USG guided patients (10.67±1.32 and 14.56±1.05 minutes respectively) were significantly lower than the PNS guided patients (16.68±1.35 and 21.02±1.21 minutes respectively).

Table 3: The onset time of complete sensory and motor block (minutes)

	Group 'P'	Group 'U'	t	p-value
The onset time of sensory block (min)	16.68±1.35	10.67±1.32	-20.062	<0.001
The onset time of motor block (min)	21.02±1.21	14.56±1.05	-25.327	<0.001

Complications were also studied among two groups. As shown in table 4, hematoma was most common complication found in group P patients followed by painful paresthesia. Only 1 patient in group P developed neuropathy and non developed toxicity. In group U patients none of the patient were found to developed any of the complications.

Table 4: Complication among study groups

Complication		Group 'P'	Group 'U'	Chi-square	p-value
Hematoma	Yes	16	0	20.000	<0.001
	No	24	40		
Painful	Yes	10	0	11.429	<0.001

paresthesia	No	30	40		
Neuropathy	Yes	1	0	1.013	0.314
	No	39	40		
Toxicity	Yes	0	0	0	1.000
	No	40	40		

The mean value of VAS was nearly equal in both the groups at 6 hours. However at 12 and 24 hours post-operative, a significant difference was found between the two groups. It showed that both groups have ascending course of increased pain intensity with time but with less intensity at group U.

Table 5 : VAS at different times

	Group 'P'	Group 'U'	t	p-value
VAS (6 hrs)	2.3±0.34	2.25±0.35	0.449	0.654
VAS (12 hrs)	3.58±0.61	3.20±0.64	2.718	0.008
VAS(24 hrs)	4.32±0.72	3.40±0.81	5.369	<0.001

Discussion:

For lower limb operations below the knee, combined femoral-sciatic nerve is a great choice.[15] Regional anaesthesia has several advantages over general anaesthesia, including better pain control, a lower risk of cognitive impairment, early discharge from hospital, more patient satisfaction, and increased cost effectiveness.[16]

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. Their study, which compared ultrasound to nerve stimulators for two groups—one receiving sciatic nerve block and the other receiving lumber plexus block—showed that ultrasonic imaging is a useful technique for locating peripheral nerves and may help with block performance. It enables real-time, direct visualisation of the nerve and needle with fewer needle passages than a group guided by a nerve stimulator. [17]

Forouzan et al. observed that USG-guided FNB had significantly lower procedural time compared to PNS, and the block duration was almost similar in both groups. This was similar to our study with respect to the procedural time and the duration of the effect of the block.[18]

Casati et al. compared USG and PNS for multiple injection axillary brachial plexus block. They observed that the number of needle passes was four in the USG group compared to eight in the PNS group (p = 0.002), which was similar to our study, where we observed a lower number of needle repositioning in the USG group (Group U) than PNS group (Group P).[19]

In the current investigation, the US group had both sensory and motor block onsets much faster than the NS group. One possible explanation for this might be that US procedures include injecting the local anaesthetic closer to the targeted nerve. These results concurred with the findings of the systematic review by Liu who compared ultrasound guiding with other methods for nerve localisation and discovered that US guidance improved the block onset of sensory and motor block onset more than the conventional method.[20] The results of Detelfobal and Ralf's systematic review of ultrasound guidance for deep peripheral nerve block, such as sciatic nerve, in comparison to nerve stimulators for nerve localisation, also support our findings. They discovered that US guidance improved block onset, both sensory and motor, compared to traditional technique. [21]

According to this study, the US group had a lower risk of unintentional vascular puncture during nerve localization which is a result of under-vision US methods. This outcome was consistent with what other writers had found. Lewis et al. discovered that, in comparison to nerve stimulation, peripheral nerve block carried out under ultrasound guidance had less complications, such as vascular puncture.[22]

In a comparative randomised study, Bansal et al. also compared the ultrasound and electrical stimulation block techniques for femoral and sciatic nerve block. They found that the ultrasound guidance was linked to a significantly lower incidence of blood vessel punctures than electrical stimulation.[9] In their investigation, Cao et al. also confirmed that ultrasound guiding for sciatic nerve block had a higher success rate and a lower vascular puncture rate than nerve stimulator guidance. [23] The present study shows that US group had no incidence of painful parasthesia and postoperative neuropathy during block while NS group had 10 and 1 cases of painful parasthesia and postoperative neuropathy. These results might be explained by the fact that the direct vision US approach reduces the risk of intraneural injection and nerve damage compared to the blind NS group. Neal et al. depicted similar result that the ultrasound guided regional anaesthesia technique had demonstrated noticeably less peripheral nerve damage in comparison to alternative nerve localisation approaches.[24] However, Liu et al. did not demonstrate a statistically significant difference in the neurologic outcome following surgery between the ultrasound guided procedure and electrical stimulation, which might be explained by the varied methodologies they employed.[25] In the current study, there were no instances of local anaesthetic toxicity found in any of the groups under investigation. These findings were consistent with the findings of Mokin et al. [26], who examined ultrasound and nerve stimulation and revealed that ultrasound may be able to lower the rate of local anaesthetic toxicity by eliminating intravascular injections and lowering local anaesthetic volumes.

In this study, the postoperative VAS at 6 hours did not differ substantially between the two groups, however at 12 and 24 hours, the group U VAS was considerably lower than the group P. This may be explained by the fact that US procedures provide a consistent and precise local anaesthetic injection around the nerve, with subsequent effective anaesthesia. The findings of Bhoi et al., who found a longer duration of block using an ultrasound-guided approach and extended analgesia, were consistent with our findings.[27]

Liu et al. also stated that ultrasound-guided techniques greatly reduced the severity of postoperative pain when compared to nerve stimulation and parasthesia.[28]

Contrary to the findings of the current study, Antonakakis et al. carried out a comparative analysis of several methods for blocking the deep proneal nerve and found that, when compared to parasthesia and nerve stimulator techniques, the ultrasound-guided technique did not significantly alter the postoperative pain intensity or the overall quality of the block; this discrepancy may be due to different nerve studies.[29]

Conclusion- It may be said that the ultrasound-guided femoral sciatic nerve block is better than the nerve-stimulation-guided one in terms of shorter recovery times, precise needle insertion, lower failure rates, and fewer problems.

Conflict o interest: None

Source of funding: Nil

References-

1. Chung F, Mezei G. What are the factors causing prolonged stay after ambulatory anesthesia? . Anesthesiol. 1998;89:3A. doi:10.1097/00000542-199809010-00003
2. Davies MJ, McGlade DP. One Hundred Sciatic Nerve Blocks: A Comparison of Localisation Techniques. Anaesth Intensive Care. 1993;21(1):76–8. doi:10.1177/0310057x9302100118.
3. Labat G. Regional Anesthesia: Its Technique and Clinical Application. Philedelphia: PA: Saundrs; 1922.
4. Winnie AP, Ramamurthy S, Durrani Z. The Inguinal Paravascular Technic of Lumbar Plexus Anesthesia. Anesth Analg. 1973;52(6):989– 96. doi:10.1213/00000539-197311000-00036.
5. Kumar R, Singh A. Amputation of lower extremity in diabetic and high resk patients under peripheral nerve blocks (combined sciatic and 3-in-1 femoral block). Kuwait Med J. 2001;33(4):310–6.
6. Singh A, Trivedi V, Kothari PU. Sciatic Nerve Block in Combination with Femoral Nerve Block for Below Knee Surgery via the “Classical” Posterior Approach. J Anesth Clin Pharmacol. 2008;24(4):444–6.
7. Sandby-Thomas M, Sullivan G, Hall JE: A national survey into the peri-operative anaesthetic management of patients presenting for surgical correction of a fractured neck of femur. Anaesthesia. 2008, 63:250-8. 10.1111/j.1365-2044.2007.05328.x
8. Marhofer P, Chan VW: Ultrasound-guided regional anesthesia: current concepts and future trends . Anesth Analg. 2007, 104:1265-9. 10.1213/01.ane.0000260614.32794.7b
9. Bansal L, Attri JP, Verma P. Lower limb surgeries under combined femoral and sciatic nerve block. Anesthesia Essays and Researches; 2016; 10 (3): 432 – 436.
10. Ilfeld BM, Said ET, Finneran JJ 4th, et al.: Ultrasound-guided percutaneous peripheral nerve stimulation: neuromodulation of the femoral nerve for postoperative analgesia following ambulatory anterior cruciate ligament reconstruction: a proof of concept study. Neuromodulation. 2019, 22:621-9. 10.1111/ner.12851

11. Orebaugh SL, Williams BA, Vallejo M, Kentor ML: Adverse outcomes associated with stimulator-based peripheral nerve blocks with versus without ultrasound visualization. Reg Anesth Pain Med. 2009, 34:251-5. 10.1097/AAP.0b013e3181a3438e
12. Sites BD, Beach ML, Chinn CD, Redborg KE, Gallagher JD: A comparison of sensory and motor loss after a femoral nerve block conducted with ultrasound versus ultrasound and nerve stimulation. Reg Anesth Pain Med. 2009, 34:508-13. 10.1097/AAP.0b013e3181ae7306
13. Munirama S and McLeod G. A systematic review and meta-analysis of ultrasound versus electrical stimulation for peripheral nerve location and blockade. Anaesthesia, 2015; 70 (9): 1084-1091.
14. Duncan M, Shetti AN, Tripathy DK, Roshansingh D and Krishnaveni N. A comparative study of nerve stimulator versus ultrasound-guided supraclavicular brachial plexus block. Anesth Essays Res. 2013; 7:359–364.
15. Mokin Y, Kang C, Joo YB. Usefulness of ultrasoundguided lower extremity nerve blockade in surgery for patient patellar fracture. KSSR (Knee Surgery and Related Research. 2015; 27 (2): 108-116.
16. Fanelli A, Ghisi D, Melotti RM. An update around the evidence base for the lower extremity ultrasound regional block technique. F1000 Research (F1000 Faculty Rev) 2016. Published online 2016 Jan 26
17. Wadhwa A, Kandadai SK, Tongpresert S, Obal D, and Gebhard RE. Ultrasound guidance for deep peripheral nerve blocks: A brief Review. Anesthesiol Res Pract. 2011, Anesthesiol Res Pract. 2011; Published online 2011 Jul 27
18. Forouzan A, Masoumi K, Motamed H, Gousheh MR, Rohani A: Nerve stimulator versus ultrasound-guided femoral nerve block; a randomized clinical trial. Emerg (Tehran). 2017, 5:e54. 10.22037/emergency.v5i1.15782
19. Casati A, Danelli G, Baciarello M, Corradi M, Leone S, Di Cianni S, Fanelli G: A prospective, randomized comparison between ultrasound and nerve stimulation guidance for multiple injection axillary brachial plexus block. Anesthesiology. 2007, 106:992-6. 10.1097/01.anes.0000265159.55179.e1
20. Liu SS. Evidence basis for ultrasound-guided block characteristics onset, quality and duration. Req Anesth Pain Mde. 2016; 41 (2): 205 – 20.
21. Detelfobal and Ralf E. Ultrasound guidance for deep peripheral nerve blocks: A brief review. Anesthesiol Res Pract., 2011: 20-70
22. Lewis SR, Price A, Walker KJ, McGrattan K and Smith AF. Ultrasound guidance for upper and lower limb blocks. Cochrane Database Syst Rev. 2015; 11 (9): CD006459
23. Cao X, Zhao X, Xu J, Liu Z and Li Q. Ultrasoundguided technology versus neurostimulation for sciatic nerve block: a meta-analysis. Int J Clin Exp Med., 2015; 8 (1):273-280.
24. Neal JM, Brull R, Chan VW, Grant SA, Horn JL, Liu SS et al. The ASRA evidence-based medicine assessment of ultrasound-guided regional anesthesia and pain medicine: Executive summary. Reg Anesth Pain Med., 2010; 35 (2): 325.
25. Liu SS, Zayas VM, Gordon MA, Beathe JC, Maalouf DB, Paroli L. et al. A prospective, randomized, controlled trial comparing ultrasound versus nerve stimulator guidance for interscalene block for ambulatory shoulder surgery for postoperative neurological symptoms. Anesth. Analg. 2009; 109 (1): 165-171.

26. Mokin Y, Kang C, Joo YB. Usefulness of ultrasoundguided lower extremity nerve blockade in surgery for patient patellar fracture. KSSR (Knee Surgery and Related Research. 2015; 27 (2): 108-116.
27. Bhoi S, Chandra A, Galwankar S. Ultrasound-guided nerve blocks in the emergency department. J Emerg Trauma Shock; 2010; 3 (1):82-88.
28. Liu SS, Ngeow J, John RS. Evidence basis for ultrasound-guided block characteristics: onset, quality, and duration. Reg Anesth Pain Med., 2010; 35 (2): 26-35.
29. Antonakakis JG, Ting PH, Sites B. Ultrasoundguided regional anesthesia for peripheral nerve blocks: and evidence-based outcome review. Anesthesiol Clin. 2011; 29 (2): 179-91.