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Original Article

Anaesthesia Section

Comparison of Ultrasound-Guided Anterior and Posterior Approaches to Sciatic Nerve Block for Lower Limb Surgeries: A Randomised Clinical Study

BUDATHA SREENIJA[1], LK SHIVANAND[2], GEETHA S HASARADDI[3], SANTOSH KUMAR ALALAMATH[4], DG TALIKOTI[5]

ABSTRACT

Introduction: Sciatic nerve block is used for anaesthesia and analgesia in lower limb surgeries. The anterior approach to the sciatic nerve is rarely performed due to unreliable anatomical surface markings.

Aim: To compare the anterior and posterior approaches to sciatic nerve block in terms of patient comfort and technical difficulty.

Materials and Methods: This randomised clinical study was conducted at the Department of Anaesthesiology, BLDE (Deemed to be University) Shri BM Patil Medical College, Hospital and Research Centre, Bijapur, Karnataka, India. A total of 84 patients who underwent lower limb surgeries from November 2020 to August 2022 were included. Informed consent was obtained, and patients were randomised into two groups- Group A and Group P using the card method. Ultrasound-guided sciatic nerve block was performed using the anterior approach in Group A and the posterior approach in Group P. Sensory and motor blockade, time to perform the block, number of attempts, duration of analgesia, and patient satisfaction were recorded. Statistical analysis was performed using the Chi-square test, Analysis of Variance (ANOVA), student t-test, and the results were represented in tables.

Results: The median age in Group A was 42.95±12.69 years, and in Group P was 43.95±8.68 years. Males were higher in number with 26 (31%) in Group A and 23 (27%) in Group P, respectively. Patient satisfaction, duration of analgesia (10.3±3.5 years Group P and 10.5±4.0 years Group A), onset of sensory (11.85±7.35 years Group P and 9.53±5.40 years Group A), and motor blockade (18.67±7.05 years Group P years and 17.82±5.70 years Group A) were similar in both groups. The number of attempts (2.85±0.90 years Group P and 3.05±0.91 years Group A) and time taken for performing the sciatic nerve block (6.75±1.10 years Group P and 7.44±1.00 years Group A) was higher in the anterior approach compared to the posterior approach.

Conclusion: Although both approaches to sciatic nerve block are equally effective, this study concludes that the posterior approach is simpler to perform, requires less time, and provides better patient comfort and satisfaction. Ultrasound-guided posterior sciatic nerve block offers effective anaesthesia and excellent post-operative analgesia.

Keywords: Beck's anterior approach, Labat's posterior approach, Peripheral nerve block, Regional anaesthesia

INTRODUCTION

Regional anaesthesia is a common and widely used method for lower limb procedures. Sciatic nerve block can be performed alone or in combination with femoral nerve blocks, which are commonly performed in regional anaesthesia. Due to its superior post-operative analgesia and low hemodynamic and metabolic abnormalities compared to general anaesthesia, peripheral nerve blocks have become a preferred anaesthetic alternative in the management of patients [1,2]. Ultrasound-guided sciatic nerve block has been shown to be safe, with a lower incidence of complications. Real-time visualisation of the needle tip and local anaesthetic spread helps to minimise the risk of intravascular injection or nerve injury. However, landmark-based techniques may carry a higher risk of complications due to reliance on palpation and surface anatomical landmarks. Therefore, ultrasound-guided sciatic nerve block is a safer option, whether combined with or without a saphenous or femoral nerve block [3].

All muscles below the knee and the posterior thigh receive motor function from the sciatic nerve. Sensory function, including the posterior thigh, posterior knee joint, and everything below the knee, except for a short band on the medial lower leg, is also supplied by the sciatic nerve. The saphenous nerve, which arises from the lumbar plexus, supplies this region [4-6].

The sciatic nerve is deep and located behind the femur, making an anterior block considered an advanced nerve block [7]. Administering the block is more difficult compared to blockades at the popliteal level and other locations along the sciatic nerve, which are influenced by the pattern of local anaesthetic dissemination. Additionally, due to the nerve's deep location, visualising the structure is less ideal and requires the use of a low-frequency, curved transducer (5-8 MHz), demanding a high level of technical expertise from the operator to successfully spread the local anaesthesia around the nerve [8]. Consequently, longer the procedure, the risk of traumatic injury increases, and the frequency of intraneural injections rises. Therefore, a comparative study of ultrasound-guided anterior and posterior approaches to sciatic nerve block is necessary to determine the benefits and drawbacks of each approach.

The primary outcomes measured were the number of attempts and patient comfort level between the anterior and posterior approaches to sciatic nerve block. The secondary outcomes measured were the time taken to perform the block, the onset of sensory and motor blockade, and the duration of analgesia.

MATERIALS AND METHODS

This non-blinded randomised clinical study was conducted at the Department of Anaesthesiology, BLDE (Deemed to be University) Shri BM Patil Medical College, Hospital and Research Centre, Bijapur, Karnataka, India, from November 2020 to August 2022. The study included 84 patients undergoing lower limb surgeries after obtaining ethical committee clearance (IEC.no. 09/2021) (CTRI NO: CTRI/2022/10/046631).

Sample size: The minimum required sample size was 42 per group (total of 84), assuming equal group sizes, to achieve 99% power and a 5% level of significance (two-sided) for detecting a true difference in means between the two groups [3].

$$N = 2\left[\frac{(Z_{\alpha} + z_{\beta}) * S}{d}\right]^2$$

Z_{α} (Level of significance)=95%

Z_{β} (Power of the study)=90%

d (Clinically significant difference between two parameters)

SD (Common standard deviation)

Inclusion criteria: The consenting patients aged 20 years and above, planned for lower limb surgeries, and classified as American Society of Anaesthesiologists (ASA) Grade-I, II & III were included in the study.

Exclusion criteria: Those patients who refused to participate, or with neuromuscular disease, haemostatic abnormalities or anti-coagulation, skin infection at the site of needle insertion, chronic pain syndromes or chronic analgesic therapy, and reported allergy to amide local anaesthetic drugs were excluded from the study.

Procedure

Prior to surgery, all patients underwent a thorough pre-anaesthetic examination and evaluation of all systems. Informed consent was obtained, and the anaesthetic procedure was explained to the patients to alleviate anxiety. Patients fasted for approximately eight hours before entering the operating room. Non-invasive monitors were attached, oxygen was administered via a facemask, and if necessary, Injection (Inj.) midazolam 1-2 mg was administered for anxiolysis while ensuring that patients remained responsive to verbal commands. Patients were randomly assigned to two groups and received anterior and posterior (subgluteal) methods of sciatic nerve block using the envelope technique [Table/Fig-1]. The sciatic nerve was imaged using a linear probe (3-9 Hz) for the posterior approach and a curvilinear probe (2.5 MHz) for the anterior approach.

Group A: For the anterior approach, the patients were placed supine with the leg externally rotated at about 45 degrees, and the hip and knee on the operated side flexed. About 8cm distal to the inguinal crease, an ultrasonic transducer (curvilinear probe) was initially placed perpendicular to the skin. Once a clear transverse picture of the hyper-echoic sciatic nerve, lying postero-medial to the lesser trochanter, was acquired, the area was further scanned by moving and tilting the transducer. Following the application of an iodine-containing solution to disinfect the skin, the sciatic nerve was preserved in the center of the ultrasound image, and a hypodermic needle was inserted in a parallel plane with the ultrasound transducer, covered with a sterile plastic cover and gel, from antero-medial to postero-lateral of the thigh. The needle was gradually introduced until it was near the nerve under real-time ultrasound supervision. A local anaesthetic solution comprising 10 mL of bupivacaine 0.5%, 10 mL of lignocaine 2%, 5 mL of lignocaine with adrenaline, and 5 mL of distilled water was taken and incrementally injected. The needle tip was repositioned to ensure a circumferential spread of the solution, and the spread of the local anaesthetic solution was confirmed by Ultrasonography (USG).

Group P: For the posterior approach, patients were positioned laterally with the side to be anesthetised on top, and the hip and knee where the surgery would be conducted were flexed at a 45-degree angle. An ultrasound transducer (linear probe) placed perpendicular to the skin on this line produced a clear transverse picture of the hyper-echoic sciatic nerve between the ischial tuberosity and greater trochanter. Following skin disinfection with an iodine-containing solution, a needle was inserted parallel and in line with the ultrasound transducer from postero-lateral to antero-medial. A local anaesthetic solution was administered similarly to the anterior method. Following sciatic nerve block, patients in both groups were put in a supine posture with both legs extended. No additional local anaesthetics were used during the surgical procedure. Injection of 1 to 2 mg of midazolam was given to the patients if needed.

Following the infiltration of the local anaesthetic solution for 30 minutes, sensory and motor blockade on the operated limb were assessed every five minutes and then again every two hours after the surgery was finished.

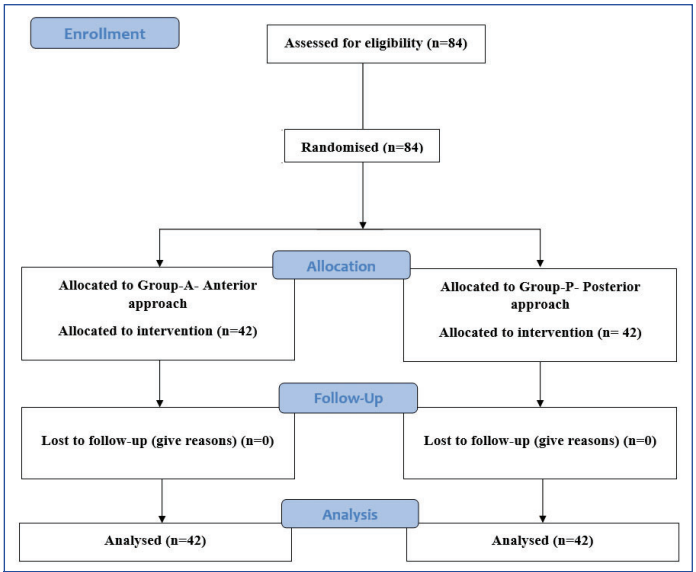
When the patient no longer felt a pinprick sensation, the sensory block was deemed complete. When the patient was unable to dorsiflex or flex their foot, the motor block was deemed complete. The patient's comfort level was analysed using the Visual Analog Scale (VAS) Score.

STATISTICAL ANALYSIS

The data obtained was entered into a Microsoft Excel sheet, and statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 20.0. The results was presented as Mean±SD, counts, percentages, and tables. For normally distributed continuous variables between two groups, independent t-tests was used for comparison. For non-normally distributed variables, the Mann-Whitney U test was used. Categorical variables between two groups was compared using the Chi-square test. A p-value of <0.05 was considered statistically significant. All statistical tests was performed as two-tailed.

RESULTS

This prospective study included a sample size of 84 patients randomised into two groups: Group A and Group P using the chit-picking method. [Table/Fig-1] shows the Consolidated Standards of Reporting Trials (CONSORT) diagram depicting how patients were enrolled in the present study.



[Table/Fig-1]: Consort diagram.

The age of the study participants was almost similar in both groups. Samples were matched with age, and there was no statistical significance (p-value=0.935). Males were more numerous, with 26 (31%) in Group A and 23 (27%) in Group P. Heights were matched between the samples (p-value=0.720, 2-tail). There was no statistical significance found between heights in both groups. The height was also found to be equal in both groups, with 170.80±12.12 cm and 171.25±7.00 cm, respectively. There was no statistical significance found between weights in both groups. The mean±SD in both groups was around 75.25±15.12 kg and 72.02±10.09 kg, respectively. ASA Grade-II and III were analysed, and there was no statistical significance found between the groups, with a p-value of 0.795 [Table/Fig-2].

Demographic and clinical data		Group A (n=42)	Group P (n=42)	p-value
Age (year) mean±SD		42.95±12.69	43.95±8.68	0.935
Gender				
Male		26 (31%)	23 (27%)	0.456
Female		16 (19%)	19 (23%)	
Height (cm)		170.80±12.12	171.25±7.00	0.720
Weight (kg)		75.25±15.12	72.02±10.09	0.516
ASA	II	30	31	0.795
	III	12	11	

[Table/Fig-2]: Demographic data.
Test used- students t-test; p-value ->0.05 statistically not significant

The onset of sensory block with Group A was 9.53±5.40 minutes compared to 11.856±7.35 minutes with Group P. A faster onset of sensory block was seen with Group A, but this was not statistically significant when compared to Group B, with a p-value of 0.165. The onset of motor block with Group P was 18.67±7.05 minutes compared to 17.82±5.70 minutes with Group A. A faster onset of motor block was seen with Group P, but this was not statistically significant when compared to Group A, with a p-value of 0.630.

The time taken to perform the anterior approach to sciatic nerve block was 7.44±1.00 minutes compared to 6.75±1.10 minutes with the posterior approach. The time taken to perform the block was significantly less in Group P than in Group A (p<0.05) [Table/Fig-3].

	Group P (n=42)	Group A (n=42)	p-value
Sensory blockade (min)	11.85±7.35	9.53±5.40	0.165
Motor blockade (min)	18.67±7.05	17.82±5.70	0.630
Time to perform block (min)	6.75±1.10	7.44±1.00	**0.045**

[Table/Fig-3]: Onset of sensory and motor blockade and time to perform in both groups.
Test used-student T-test; p-value >0.05 statistically not significant. (sensory and motor blockade)
p-value <0.05 statistically significant (time to perform block)

Number of attempts (2.85±0.90) were lower in Group P than in Group A (3.05±0.91). There was no statistical significance between the groups (p=0.395) [Table/Fig-4].

Patients in Group A had a duration of analgesia of 10.5±4.0, while Group P had a duration of 10.3±3.5. The duration of analgesia was similar in both groups, and there was no statistical significance between the groups with a p-value of 0.25 at a confidence level of 95% [Table/Fig-5].

[Table/Fig-6] compared patient satisfaction between the two groups and showed a difference in the comfort level of patient 3 between the two groups. Patient satisfaction levels were marked as 0, 2, 4, 6, 8, and 10. In Group A, 18 (42.8%) patients marked their comfort level as 6, and only 2 (4.7%) patients experienced severe discomfort, rating their level as 10, signifying severe pain. In Group P, 14 (33.3%) patients marked their comfort level as 6, and 4 (9.5%) patients rated their level as 10. However, there was no statistical significance between the groups.

	Group P (n=42)	Group A (n=42)	p-value
Number of attempts	2.85±0.90	3.05±0.91	0.395

[Table/Fig-4]: Number of attempts taken to perform block in both groups.
Test used- student t-test; p-value >0.05 statistically not significant

	Group P (n=42)	Group A (n=42)	p-value
Duration of analgesia (hour)	10.3±3.5	10.5±4.0	0.25

[Table/Fig-5]: Duration of analgesia in both groups.
Test used-student t-test; p-value >0.05 statistically not significant

DISCUSSION

The sciatic nerve divides into the tibial and common peroneal nerves just before the popliteal crease. There are various anatomical sites where the sciatic nerve can be blocked using regional anaesthesia [9,10]. These locations include the sacral plexus, traditional transgluteal approach, subgluteal approach, anterior approach, and popliteal approach, in that order [11,12]. Sciatic nerve block is commonly used for anaesthesia or analgesia during lower leg, ankle, and foot surgery, and different proximal approaches to the sciatic nerve have been described in the literature [13]. However, the traditional Labat posterior method is the most commonly used. Both techniques have advantages and disadvantages in individuals with restricted mobility, morbid obesity, spine instability, and hemodynamic instability [14]. The anterior approach to sciatic nerve block under ultrasound guidance has also been used in practice, showing that it can be as fast and effective as the posterior route for lower limb surgery. Ultrasound-guided approach may reduce the risk of femoral artery puncture compared to landmark-based strategies. Peripheral nerve block is a suitable approach as it provides improved hemodynamic stability by targeting a specific area without affecting the patient's sympathetic nervous system [15].

Time required to perform the block [Table/Fig-3]: In contrast to the study by Ota J et al., which found that the combined sciatic and femoral block required a mean execution time of 12 minutes in both groups, the mean time needed to perform the sciatic block in the current study was 6.75±1.10 minutes in Group P and 7.44±1.00 minutes in Group A [3]. The additional time in Group A may be attributed to the time needed to change transducers and wrap the nerves with local anaesthetic guided by ultrasound. It has been found that the anterior technique requires more effort and time compared to the posterior method. Ultrasound-guided peripheral nerve blocks, compared to the more commonly used techniques of paresthesia and peripheral nerve stimulators, are a relatively new technique that is gaining popularity.

Comparison of the number of attempts to achieve the block [Table/Fig-4]: The present study did not show any statistical significance between the groups regarding the number of attempts to perform the block. However, the number of attempts in Group P were lower than in Group A, but there was no statistical significance found between the two groups.

Comparison of onset of sensory block and motor block [Table/Fig-3]: Patients in the anterior approach group had a mean time of 9.53±5.40 minutes, while patients in the posterior approach group had a mean time of 11.856±7.35 minutes for sensory block onset. The faster onset of sensory block in Group A was not statistically significant compared to Group B, with a p-value of 0.165.

For motor block onset, patients in the posterior approach group had a mean time of 18.67±7.05 minutes, while patients in the anterior approach group had a mean time of 17.82±5.70 minutes. The faster onset of motor block in Group P was not statistically significant compared to Group A, with a p-value of 0.630. In a study by di Benedetto P et al., comparing the new posterior approach to the traditional posterior approach for sciatic nerve block, no differences were found in the final distribution of nerve blockade regarding onset time of sensory and motor blocks [13]. These findings are consistent with previous studies by Ota J et al., which also showed no differences in the onset of sensory and motor blockade of the sciatic nerve between the two approaches [3].

Comparison of duration of analgesia [Table/Fig-5]: The duration of analgesia was similar in both groups, and there was no statistical

	Group A (n=42)						Group P (n=42)						p-value
VAS score	0	2	4	6	8	10	0	2	4	6	8	10	
The comfort of patient (%)	0	2 (4.7)	6 (14.2)	18 (42.8)	14 (33.3)	2 (4.7)	0	4 (9.5)	8 (19.04)	14 (33.3)	12 (28.5)	4 (9.5)	**0.005**

[Table/Fig-6]: Comparison of patient satisfaction in both groups.
Test used- Fishers test; p-value <0.05 statistically significant; VAS: Visual analog scale

significance between the groups with a p-value of 0.25. This finding is consistent with a study by Karmakar MK et al., who found that blocking the sciatic nerve before its bifurcation took longer than blocking the tibial and common peroneal nerves using ultrasound after they had been divided in the popliteal fossa. The nerve in the bifurcation site is thinner than in the sub-gluteal region, which is why, they compared the bifurcation with the block immediately caudate [16]. These results align with a study by Taboada M et al., which showed that lateral popliteal methods took longer to achieve anaesthesia for patients receiving sciatic nerve blocks compared to sub-gluteal techniques [17].

The ultrasound-guided sciatic nerve block in the sub-gluteal area is considered to be one of the more challenging blocks. Despite its size (ranging from 1 to 2 cm in thickness), it can be difficult to clearly visualise in ultrasound images. Multiple needle pricks may be required to achieve an adequate block, and a nerve stimulator may be needed to ensure proper needle position, as mentioned in a different study [16]. This difficulty is attributed to anatomical variations at the injection sites, which can impede the diffusion of local anaesthetic. The close proximity of the two sciatic nerve trunks in the sub-gluteal area, separated by a small amount of adipose tissue, makes it easier for local anaesthetic to spread. In contrast, the distance between the tibial and common peroneal nerves above the popliteal fossa crease can vary and may be long enough to make it challenging for the local anaesthetic to reach this distance. Additionally, the popliteal cavity may contain multiple layers of connective tissue or fat [18].

Initially, patient pain during the sub-gluteal approach was attributed to the challenging nature of the method, which required multiple attempts and therefore took longer to perform the block. The incidence of non-blocked regions was also higher with the sub-gluteal approach. However, when patients were surveyed after the procedure to assess their level of satisfaction, there was no noticeable difference between the two methods. While more surgeons preferred the sub-gluteal technique because it produced motor block that restricted knee flexion and prevented patient movement, the sub-gluteal route made the procedure easier. Peripheral nerve blocks are highly effective and useful for foot and lower limb surgery [19]. Patients at high risk for hemodynamic instability should not undergo central neuraxial blockade, which can cause bilateral blockade and severe sympathectomy [20]. Other procedures for these individuals under regional anaesthesia include unilateral spinal or graded epidural anaesthesia, but these also have their own drawbacks and risks [21]. While general anaesthesia is a viable option, it has its own set of problems [22].

Peripheral nerve blocks are widely used for various procedures, either intraoperatively or for post-operative analgesia. Labat's posterior technique is the most commonly used method for blocking the sciatic nerve [23]. Few studies have compared the posterior approach to the lateral method, and the posterior technique has shown better outcomes [24,25]. Patient comfort level [Table/Fig-6]: In Group A, 18 patients rated their comfort level as six, and only two patients experienced severe pain, rating their discomfort level as 10.

In Group P, 14 patients rated their comfort level as six, and four patients rated it as 10. However, there was no statistical significance between the groups.

Patient comfort levels were lower in Group A compared to Group P, possibly due to the discomfort of being in a lateral position and having to hold it for 15 to 20 minutes. The authors did not use any sedatives or analgesics before the block to accurately assess the block. They found that patients in a supine position were more comfortable, although both procedures are uncomfortable due to the deep block. Overall, the effectiveness of both techniques is similar. The anterior technique provided a longer duration of analgesia compared to the posterior technique, but the difference was not statistically significant.

The placement of the sciatic nerve can vary from person to person, despite obvious markers. Additionally, when the sciatic nerve is accessed deep within the body through the anterior approach, the block needle must travel a considerable distance, increasing the risk of needle deviation from the desired nerve [17]. By using ultrasound guidance to evaluate the success and safety of sciatic and other peripheral nerve blocks, vascular structures can be avoided, and the local anaesthetic can be directly observed around the neural targets [26,27].

In a meta-analysis by Gelfand HF et al., it was found that ultrasound-guided peripheral nerve blocks have a higher success rate compared to nerve stimulation alone for specific blocks such as those to the brachial plexus, sciatic nerve, and popliteal nerve [28].

Limitation(s)

There was no blinding, and all blocks were performed by the authors, who were experienced anaesthesiologists with expertise in ultrasound-guided peripheral nerve blocks, including the techniques used in the study. Therefore, the nerve visualisation and subsequent sensory and motor blockade outcomes may be less accurate in a typical clinical setting.

CONCLUSION(S)

While the efficacy of both approaches to block the sciatic nerve was the same, the posterior approach was easier and required less time to perform, resulting in better patient comfort. The use of ultrasound guidance provided better visualisation and reduced the time needed to administer the block compared to a blind approach. With the increasing availability of USG in all centers, USG-guided sciatic nerve blocks can be a useful alternative when other anaesthesia techniques are contraindicated.

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PARTICULARS OF CONTRIBUTORS:
1. Junior Resident, Department of Anaesthesiology, Shri BM Patil Medical College and Hospital, BLDE University, Bijapur, Karnataka, India.
2. Associate Professor, Department of Anaesthesiology, Shri BM Patil Medical College and Hospital, BLDE University, Bijapur, Karnataka, India.
3. Associate Professor, Department of Anaesthesiology, Navodaya Medical College and Research Centre, Raichur, Karnataka, India.
4. Assistant Professor, Department of Anaesthesiology, Shri BM Patil Medical College and Hospital, BLDE University, Bijapur, Karnataka, India.
5. Professor, Department of Anaesthesiology, Shri BM Patil Medical College and Hospital, BLDE University, Bijapur, Karnataka, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Geetha S Hasaraddi,
Navodaya Medical College and Research Centre, Mantralayam Road,
Raichur, Karnataka-584103, India.
E-mail: geethasaisrivathsa@gmail.com

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