MEDICINE UPDATES JOURNAL

Faculty of Medicine Port Said University

Volum: 21 No:5 PP:65 -75

" *Assessment of posterior, lateral, and medial techniques for ultrasound-guided popliteal nerve block: A randomized clinical study*"

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Submitted: 09/12/2024

Accepted:31/12/2024

DOI: 10.21608/muj.2024.342831.1195

ISSN : 2682-2741

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ABSTRACT:

Background: The popliteal block is frequently employed for analgesia and anaesthesia in below-knee surgical procedures. This study evaluates ultrasound-guided popliteal blocks using different approaches (posterior, lateral, and medial) to ascertain the optimal method concerning block performance time and patient satisfaction.

Methods: This randomized trial encompassed 120 individuals slated for below-knee surgery. Patients were randomly allocated into three equal groups based on the popliteal block technique: posterior (P), lateral (L), and medial (M). We documented the number of attempts to identify the injection site, the duration of the block performance, the discomfort associated with positioning and needle insertion, and any complications.

Results: The mean block performance time was 9.5±2.15 minutes for P, 5.6±1.25 minutes for L, and 5.35±1.35 minutes for M groups. The block performance time was significantly greater in the (P) group (P1 < 0.001 and P2 < 0.001), while the (L) and (M) groups had comparable timings (P3 = 0.77). No significant variation was seen in the total number of attempts among the different approaches for identifying the injection site. The posterior technique had more positioning difficulty than the other two, although the lateral and medial approaches had higher needle insertion discomfort. None of the three methods had complications.

Conclusions: The medial and lateral methods with ultrasound-guided popliteal blocks demonstrated reduced block performance time and little patient positioning changes compared to the posterior strategy. Nevertheless, the posterior procedure diminishes needle insertion discomfort while preserving patient satisfaction across all techniques.

Keywords: Sciatic nerve block, below knew surgery, popliteal block, and ultrasound-guided nerve block

Introduction:

Peripheral nerve blocks guided by ultrasound are becoming more common. The implementation of real-time nerve imaging allows clinicians to directly visualize needle advancement and local anesthetic delivery. This has resulted in shorter treatment durations and improved block efficacy. [(1)]

The Popliteal Sciatic Nerve Block (PSNB) is employed to anesthetize the region innervated by the sciatic nerve and its branches in the popliteal fossa during lower limb surgeries. [(2)]

The sciatic nerve supplies both sensory and motor to the lower limbs, except for a small part of the inner side of the leg and foot, which gets its supply from the saphenous nerve, a branch of the femoral nerve. The sciatic nerve can be blocked higher up in gluteal area, around the middle of the thigh, or further down near the knee (called a popliteal block). [(3,4,5)]

The popliteal block can be performed either before or after the bifurcation of the sciatic nerve. [(6)] Popliteal nerve block can be done through the posterior (prone position) [(7)], lateral (either in a prone or supine position) [(8)], or medial approaches (supine orientation). [(9)]

There are pros and cons to each patient's position. Popliteal blocks performed while the patient is prone can necessitate repositioning to accommodate additional femoral nerve blocks or even surgical procedures. To execute a popliteal block in the supine position, it is essential to elevate the lower limb adequately to provide sufficient space around the knee joint for precise transducer placement. [(8)]

Objectives:

This study seeks to assess the optimal strategy with block performance duration and patient satisfaction.

Methods:

This randomized, double-blind study included 120 patients and was performed at Zagazig University Hospitals.

Inclusion Criteria:

Patients aged 21 to 50 years, of both genders. defined by the American Society of Anesthesiologists (ASA) as class I to II. Patients scheduled for below-knee surgery under ultrasound-guided popliteal nerve block, were included. The research obtained authorization from the Ethical Committee of the Faculty of Medicine at Zagazig University, Zagazig, Egypt (Code: 4428-4-3-2018). All patients were granted informed written consent. The trial is registered on clinicaltrials.gov (ID: NCT06489210).

Exclusion criteria:

Exclusion criteria for the study encompassed patient refusal, hypersensitivity to local anesthetics, peripheral nerve disease, bleeding disorder, diabetes, severe renal or hepatic dysfunction, infected wound at the area of the block, or prolonged use of analgesics.

Randomization and Blindness:

The assignment was hidden within sealed opaque envelopes. Both outcome assessors and patients were kept unaware of relevant information during the trial. An anesthesiologist not involved in the study performed the ultrasound-guided popliteal sciatic nerve block. Patients were randomly allocated into three equal groups: posterior approach (P) group, lateral approach (L) group, and medial approach (M) group.

Monitoring:

Once a patient arrived at the operating room, the patient was connected to monitor using pulse oximetry, non-invasive blood pressure, and ECG. An intravenous cannula was placed, and conscious sedation was attained with intravenous midazolam (0.01 to 0.05 mg/kg), with supplemental oxygen administered through a face mask during the surgery.

Procedure:

The (P) group positioned the patients in a prone orientation, fully extending their legs at the knees and aligning their hips in a neutral position. We positioned a high-frequency linear ultrasound transducer transversely over the popliteal crease. Next, the transducer was progressively moved proximally with caudal angulation, targeting the sciatic nerve prior to its bifurcation into the tibial and common peroneal nerves. Upon locating the sciatic nerve as a hyperechoic structure and positioned posteriorly (superficially) and laterally relative to the popliteal artery. we inserted a 20-gauge needle in-plane, 1 cm from the transducer on the lateral aspect. The (L) group comprised positioning the patient supine, elevating the affected leg, and gently flexing it at the knee. We positioned the transducer 3 cm superior to the in-plane needle insertion site on the lateral aspect of the thigh.

The (M) group positioned the patient’s supine, flexing the hips and knees of the operated side and externally rotating the thighs at an angle of about 45 degrees. The in-plane needle insertion site was located three centimeters above the transducer's medial boundary on the medial aspect of the thigh.

In all methodologies, following the insertion of the needle tip into the paraneural sheath, the local anesthetic mixture was administered in 5 ml increments, culminating in a total volume of 20 ml. This comprised 20-ml syringes containing 10 ml of 0.5% isobaric bupivacaine combined with 10 ml of 2% lidocaine, resulting in a

"doughnut sign" due to the circumferential distribution of the local anesthetic around the sciatic nerve. Patients were thereafter positioned supine, contingent upon the surgeon's technique and preferences.

If the surgical field involves the saphenous nerve's region, a supplementary block was given. The sensory and motor blocks of both components of the sciatic nerve were evaluated every 3 minutes until total blockade was attained, with a maximum duration of 45 minutes post-local anesthetic administration. The surgical procedure began upon the confirmation of sufficient sensory and motor blockage.

Postoperative Management: All patients were transferred to their designated wards. The degree of pain was assessed using a Visual Analogue Scale (VAS) score, and rescue analgesia (75 mg of injectable Diclofenac Sodium) was administered if the score exceeded 3, with re-administration every 6 hours as required.

Data recorded:

Primary Outcome: Block performance time, defined as the interval between patient positioning for the popliteal block to the subsequent repositioning to the standard supine position following local anesthetic injection and needle withdrawal.

The secondary outcome: Number of attempts to find the correct injection site, discomfort rates related to positioning, also needle insertion pain (graded as no discomfort, minimal discomfort, moderate discomfort, and extreme discomfort) and Patient satisfaction with anesthesia in the first 24 hours postoperatively, (graded as 0=poor, 1=fair, 2=good, and 3=excellent). [(10)]

Post-operative problems included vascular injury during the procedure, local anesthetic hypersensitivity and toxicity, and sciatic nerve injury. If had hypotension (mean arterial pressure <65 mmHg or a 20% decrease from baseline mean arterial pressure, treated with intravenous fluids), bradycardia (heart rate <50 beats per minute, managed with intravenous atropine 0.02 mg/kg), shivering (addressed with intravenous pethidine 30 mg bolus), nausea, vomiting (managed with intravenous ondansetron 4 mg), and discomfort.

Sample size:

In our pilot study of 15 cases (5 per group), the mean ± SD block performance times were 8.2±4.5 min, 7.4±2.5 min, and 5.7±2 min for P group, L group, and M group, respectively. Open Epi software evaluated 108 instances (36 per group) with 95% confidence and 90% power. This was raised to 120 instances (40 per group) for dropouts.

Statistical analysis

SPSS version 20.0 was used to collect, tabulate, and analyze all data. Quantitative data were presented as range and mean ± SD, whereas qualitative data represented as numbers and percentages. Multiple sets of normally

distributed variables were compared using a one-way ANOVA test. Repeated measurement ANOVA was used to compare repeated measurements within the same group at different intervals. The Chi-square test compared categorical variable percentages. All tests were two-sided. At a 95% confidence range, p-value ≤0.05 was considered statistically significant.

Results

A total of 120 patients participated in the study conducted at Zagazig University Hospitals. The clinical study was conducted in accordance with the CONSORT flow diagram depicted in Figure 1. The recruitment concluded upon the selection of a sufficient number of cases as determined by the sample size calculation.

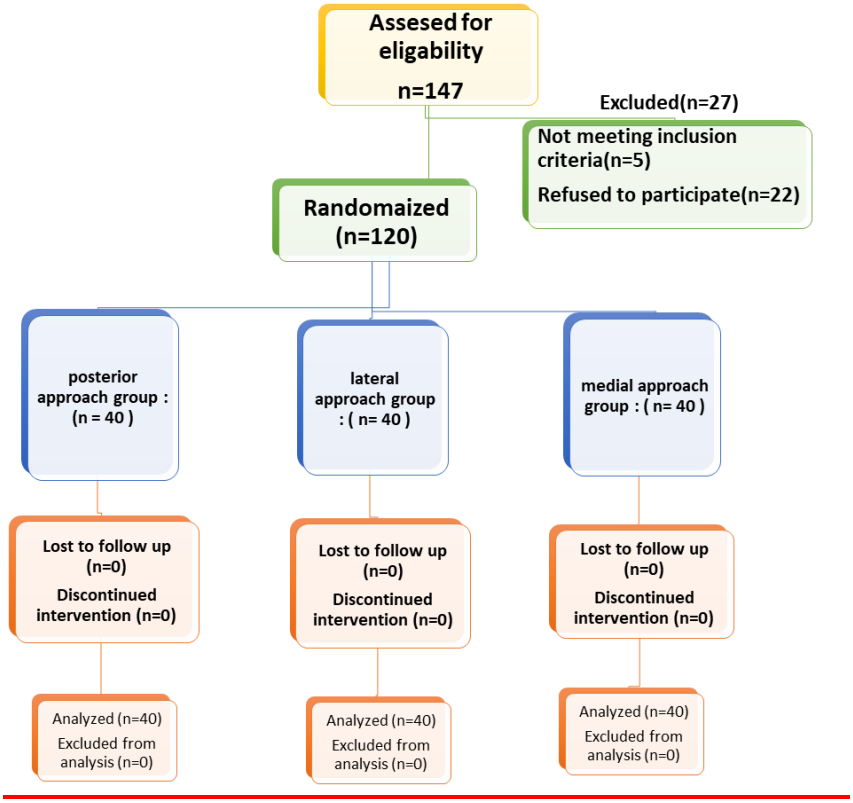

Figure 1 CONSORT diagram showing the flow of participants through each stage of a randomized trial.

The demographic characteristics of patients and the duration of procedures among the three examined groups were statistically equivalent (Table 1).

The frequency of efforts to identify the appropriate injection location was similar across the three methods (Table 2). The performance times for the US-guided popliteal block were 9.5±2.15 minutes for the (P) group, 5.6±1.25 minutes for the (L) group, and 5.35±1.35 minutes for the (M) group. Statistical analysis for block performance time in the (P) group was statistically substantially longer than in the other two groups with P1 < 0.001 and P2 < 0.001, but the (L) group and (M) group exhibited comparable timings with P3 = 0.77. (Table 2).

The discomfort rate linked to positioning in the (P) group was markedly greater than that of the (L) group and (M) group, although the discomfort rates in the latter two groups were similar. The discomfort level and intensity related to needle insertion were markedly reduced in the (P group) (Table 3).

Statistically, patient satisfaction about the quality of anesthesia provided by US-guided popliteal block through (P) group, (L) group, and (M) group was equivalent (Table 4). The related complications were not identified in the three groups.

Table 1: Demographic data, block added and duration of surgery of the three groups.

Variable	**(P) group (n=40)**	**(L) group (n=40)**	**(M) group (n=40)**	**Tests**	
				f/X^2	***P* value**
Age (years)	42.8±13.91	44.6±13.61	43.5±12.22	0.145	0.86
Weight (kg)	78.5±6.24	77.6±5.13	79.2±6.52	1.18	0.3
Height (cm)	170.3±2.79	169.1±2.79	169.63±3.52	1.13	0.32
BMI (kg/m^2)	25.30±2.15	25.37±2.25	24.94±2.46	0.31	0.73
Sex [No] Males/Females	28/12	26/14	27/13	0.22	0.89
ASA physical status [N]: I/II	21/19	23/17	22/18	0.2	0.9
Need to supplementary saphenous nerve block [N (%)]	17 (42.5%)	16 (40%)	18 (45%)		
Duration of surgery (min).	55.25±11.51	53.75±10.32	54.85±11.51		

Data are shown as Mean ± Standard Deviation (SD) and numbers (%).
n = group number. N (%) = Number and percent of variable in given group.
f = one-way ANOVA test. X2 = Chi square test. Significant when P≤0.05

Table 2: Technical characteristics of the three approaches.

Variable	**(P) group (n=40)**	**(L) group (n=40)**	**(M) group (n=40)**	***P* value**
Number of attempts to get the proper injection site [N (%)].				
1^{st} attempt	31 (77.5%)	29 (72.5%)	30 (75%)	P=0.87 P=0.93 P=0.9
2^{nd} attempt	6 (15.0)	7 (17.5%)	6 (15)	
3^{rd} attempt	3 (7.5%)	4 (10.0%)	4 (10.0%)	
Block performance time (min.)	9.5 ± 2.15	5.6 ± 1.25	5.35±1.35	P=<0.001 P1<0.001 P2<0.001 P3 = 0.77

Data are presented as Mean ± Standard Deviation (SD) and numbers (%).
n = group number. Significant when P≤0.05
P1=posterior group vs. lateral group. P2 =posterior group vs. medial group. P3 =lateral group vs. medial group.

Table 3: Patients' discomfort rate due to positioning and needle insertion of the studied groups.

Variable	(P) group (n=40)		(L) group (n=40)		(M) group (n=40)		Fischer Exact test		*P* value
	No.	(%)	No.	(%)	No.	(%)	X^2	*P* value	
Rate of patients' discomfort due to positioning [No (%)].	23	(57.5%)	2	(15%)	2	(15%)	33.1	<0.001	P1 <0.001 P2 <0.001 P3= NA
Rate of patients' discomfort due to needle insertion [No (%)].	19	(47.5%)	33	(82.5%)	33	(82.5%)			
The severity of patients' discomfort due to needle insertion [No (%)]:									
No discomfort with feeling no pain	21	(52.5%)	7	(17.5 %)	7	(17.5%)	20.8	<0.001	P1 <0.001 P2 <0.001 P3= NA
Minimal discomfort with feeling minimal pain.	15	(37.5 %)	13	(32.5 %)	13	(32.5%)			
Moderate discomfort with feeling moderate pain.	4	(10 %)	20	(50%)	20	(50%)			
Extremely discomfort with feeling extreme pain.	0	(0 %)	0	(0 %)	0	(0 %)			

Data are expressed by numbers and percentages. n = group number. X^2 = Chi square test.
P value<0.01 means a highly significant difference.
P1=posterior group vs. lateral group. P2 =posterior group vs. medial group. P3 =lateral group vs. medial group.
NA= Not applicable.

Table 4: The patients' satisfaction levels of the studied groups.

Variable	(P) group (n=40)		(L) group (n=40)		(M) group (n=40)		X^2	*P* value
	N	(%)	N	(%)	N	(%)		
Poor satisfaction.	0	(0%)	0	(0%)	0	(0%)	0.31	0.85
Fair satisfaction	0	(0%)	0	(0%)	0	(0%)		
Good satisfaction	8	(20%)	7	(17.5%)	9	(22.5%)		
Excellent satisfaction	32	(80%)	33	(82.5%)	31	(77.5%)		

Data are expressed by numbers and percentages. n =group number. X^2 = Chi square test.
N (%) = Number and percent of the variable in the corresponding group.
Significant when *P* value≤0.05

Discussion

The popliteal nerve block delivers comprehensive anaesthesia and analgesia for the sciatic nerve distribution below the knee during and post-surgery. [(11)] The current study found that the performance times for US-guided

popliteal block were 9.5±2.15 minutes for the posterior approach, 5.6±1.25 minutes for the lateral approach, and 5.35±1.35 minutes for the medial approach. Statistical analysis revealed that the performance time for the posterior approach was significantly longer compared to the lateral and medial approaches.

The recorded performance durations were comparable to those indicated by Ota et al., who discovered that the performance time for US-guided popliteal block via the posterior route exceeded that of the medial technique. [(3)] Yanaru et al. indicated that the duration for performing the popliteal block via the medial approach in the supine position was 1.8±0.5 minutes which was comparable 1.9±.0.3 min to the performance time for the popliteal block via the lateral approach in the supine position. [(12)]

Hadzic and Vloka, on the other hand, found that the lateral method took 8 minutes longer to block the sciatic nerve in the popliteal fossa than the posterior approach (6 minutes), from the time the needle was inserted to the time the nerve was successfully located. [(13)] According to van Geffen et al., the duration of a US-guided popliteal block via the posterior method was 6 minutes, calculated from the onset of distal sciatic nerve visualization to the withdrawal of the needle after local anesthetic administration. [(14)]

Prasad et al. conducted research revealing that the US-guided popliteal block using the lateral approach in a prone posture required an average of 9±3 minutes to perform, from setting up the ultrasound transducer to the end of the local anesthetic injection. [(7)]

The relative discrepancies in performance durations those reported by other researchers can be ascribed to differing definitions of block performance times, variations in operator speeds influenced by experience in US machine adjustment, differing patient body weights, distinct nerve localization techniques, diverse transducer placements, and multiple needle insertion attempts.

In this study, the attempts to locate suitable injection sites for US-guided popliteal block utilizing posterior, lateral, and medial techniques were similar, with most happening after the initial attempt in all three groups. This corresponds with the findings of Faiz et al., whereas Hassan et al. noted that significantly less needle attempts were necessary to get the accurate needle tip position in relation to the sciatic nerve when employing ultrasonic guidance as opposed to electric nerve stimulation. [(6,15)]

In our investigation, the posterior approach resulted in significantly greater discomfort during ultrasound-guided popliteal block compared to medial and lateral positioning. The posterior approach group experienced significantly less needle insertion discomfort and severity compared to the lateral and medial approaches. Several workers consented. Franco stated that the lateral popliteal block administered in the supine position was more comfortable than the posterior approach conducted in the prone position, whereas the posterior

method was more comfortable than the lateral and medial approaches regarding needle discomfort in the sciatic nerve. [16] The insertion of the needle for lateral and medial popliteal block resulted in greater discomfort compared to the posterior approach, as the needle traversed muscle or tendons in addition to skin and subcutaneous tissue. [17]

The study determined that ultrasound-guided popliteal nerve blocks, executed via posterior, lateral, and medial approaches, did not cause sciatic nerve injury, vascular puncture, hematoma development, local anesthetic toxicity, adverse cardiovascular or respiratory effects, or nausea and vomiting. These results validated the conclusions of several prior studies. van Geffen and Vloka found no complications associated with posterior ultrasound-guided popliteal blocks. [14,18]

Buys, Ali, Bang, and Zhu encountered no complications with the US-guided popliteal block administered via the lateral approach. [8,19,20,21] The US-guided popliteal block using a medial route posed no challenges for Taha and Yanaru. [9,12] The direct ultrasound visualization of the needle, sciatic nerve, and surrounding vascular structures mitigated nerve injury, local anesthetic toxicity, and vascular penetration. Frequent negative aspiration can prevent accidental intravascular local anaesthetic injection and subsequent toxicity. [22]

Patient satisfaction with ultrasound-guided popliteal block anesthesia via posterior, lateral, and medial routes was statistically equivalent. These findings aligned with those of other studies. Taboada et al. found that 92% (satisfactory), 8% (unsatisfactory) via the posterior approach and 96% (satisfactory), 4% (unsatisfactory) via the lateral approach of patients reported high satisfaction with the US-guided popliteal block [10] Eldegwy et al. discovered that 10% (Poor), 10% (fair), 39% good, and 50% (excellent) of patients expressed satisfaction with the US-guided popliteal block administered via the posterior approach anesthesia. [23]

In conclusion, when compared ultrasound-guided popliteal blocks by posterior approach, to the lateral and medial approaches result in less block performance time and little modifications to the patient's position. Nonetheless, it seems that the posterior method reduces needle insertion discomfort while maintaining patient satisfaction in all approaches.

Authors declared that they did not receive funding and had no conflict of interest about this research.

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