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Research Article

LATERAL APPROACH OF POPLITEAL BLOCK VERSUS UNILATERAL SPINAL ANESTHESIA FOR BELOW KNEE SURGERIES: A COMPARATIVE STUDY

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ABSTRACT

Objectives: The aims of the study were to compare efficacy and side effects of popliteal block and unilateral spinal anesthesia in patients undergoing below knee surgeries.

Methods: This was a comparative study comprising patients undergoing below knee surgeries. Sixty patients were divided into two groups depending on whether surgery was done under unilateral spinal anesthesia (Group SA) or popliteal block (Group PB). The parameters compared between the studied groups included hemodynamic changes, onset of motor block, onset and duration of analgesia, duration of motor block, onset of pain, and amount of rescue analgesia required. Side effects such as bradycardia, hypotension, cardiac arrhythmia, and urinary retention were compared between the two groups. SSPS 22.0 was used for statistical analysis and $p<0.05$ was taken as statistically significant.

Results: There were 14 (46.67%) males and 16 (53.33%) females, whereas, in Group PB, there were 13 (43.33%) males and 17 (56.67%) females. Mean age of patients in Group SA was found to be 42.93±16.79 and 39.57±14.05 in Group PB. The mean age and gender distribution and ASA grades of patients in both the groups were found to be comparable with no statistically significant difference. The mean duration of sensory as well as motor block was found to be significantly less in Group SA as compared to Group PB and the difference was statistically highly significant ($p<0.001$). Group PB showed a better hemodynamic as well as analgesic profile as compared to Group SA. The analgesic requirement in first 24 h was more in Group SA as compared to Group PB and the difference was statistically highly significant ($p<0.001$). Adverse effects in both the groups were comparable ($p>0.05$).

Conclusion: Popliteal block provides better analgesia and hemodynamic stability as compared to unilateral spinal anesthesia and, hence, can be considered preferred mode of anesthesia in patients undergoing lower limb surgeries.

Keywords: Popliteal block, Unilateral spinal anesthesia, Lower limb surgeries, Analgesia.

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INTRODUCTION

Both unilateral spinal anesthesia and popliteal block are effective anesthetic technique for below knee surgeries. The peripheral location of surgical sites in the lower limb surgery and possibility to block the pain pathways at multiple levels presents a clear advantage of regional anesthesia in these patients. When unilateral spinal anesthesia is planned, limiting the block to the lower dermatomal level and avoiding the occurrence of hypotension is important. The block of sciatic nerve at popliteal fossa is quite suitable for the lower limb surgery [1]. Lateral approach to the sciatic nerve through the popliteal fossa provides adequate anesthesia and post-operative analgesia. Patients having comorbidities require regional block particularly popliteal block for foot surgeries to prevent systemic decompensation. Regional anesthesia is preferred for the lower limb surgeries and spinal anesthesia is often a choice. Spinal anesthesia is a simple and quick technique, but it has risk of severe hypotension. Even though spinal anesthesia provides intense and reliable block, it has risk of limited duration of action [2].

Popliteal fossa block is a clinically valuable technique that results in anesthesia of calf, tibia, fibula, ankle, and foot. The Popliteal block is one of the most commonly used techniques in regional anesthesia practice for surgeries such as corrective foot surgery, foot debridement, short saphenous vein stripping, repair of Achilles tendon, and others. As opposed to the more proximal block of sciatic nerve, popliteal fossa block anesthetizes the leg distal to the hamstring muscles, allowing patients to retain knee flexion [3].

The sciatic nerve can be approached from either the posterior approach described by Duane Keith Rorie or the lateral approach described by jerry vloka. Both approaches provide equivalent anesthesia and are suitable for catheter placement. The popliteal sciatic nerve block is a form of regional anesthesia most commonly used as a form of post-operative analgesia. It has shown to be effective for 15–20 h postoperatively. It can also be used for various foot and ankle pathologies including fracture and dislocation reduction, exploration of foreign bodies, and bedside incision and drainage. The popliteal sciatic nerve block has an additional benefit in that it decreases amount of post-operative opioid consumption limiting the complications of these medications [4].

There are several techniques in administering this form of anesthesia including a posterior approach for prone patients or a lateral approach for a supine patient which requires less time. It is physician's preference whether the use of single or double injection technique is employed. However, ultrasound guidance and PNS machine-guided nerve stimulation are typically utilized during this procedure [5]. When using PNS machine-guided nerve stimulation, a plantar flexion response is more predictive of complete sensory blockade than a dorsiflexion response. Using ultrasound with PNS machine-guided nerve stimulation has greater efficacy at 60 min than using PNS machine-guided nerve stimulation alone. Popliteal fossa block performed with long acting local anesthetics such as ropivacaine can provide 12–24 h of analgesia after foot surgery. When used as a sole technique, popliteal fossa block provides excellent anesthesia and postoperative analgesia, allows use of a calf tourniquet, and avoids the disadvantages of neuraxial blockade [6].

Analgesia with popliteal fossa block lasts significantly longer than with ankle block. Popliteal fossa block has also been used as an effective

analgesic technique in children. Popliteal blocks can potentially be utilized as the sole source of anesthesia for foot and ankle surgery [7]. This can be beneficial in medically compromised patients. Profound analgesia during both the operative and post-operative time periods and the avoidance of systemic complications such as nausea and vomiting are also potential benefits of the popliteal nerve block. Other advantages include earlier discharge from the post-anesthesia care unit and decreased opiod consumption perioperatively [8].

There are several approaches to administering a popliteal sciatic nerve block all with unique advantages and disadvantages. Commonly, a posterior approach is employed with the patient positioned prone. Alternatively, the lateral approach can be used with patient in the supine position. The medial approach has been described in the literature, although it is less frequently utilized. There are various techniques when administering anesthetic to the therapeutic plexus of nerves of the popliteal fossa. Single and double injection, continuous infusion and bolus dosing through a perineural catheter, and the use of electrical stimulation with or without ultrasound guidance have all been described [9].

We conducted this study to compare efficacy and side effects of popliteal block and unilateral spinal anesthesia in patients undergoing below knee surgeries.

METHODS

This was a comparative study conducted in the department of anesthesiology in a tertiary care government hospital of Maharashtra India. Duration of study was 2 years from January 21 to December 22. Sixty patients undergoing below knee surgery were included in this study on the basis of a predefined inclusion and exclusion criteria. After obtaining approval from the Institutional Ethics Committee, all the patients were explained about the study procedure and written informed consent was obtained from the patients. The sample size was calculated on the basis of pilot study done on the subject of unilateral spinal anesthesia assuming 90% power and 95% confidence interval, the sample size required was 26 patients per arm (total 52). Based on central limit theorem, sample size was determined to be enough if it was more than 26 patients in each group thus, we included total 60 patients ie, 30 patients in each group.

A detailed history and pre-anesthetic evaluation was done on the previous day of the surgery. Routine investigations such as hemoglobin, blood grouping, serum electrolytes, and blood sugar will be measured. Patients were kept nil oral for 6 h before the surgery. All patients were monitored with electrocardiography, pulse oximetry, and blood pressure. Baseline heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and oxygen saturation (SpO_2) were monitored. A peripheral intravenous line was secured with 22 Gauge intravenous cannula and ringer lactate solution was started as maintenance fluid. The patients were pre-medicated with Injection Ondansetron (0.1 mg/kg) intravenous and Injection glycopyrrolate (4 μg/kg) intravenous.

Patients were randomized to either of the two groups depending on whether the surgery was done under unilateral popliteal block or unilateral spinal anesthesia and for this purpose computer based randomization was done. Thirty patients were included in each group.

Group PB: Thirty patients who were operated for under knee surgeries under popliteal block.

Group SA: Thirty patients who were operated for under knee surgeries under unilateral spinal anesthesia.

Group SA (Unilateral spinal anesthesia)
Under all aseptic precaution subarachnoid block was given with 25 g Quincke needle with 6 mg of 0.5% bupivacaine in lateral position with operative side down in midline L3-L4 interspace. The patient is kept in same position for 10 min to achieve selective unilateral spinal anesthesia. To achieve an exclusively unilateral block we used 0.5% hyperbaric bupivacaine which was injected at a rate of 0.33 ml/min or slower.

Group PB (Popliteal block)
Landmarks for the lateral approach to popliteal block include the popliteal fossa crease, vastus lateralis muscle, and biceps femoris muscle. The needle insertion site was marked in the groove between the vastus lateralis and biceps femoris muscles, 8 cm proximal to the popliteal crease. The site of needle insertion was cleaned with an antiseptic solution and infiltrated with local anesthetic. A 10-cm, 22-gauge needle was connected to a nerve stimulator inserted in a horizontal plane between the vastus lateralis and biceps femoris muscles, and advanced to contact the femur. The current intensity was initially set at 1.5 mA. Keeping the fingers of the palpating hands firmly pressed and immobile in the groove, the needle is then withdrawn to the skin, redirected 30° posterior to the angle at which the femur was contacted, and advanced toward the nerve. After the initial stimulation of the sciatic nerve was obtained, the stimulating current was gradually decreased until the motor response of the foot or toes (dorsiflexion or plantar flexion) was still seen or felt at 0.5 mA. The needle should was stabilized after the "click" is heard and after negative aspiration for blood, 30 mL (150 mg) 0f 0.5% bupivacaine was injected.

After completion of surgery, patients were shifted to post-anesthesia care unit (PACU). They were observed for side effects such as nausea, vomiting, pruritus, pain, and retention of urine. The patients were discharged from PACU after complete resolution of spinal block, with stable vital signs and spontaneous urination. The time of first request for analgesic was also noted.

The parameters compared between the studied groups included hemodynamic changes, onset of motor block, onset and duration of analgesia, duration of motor block, onset of pain, and amount of rescue analgesia required. Side effects such as bradycardia, hypotension, cardiac arrhythmia, and urinary retention were compared between the two groups.

Descriptive statistics were represented as percentages, mean, and standard deviation. SPSS version 22 (IBM SPSS Statistics, Somers NY, USA) was used for statistical analysis. Chi-square test, unpaired t-test, and fisher test were applied to find significance and $p<0.05$ was considered as statistically significant.

Inclusion criteria
The following criteria were included in the study:
1. Patients undergoing elective below knee surgeries
2. Those who gave informed written consent to be part of study
3. ASA grade I and II
4. Age group of 18–60 years of either sex.

Exclusion criteria
The following criteria were excluded from the study:
1. Those who refused consent
2. Any H/O bleeding disorder, coagulation abnormalities, and raised ICT
3. Skin infection at injection site
4. Neurodeficit involving lower limbs
5. ASA grade III and IV
6. Pregnant women.

RESULTS

The analysis of gender distribution of the cases showed that, in Group SA, there were 14 (46.67%) males and 16 (53.33%) females, whereas, in Group PB, there were 13 (43.33%) males and 17 (56.67%) females. Comparison of the cases on the basis of gender distribution showed that the groups were comparable with no statistically significant difference (Table 1).

Table 1: Gender distribution of the studied cases

Gender distribution of studied cases	Group, count (%)	
Sex	**SA**	**PB**
Female	16 (53.33)	17 (56.67)
Male	14 (46.67)	13 (43.33)

p=0.795 (not significant). SA: Spinal anesthesia, PB: Popliteal block

Table 2: Age distribution of the cases in both the groups

Age (years)	Group, count (%)	
	SA	**PB**
≤30	10 (30.00)	11 (36.67)
30–40	6 (16.67)	5 (13.33)
41–50	4 (10.00)	6 (20.00)
51–60	10 (30.00)	8 (26.67)
Mean age	42.93±16.79	39.57±14.05

p=0.530 (not significant). SA: Spinal anesthesia, PB: Popliteal block

In Group SA, 10 (30%) patients were below 30 years of age, whereas 10 (30%) patients were above 50 years of age (Table 2). In Group PB, most common age group was <30 years (36.67%), followed by 51–60 years (26.67%), 41–50 years (20%), and 30–40 years (13.33%). Mean age of patients in Group SA was found to be 42.93±16.79 and 39.57±14.05 in Group PB. The mean age of patients in both the groups was found to be comparable with no statistically significant difference (p=0.530) (Table 2).

Mean weight, in Group SA, was 59.5±4.93 and, in Group PB, was 57.37±5.24. There was no significant difference in mean weight comparison between two groups (Table 3).

Analysis of the patients on the basis of ASA grades showed that there were 10 (33.33%) patients having ASA grade I in both the groups whereas 20 (66.67%) patients belonged to ASA II in each of the groups. ASA grades of patients in both the groups were found to be comparable with no statistically significant difference (Table 4).

Mean onset of sensory block in Group SA was 10.97±2.08 min and in Group PB was 15.6±3.41 min. Mean onset of motor block in Group SA was 13.27±2.36 min and in Group PB was 19.53±3.63 min. Mean onset of sensory as well as motor block was significantly less in SA group as compared to PB group and the difference was statistically highly significant (p<0.001). Similarly, mean duration of sensory block in SA and PB group was found to be 92.2±10.86 and 679.8±47.43 min, respectively, whereas mean duration of motor block in Group SA and PB was found to be 144±10.33 min and 773.6±46.42 min. The mean duration of sensory as well as motor block was found to be significantly less in Group SA as compared to Group PB and the difference was statistically highly significant (p<0.001) (Table 5).

There was a significant difference in mean HR between two groups at post-induction 10 min and at 16 h. There was a significant difference in mean SBP between two groups at the time of block to post-induction 10 min, at 4 h, and at 16 h. There was a significant difference in mean DBP between two groups at the time of block, 4 hrs and from 16 hrs to 18 hrs after block. At rest of the times, HR, SBP, and DBP were found to be comparable with no significant difference. Mean SpO_2 levels were found to be comparable in both the groups all the times (p>0.05) (Table 6).

Mean VAS score was more in Group SA as compared to Group PB at all the times from 1 h to 24 h. The difference was found to be statistically significant at 1 h and the difference was highly significant rest of the times (Table 7).

There was a significant difference in requirement of rescue analgesia in both the groups. In SA group, 13 (43.33%) patients required two doses

Table 3: Mean weight in studied cases

Weight	Group SA	Group PB
Mean weight (kg)	59.5±4.93	57.37±5.24

p=0.110 (not significant). SA: Spinal anesthesia, PB: Popliteal block

Table 4: Comparison of the American Society of Anesthesiologists grades of studied cases

ASA grades	Group, count (%)	
	SA	**PB**
I	10 (33.33)	10 (33.33)
II	20 (66.67)	20 (66.67)

p=1.00 (not significant). ASA: American Society of Anesthesiologists, SA: Spinal anesthesia, PB: Popliteal block

of rescue analgesia, whereas 17 (56.67%) patients required three doses of analgesia. IN PB group, all patients required only one dose of rescue analgesia. The analgesic requirement in first 24 h was more in Group SA as compared to Group PB and the difference was statistically highly significant (p<0.001) (Table 8).

The patients in both the groups were compared for adverse effects. There were no major adverse events in any of the patients in both the groups. Two (6.66%) patients in Group SA developed nausea which could be controlled by injection ondansetron (4 mg IV). No patient in Group PB developed nausea or any other side effect. The side effects profile of patients in both the groups was found to be comparable with no statistically significant difference (p=0.15).

DISCUSSION

Peripheral nerve blocks are ideally suited for all minor, substantial proportion of major surgeries, and for ambulatory surgery due to the peripheral location of the surgical site and the potential to block pain pathways at multiple levels [10]. In contrast to other anesthetic techniques, such as general or spinal anesthesia, properly conducted peripheral nerve blocks avoid hemodynamic instability and pulmonary complications, excellent for post-operative pain management, and timely discharge. Additional advantages of peripheral nerve block are generally not contraindicated in patients taking anticoagulants, they can be used in patients with spinal pathology, sacral disease, and avoid the need for airway instrumentation [11].

The popliteal block or block of the sciatic nerve in the popliteal fossa is an excellent anesthetic choice for below knee surgeries. Zetlaoui and Bouaziz found that while the lateral approach appeared to be techniqually more demanding, the added advantage of the lateral technique was more convenient as far as patient positioning and catheter placement was concerned [12]. The term unilateral spinal anesthesia is used when block is of operative site only with absence of block on non-operative side. Enk *et al*. found that when surgery involves only one lower limb, such block is advantageous as it minimizes cardiovascular effects, avoids motor block of non-operative limb, and facilitates early discharge [13].

There was a significant difference in mean HR between two groups at post-induction 10 min and at 16 h. There was a significant difference in mean SBP between two groups at the time of block to post-induction 10 min, at 4 h, and at 16 h. There was a significant difference in mean DBP between two groups at the time of block, 4 h and from 16 h to 18 h. Rest of the times both the groups remained comparable. Similar hemodynamic profile in both the groups was also reported by the authors such as Karaarslan *et al*. [14] and Zhang *et al*. [15].

In our study, we observed that onset of sensory block was earlier in study group of unilateral spinal anesthesia, having a mean value of

Table 5: Onset and duration of sensory and motor block in studied cases

Sensory and motor block in cases (min)	SA	PB	Significance
Onset of sensory block	10.97±2.08	15.6±3.41	<0.001* (Highly significant)
Onset of motor block	13.27±2.36	19.53±3.63	<0.001* (Highly significant)
Duration of sensory block	92.2±10.86	679.8±47.43	<0.001* (Highly significant)
Duration of motor block	144±10.33	773.6±46.42	<0.001* (Highly significant)

SA: Spinal anesthesia, PB: Popliteal block

Table 6: Comparison of hemodynamic parameters and oxygen saturation in both the groups

HR, SBP, DBP, and SpO_2	Group SA	Group PB	p
HR			
Pre-induction	82.47±8.48	81.07±8.54	0.527
At the time of block	94.4±10.08	90.93±10.05	0.187
At the time of surgery	90.43±9.87	89.67±9.53	0.761
After 10 min	86.6±9.05	81.47±5.29	0.009*
30 min	86.22±8.61	85.7±8.84	0.895
1 h	83.17±8.2	84.2±9.18	0.647
2 h	82.47±8.48	82.44±8.48	1
4 h	78.57±6.54	82.47±8.42	0.051
6 h	79.67±7.34	82.46±8.46	0.177
8 h	82.47±8.48	82.47±8.48	1
12 h	82.47±8.48	82.44±8.48	1
16 h	76±5.2	82.48±8.40	0.001*
18 h	82.47±8.48	82.47±8.48	1
24 h	81.07±8.54	82.42±8.42	0.527
SBP			
Pre-induction	124.6±8.41	124.7±8.43	0.951
At the time of block	103±7.26	132.6±8.76	<0.001*
At the time of surgery	108.1±6.32	127.3±9.5	<0.001*
After 10 min	117±7.24	121.6±9.69	0.043*
30 min	115.6±11.28	115.3±11.44	0.928
1 h	116.3±7.18	112.1±12.13	0.105
2 h	124.6±8.41	124.7±8.43	0.951
4 h	118.1±6.71	124.7±8.43	0.001*
6 h	121.8±7.67	124.7±8.43	0.164
8 h	120.9±9.54	124.7±8.43	0.102
12 h	124.6±8.41	124.7±8.43	0.951
16 h	120.4±8.2	124.7±8.43	0.047*
18 h	124.6±8.41	124.7±8.43	0.951
24 h	122.1±8.2	124.7±8.43	0.219
DBP			
Pre-induction	81.87±6.01	81.6±5.57	0.859
At the time of block	72.13±6.83	87.87±5.17	<0.001*
At the time of surgery	83.4±6.61	83.4±6.61	1
After 10 min	78.6±6.37	78.53±6.37	0.968
30 min	75.07±7.4	75.02±7.37	0.972
1 h	74.27±6.34	71.8±8.68	0.214
2 h	81.87±6.01	81.87±6.01	1
4 h	77.73±5.42	81.87±6.01	0.007*
6 h	79.57±6.14	81.87±6.01	0.148
8 h	78.9±5.6	81.87±6.01	0.053
12 h	81.87±6.01	81.87±6.01	1
16 h	77.1±5.04	81.87±6.01	0.002*
18 h	77.2±5.93	81.87±6.01	0.004*
24 h	81.6±5.57	81.87±6.01	0.859
SpO_2			
Pre Induction	99.58 ± 0.46	99.30 ± 0.82	P > 0.05
At the time of block	99.46 ± 0.84	99.44 ± 0.746	P > 0.05
At the time of surgery	99.38 ± 0.52	99.24 ± 0.64	P > 0.05
After 10 mins	99.36± 0.50	99.34 ± 0.72	P > 0.05
30 mins	99.24 ± 0.82	99.60 ± 0.56	P > 0.05
1 hour	99.34 ± 0.70	99.20 ± 0.66	P > 0.05
2 hours	99.52 ± 0.68	99.42 ± 0.72	P > 0.05
4 hours	99.12 ± 0.88	99.32 ± 0.80	P > 0.05
6 hours	98.70 ± 1.10	99.40 ± 0.70	P > 0.05
8 hours	99.10 ± 0.70	99.18 ± 0.52	P > 0.05
12 hours	99.34 ± 0.58	98.90 ± 0.94	P > 0.05
16 hours	99.12 ± 0.82	99.30 ± 0.54	P > 0.05
18 hours	99.30 ± 0.62	99.40 ± 0.64	P > 0.05
24 hours	99.12 ± 0.74	99.44 ± 0. 72	P > 0.05

HR: Heart rate, SBP: Systolic blood pressure, DBP: Diastolic blood pressure SpO_2: Oxygen saturation, SA: Spinal anesthesia, PB: Popliteal block

Table 7: Comparison of visual analog scale scores in both the groups at various intervals

VAS score (h)	Group SA			Group PB			p
	Mean	Median	SD	Mean	Median	SD	
1	0.13	0	0.35	0	0	0	0.039*
2	1.47	1	0.51	0	0	0	<0.001*
4	3.27	3	0.74	0	0	0	<0.001*
6	4.07	4	0.58	0.2	0	0.41	<0.001*
8	4.93	5	0.74	0.2	0	0.41	<0.001*
12	6.93	7	0.64	4.93	5	0.87	<0.001*
16	8.1	8	0.66	6.5	6.5	0.51	<0.001*
18	8.8	9	0.61	7.5	7.5	0.51	<0.001*
24	9.13	9	0.43	8.57	9	0.5	<0.001*

VAS: Visual analog scale, SA: Spinal anesthesia, PB: Popliteal block, SD: Standard deviation

Table 8: Requirement of rescue analgesic doses within 24 h of surgery

Rescue analgesic doses within 24 h of post-operative (doses)	Count (%)	
	SA	PB
1	0	30 (100)
2	13 (43.33)	0
3	17 (56.67)	0

p<0.001 (highly significant). SA: Spinal anesthesia, PB: Popliteal block

onset of sensory block in min. In group, unilateral spinal anesthesia was 10.97±2.08 min and in popliteal nerve block group, mean value of onset of sensory block in min was 15.6±3.41. There was a significant difference in mean onset of sensory block in min comparison between two groups. Similar observations were also made by the authors such as Imbelloni who found the mean onset of sensory block in unilateral spinal anesthesia group to be 10.20±2.02 min with 0.5% hyperbaric bupivacaine 6 mg dose for below knee surgeries [16]. Similarly, Taboada *et al*. who reported that onset of sensory block in popliteal nerve block group was 16.6±5.1 min after single injection of 30 mL of 0.5% bupivacaine [17].

In our study, we observed that onset of motor block in min in unilateral spinal anesthesia group was 13.27±2.36 min and in popliteal nerve block group, it was 19.53±3.63 min. There was a significant difference in mean onset of motor block in min between two groups. This observation matches well with study conducted by Krobot *et al*. which showed duration of motor block in unilateral spinal anesthesia group was 10.20±3.26 min and, in popliteal nerve block group, it was 20.34±2.14 min [18]. Similarly, Hossary *et al*. found that onset of motor block in unilateral spinal anesthesia group was 10.2±3.02 min and in popliteal nerve block group 16.23±2.3 min [19]. There was a significant statistical difference in mean duration of motor block in min between two groups.

In our study, mean duration of sensory block in unilateral spinal anesthesia and popliteal block group was found to be 92.2±10.86 and 679±47.43 min, respectively. Mean duration of motor block in unilateral spinal anesthesia and popliteal block group was 144±10.33 and 773.6±46.42 min, respectively.

There was a significant statistical difference in mean duration of motor block in between two groups. Similar findings were also reported by the authors such as Jeon *et al*. who reported that mean duration of sensory as well as motor block was more in popliteal block group as compared to unilateral spinal group ($p<0.05$) [20].

Adverse effects were found to be comparable in both the groups with no statistically significant difference ($p<0.05$).

CONCLUSION

Popliteal block is preferable over unilateral spinal anesthesia in patients undergoing lower limb surgeries due to its excellent analgesic properties, hemodynamic stability, and comparable adverse effect profile.

CONFLICTS OF INTEREST

None.

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