ORIGINAL ARTICLE

Comparative Study Between Ultrasound-Guided Femoro-sciatic Nerve Block Versus Unilateral Spinal Anesthesia in below Knee Orthopaedic Surgeries

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Abstract

Background: ***It has been recognized that both spinal anesthesia and peripheral nerve blocks offer adequate anesthesia, improved analgesia following surgery, and enhanced case satisfaction compared to general anesthesia. Ultrasound-guided femoro-sciatic nerve block (UFSB) is increasingly favored due to the prevention of negative consequences correlated with the conventional technique.***

Aim: ***The goal of this research is to compare ultrasound-guided femoro-sciatic nerve block and unilateral spinal anesthesia in elective below-knee orthopedic operations.***

Methods: ***This prospective comparative study, included 100 patients undergoing elective below knee surgery. Cases have been randomized utilizing a computer-generated randomization table into 2 equal groups with fifty cases in each group. Group (ULSA) received unilateral spinal anesthesia, whilst group (UFSB) received ultrasound-guided femoro-sciatic nerve block. The primary outcome was to compare the success rates of the two methods.***

Results: ***This study demonstrated a statistically non-significant variance among UFSB group and ULSA group within Success rate (92 vs 96 %, p=0.709) respectively. There was a statistically significant variance regarding onset and recovery duration from sensory and motor block. Postoperative narcotic sparing was more frequently encountered in UFSB group, compared to ULSA group (92 vs. 76 %), with significant comparison (P = 0.016).***

Conclusion: ***Both ULSA and UFSB lead to sufficient anesthesia during surgery and postoperative analgesia with stable hemodynamics and adequate case satisfaction with low negative consequences. UFSB was superior to ULSA in analgesia following surgery, evidenced by prolonged duration to the first rescue analgesia and lower analgesia consumption.***

Keywords: Femoral nerve block; Sciatic nerve block; Unilateral spinal anesthesia; Pain Management

1. Introduction

Orthopedic operations below the knee have become common because of the efficacy of anesthesia methods, which allow safe and rapid discharge. Regional anesthesia methods act as a substitute for general anesthesia in these types of surgeries. It has been recognized that both spinal anesthesia and peripheral nerve blocks offer adequate anesthesia, improved analgesia following surgery, and enhanced case satisfaction compared to general anesthesia.[1]

Routinely, spinal anesthesia with bupivacaine is given for lower limb operations. The motor block helps the surgeons' work, whereas the nerve block is enough to ensure a painless operation in this case. Indeed, several adjuvants were added to local anesthesia to prolong the period of spinal anesthesia. Nevertheless, these are correlated with negative consequences.[2]

Cases undergoing unilateral lower limb operation are more likely to prefer unilateral spinal anesthesia (ULSA) because nerve blocking is limited to the targeted area, resulting in high satisfaction among cases and early mobilization. Furthermore, ULSA is recognized for maintaining hemodynamic stability.[3]

Unilateral lower limb operation additionally utilizes the combined sciatic–femoral nerve block (FSNB). It is less commonly utilized due to its prolonged period to conduct, the need for a greater local anesthetic dose, and the occurrence of paresthesia.[4]

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The use of ultrasound guidance in regional nerves is becoming more common, and it is commonly utilized for anesthesia and pain control following surgery in these patients. This provides the benefits of effective anesthesia during surgery and prolonged analgesia following surgery.[5]

Ultrasound-guided femoro-sciatic nerve block (UFSB) is increasingly favored due to the prevention of negative consequences correlated with the conventional technique. It has several advantages, including rapid onset of nerve blocking, enhanced block quality, reduced needle insertions, reduced local anesthetic dose, and short administration time.[6]

The goal of this research is to compare UFSB and ULSA in elective below-knee orthopedic operations.

2. Patients and methods

This trial adheres to the tenets outlined in the Consolidated Standards of Reporting Trials (CONSORT) guidelines. This prospective comparative study included 100 patients undergoing elective surgery below the knee at the Orthopedics department of Al-Azhar University Hospitals. Cases have been randomized utilizing a computer-generated randomization table into two equal groups with fifty cases in each group:

Group (ULSA): patient who underwent unilateral spinal anesthesia.

Group (UFSB): patients who underwent Ultrasound-guided femoro-sciatic nerve block.

Inclusion criteria:

Cases between the ages of eighteen and sixty-five.

Scheduled to undergo orthopedic surgery below the knee, including subchondral bone drilling, diabetic foot debridement, below-knee amputation, fixation with K-wire fracture metatarsal bone, Nancy nail removal, tibial plate removal, and other operating techniques.

American Society of Anesthesiologists (ASA) physical status I-III.

Exclusion criteria:

Allergies. Neurological disease. Localized infections.

Coagulopathy. Anatomical abnormalities of the spinal column.

Morbid obesity. Chronic analgesic therapy.

Patients' refusal to participate. Previous femoral artery grafts or injuries.

Outcome assessment

The primary outcome was to compare the success rates of the two methods. Secondary outcomes involved the period of the block, the time required to complete the motor and sensory blocks, the complications following surgery, and satisfaction of the enrolled cases.

Procedure

The case has been placed in a sitting position and underwent unilateral spinal anesthesia. The iliac crest was palpated following the aseptic method, and the thumb was extended to meet the midline to feel the space between L3-4 or L4-5. Subsequently, subcutaneous injection of 1:2 milliliter of one percent lidocaine has been injected. Subsequently, a 22-gauge spinal needle has been inserted. Following the confirmation of the proper position of the spinal needle by the free flow of cerebrospinal fluid (CSF), 10 mg of 0.5 percent hyperbaric bupivacaine has been slowly administered during a 1-minute period with no aspiration. The case has been positioned in the lateral decubitus position on the same side as the operating limb for 20 min following the withdrawal of the spinal needle. Subsequently, sympathetic motor and sensory functions have been assessed.

Assessments were conducted immediately following spinal injections, at five-minute intervals for a period of 10 minutes, and at fifteen-minute intervals till the end of the operation and the regression of the block to the L2 level. A 23-gauge hypodermic needle has been used to evaluate sensory block, which has been defined as a whole absence of sensation to a pinprick. A modified Bromage scale has been used to evaluate motor block.

Femoral nerve block

Once the case has been appropriately positioned for femoral nerve blockade, the skin has been sterilized using two percent povidone-iodine. A gel was applied to the probe, and it was subsequently placed in a sterile sheath. The wide-band transducer (five to ten megahertz, SonoScape®, SSI-6000, China) has been positioned over the inguinal region to visualize the femoral vein and artery. The nerve is located just lateral to the artery and appears in cross-section as a hyper-echoic, oval structure or a speckled triangular structure. Rotation and tilt were necessary to enhance the visualization of this nerve compression, aiding in the differentiation between veins and arteries. Ultimately, color Doppler imaging has been correlated with real-time ultrasound in every patient. Aspiration has been attempted with the syringe for checking blood to prevent accidental vascular puncture after the needle tip had passed through the fascia iliaca and fascia lata and entered the femoral nerve compartment. After imaging confirmed the position, five milliliters of two percent lidocaine and ten milliliters of 0.5 percent bupivacaine were injected in five milliliter boluses following aspiration to prevent intravascular injection. Any pain or resistance during the injection required the needle to be repositioned to prevent intraneural injection.[7]

Sciatic nerve block: (subgluteal method)

To interpret and detect motor responses, the cases have been placed laterally, with the side to be anesthetized uppermost and the knees and hips flexed. Exposure to the calf, hamstrings, and foot is required. Subsequently, the ischial tuberosity and the lateral prominence of the greater trochanter were determined, and a line was drawn between the two landmarks using a skin marking pen. After imaging confirmed the position, five milliliters of two percent lidocaine and ten milliliters of 0.5 percent bupivacaine were injected in five milliliter boluses following aspiration to prevent intravascular injection. Any pain or resistance during the injection required the needle to be repositioned to prevent intraneural injection.[8]

Statistical analysis

The minimum sample size for this research has been determined utilizing Epi Info Version 7, using an eighty percent power, ninety-five percent confidence limit, the ratio between the control and intervention groups is 1:1, and, regarding the research performed by Saleh et al., the sample size was 90 cases. With a 10% dropout rate, this study finally included 100 cases.

SPSS version 20 was utilized for recording data, preparation, and statistical analysis. Both the mean and the standard deviation were employed to analyze parametric quantitative data, whilst the inter-quartile range (IQR) and median were utilized for non-parametric quantitative data. Non-numerical data has been analyzed using frequency and percentage. The students' t-test was used on continuous parameters that follow a normal distribution. The Mann–Whitney U test has been adopted to judge the statistical significance of the disparity in a non-parametric variable. P-values below 0.05 have been deemed statistically significant.

3. Results

This research demonstrated which statistically insignificant variance was observed among UFSB group and ULSA group regarding age, gender, ASA and BMI (Table 1). Figure 1 depicted the flow diagram illustrating the study procedure and the rationale for exclusion that occurred during the entire study duration.

Table 1. demographic characteristic of studied groups.

	GROUP (ULSA) N = 50	GROUP (UFSB) N = 50	P VALUE
AGE MEAN ±SD	35.73±9.4	34.71±9.2	0.584
GENDER N (%)			
MALE	32 (64%)	29 (58%)	0.538
FEMALE	18 (36%)	21 (42%)	
ASA N (%)			
ASA I	18 (36)	20 (40)	0.417
ASA II	30 (60)	27 (54)	
ASA III	2 (4)	3 (6)	
BMI (KG/M^2) MEAN ±SD	21.75±4.6	23.64±3.92	0.291

BMI, body mass index; ASA, American Society of Anesthesiologists

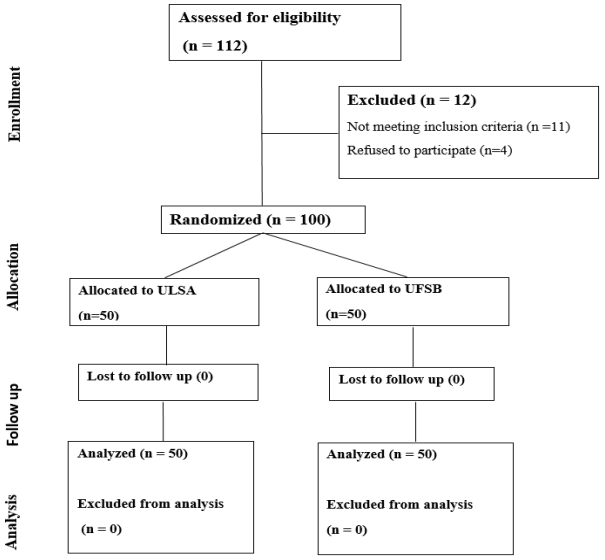

Figure 1. Flow diagram of the study process.

The primary outcome

This research demonstrated that statistically non-significant variance was observed among UFSB group and ULSA group within Success rate (92 vs 96 %, p=0.709) respectively (Table 2).

Table 2. Success rate among the study groups.

	GROUP (ULSA) N= 50	GROUP (UFSB) N= 50	P VALUE
SUCCESS RATE	46 (92%)	48 (96%)	0.709

Data presented as number (%)

Secondary outcomes

Table 3 demonstrated that statistically insignificant variance was observed among the groups, regarding the operation time, while statistically significant variance was observed concerning recovery period from motor blocking. Moreover, highly statistically significant variance was observed regarding onset of motor block, recovery duration from sensory and motor block, and onset of sensory block, as detailed in table 3.

Table 3. Comparison between groups according to operation, recovery, sensory and motor block timings.

	GROUP (ULSA) N = 50	GROUP (UFSB) N = 50	P VALUE
OPERATION TIME (MIN) (MEAN ±SD)	60.50±18.33	58.45±19.78	0.5921
ONSET OF SENSORY BLOCK (MIN) (MEAN ±SD)	3.70±1.15	9.60±2.29	≤0.0001*
ONSET OF MOTOR BLOCK (MIN) (MEAN ±SD)	4.59±1	14.00±1.35	≤0.0001*

TIME FOR RECOVERY FROM SENSORY BLOCK (H) (MEAN ±SD)	2±0.90	5.45±3	≤0.0001*
TIME FOR RECOVERY FROM MOTOR BLOCK (H) (MEAN ±SD)	3.00±0.92	4.00±2.75	0.0166*

*P value <0.05 is statistically significant

In addition, morphine 2mg IV was administered postoperatively as opioid rescue analgesia, if VAS score was> 4. Postoperative narcotic sparing was more frequently encountered in UFSB group, compared to ULSA group (92 vs. 76 %), with significant comparison (P = 0.016) (Table 4). In ULSA group, 5 patients required more than one dose of morphine to keep VAS ≤ 3, compared to 2 patients in UFSB group (P = 0.027), as shown in (Table 4).

Table 4. Comparison between the groups according to postoperative opioid rescue analgesia.

	ULSA N=50	UFSB N=50	X^2	P VALUE
MORPHINE (2MG)				
YES	12 (24)	4 (8)	4.812	0.016*
NO	38 (76)	46 (92)		
FREQUENCY				
1 DOSE	7 (14)	2 (4)	5.408	0.027*
2 DOSES	2 (4)	1 (2)		
3 DOSES	3 (6)	1 (2)		

Values are expressed as number (%)

*P value <0.05 is statistically significant

Moreover, the average 24-hour consumption of morphine was greater in ULSA group than UFSB group (3.51 vs. 2.84 mg, P=0.001). Ketorolac-paracetamol consumption showed similar findings, with non-significant result. Furthermore, the period to first administration of morphine was more prolonged in UFSB group, than ULSA group, with significant comparison (11.21 vs. 4.58 hours, P-value = 0.001).

Table 5. Comparison of patient satisfaction between the studied groups.

PATIENT SATISFACTION	GROUP (ULSA) N= 50	GROUP (UFSB) N= 50	P VALUE
EXCELLENT	16 (32%)	25 (50%)	0.234
GOOD	18 (36%)	16 (32%)	
SATISFACTORY	11 (22%)	7 (14%)	
UNSATISFACTORY	5 (10%)	2 (4%)	

Data presented as number (%)

Moreover, this research demonstrated that statistically insignificant variance was observed among studied groups regarding patient satisfaction (Table 5). Regarding complications, insignificant variance has been stated among the research groups, concerning headache, paresthesia, nausea and vomiting (Table 6).

Table 6. Complications between the study groups.

COMPLICATIONS	GROUP (ULSA) N= 50	GROUP (UFSB) N= 50	P VALUE
NAUSEA/VOMITING	3(6%)	5(10%)	0.543
HEADACHE	3(6%)	0(0%)	3.093
PARESTHESIA	2(4%)	7(14%)	3.053

Data presented as number (%)

4. Discussion

In this research, a statistically insignificant variance was observed among UFSB group and ULSA group according to operation time, while statistically significant variance was observed among UFSB group and ULSA group according to recovery period from motor block and highly statistically significant variance was observed regarding onset of motor block, period of motor block, onset of sensory block, recovery period from sensory block and period of sensory block.

This result was consistent with Hussein et al., who found that statistically insignificant variance was observed among the ULSA group and UFSB group according to operation time, while highly statistically significant variance was observed according to the onset of motor block, period of motor block, onset of sensory block, recovery period from sensory block, and period of sensory block. Regarding the onset of motor and sensory blocks, it was significantly longer in group B than in group A, while the recovery period for motor and sensory blocks was shorter in group A than in group B.[3]

Also, this result was consistent with AHMED et al., who reported that statistically insignificant variance was observed among the FSNB group and ULSA group according to operation time, while highly statistically significant variance was observed among the UFSB group and ULSA group according to period of sensory block, onset of motor block, period of motor block, and onset of sensory block. Onset of motor and sensory block was longer in the combined sciatic–femoral nerve block technique compared to the unilateral spinal anesthesia technique; nevertheless, the period of motor and sensory block was shorter in the unilateral spinal anesthesia technique compared to the combined sciatic–femoral nerve block technique.[9]

As well, this result was consistent with Shah et al., who aimed to compare the efficiency and safety of unilateral spinal anesthesia and USG-guided SFB according to quality of block, hemodynamic stability, and analgesia following surgery for below-knee operating cases.[10] The enrolled eighty cases were randomly classified into two groups:

Group A: cases received unilateral spinal anesthesia with hyperbaric injection of

ropivacaine 0.75% 1.5 milliliters, and Group B: cases received ultrasound-guided sciatic–femoral nerve block with thirty milliliters of 0.5 percent ropivacaine (fifteen milliliters for the femoral nerve block and fifteen milliliters for the sciatic nerve block). They found that surgical anesthesia time (SAT) and the mean time for peripheral nerve block onset were longer in Group B than in Group A and were discovered to be significant. The mean period for obtaining complete motor blocking was faster in Group A (8 mins vs. 15 mins).

Moreover, this study demonstrated that highly statistically significant variance was observed among UFSB group and ULSA group according to first rescue analgesia (Morphine) (min) and Cumulative morphine consumption during the 1st 24 hours.

This result was consistent with Saleh et al., who found that the cumulative morphine consumption in the unilateral spinal anesthesia group was 63.1 milligrams, while it was 19.3 milligrams in the ultrasound-guided femoro-sciatic nerve block group (p-value < 0.001). Moreover, the period of the first application of analgesia was more prolonged in the ultrasound-guided femoro-sciatic nerve block group, rather than the unilateral spinal anesthesia group (347.2 vs. 182.63 minutes, p-value < 0.001).[11]

Also, this result was consistent with AHMED et al., who found that a highly statistically significant variance was observed among the FSNB group and the ULSA group regarding total analgesic requirement (milligrams) and first rescue analgesia (minutes) (P<0.001).[9]

As well, this result was consistent with Shah et al. (2023), who reported that a highly statistically significant variance was observed among the two examined groups, with the period to first rescue analgesic being greater in Group B (265.71±33.69 mins) than in Group A (132.40±17.41 mins).[10]

Furthermore, Davarci et al. aimed to investigate the comparison between ultrasound-guided sciatic–femoral nerve block and unilateral spinal anesthesia in cases undergoing knee operation.[12] A total of 40 cases have been enrolled in the research, comparing the USA group against the UFSB group. They found that highly statistically significant variance was observed among the USA group and the UFSB group regarding first rescue analgesia, as the mean time-to-1st analgesia requirement was significantly longer in the ultrasound-guided sciatic–femoral nerve block group compared to the unilateral spinal anesthesia group (P-value = 0.0001).

In this study, we demonstrated that statistically insignificant variance was observed between studied groups in complications, including nausea/vomiting, Headache, paresthesia, Transient neurological symptoms, and low back pain.

This result was consistent with AHMED et al., who found that no statistically significant variance was observed among studied groups in complications, including vomiting and nausea, Headache, and paresthesia.[9]

Furthermore, this result was consistent with Karaduman et al., who aimed to compare the clinical effectiveness and safety of an ultrasound-guided combined sciatic-femoral nerve block with spinal anesthesia in lower limb operating techniques. They observed that statistically insignificant variance was observed among the studied groups in complications, including nausea/vomiting and Headache.[13]

Moreover, this study found no statistically significant variance among the examined groups according to patient satisfaction. This result was consistent with AHMED et al. who found that no statistically significant difference regarding patient satisfaction.

Also, this result was consistent with Davarci et al., who reported that while case satisfaction was improved in the ultrasound-guided sciatic–femoral nerve block group compared with the unilateral spinal anesthesia group, insignificant variance was observed among both groups.[12] This result was consistent with Shah et al., who reported that statistically insignificant variance was observed among examined groups in terms of patient satisfaction.[10] Conversely, Hussein et al. discovered that there was a significant difference between the USG-guided SFB group and the ULSA group regarding patient satisfaction.[3]

Limitations: This study had some limitations including the relatively small sample size and being a single-centered study. In addition, dermatomal distribution of sensory block was not applicable. Further studies of multi-center design are recommended to validate this outcome.

4. Conclusion

Both ULSA and UFSB lead to sufficient anesthesia during surgery and postoperative analgesia with stable hemodynamics and adequate case satisfaction with low negative consequences. UFSB was superior to ULSA in analgesia following surgery, evidenced by prolonged duration to the first rescue analgesia and lower analgesia consumption.

Disclosure

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All authors have a substantial contribution to the article

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Conflicts of interest

There are no conflicts of interest.

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