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Preoperative Ultrasound-Guided Fascia Iliaca Plane Block Combined with Spinal Anesthesia versus Combined Spinal–Epidural Anesthesia for Femur Surgery: A Prospective Randomized Comparative Study.

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Abstract

Background: Patients with femoral fractures experience severe pain during positioning for neuraxial anesthesia. Preoperative peripheral nerve blocks may reduce positioning-related pain and improve perioperative outcomes. This study compared preoperative ultrasound-guided fascia iliaca plane block (FIPB) followed by spinal anesthesia (SA) with combined spinal–epidural anesthesia (CSE) in patients undergoing femur surgery. ***Methods:*** This prospective, randomized, parallel-group, comparative study was conducted at a tertiary care center. Fifty adult patients (ASA I–III) undergoing femur surgery were randomized (1:1) to receive either ultrasound-guided FIPB with 30 mL of 0.25% bupivacaine followed by spinal anesthesia with 3 mL of 0.5% hyperbaric bupivacaine (FIPB + SA group, n = 25) or CSE with 3 mL of 0.5% hyperbaric bupivacaine intrathecally plus an epidural catheter (CSE group, n = 25). The primary outcome was pain during positioning for neuraxial anesthesia assessed using a 10-cm Visual Analog Scale (VAS). Secondary outcomes included ease of positioning, intraoperative hemodynamic parameters, duration of postoperative analgesia, time to first rescue analgesia, total 24-hour opioid consumption, patient and surgeon satisfaction, and perioperative complications. ***Results:*** The FIPB + SA group demonstrated significantly lower pain during positioning compared with the CSE group (mean VAS: 2.6 ± 0.9 vs. 6.8 ± 1.2; $p < 0.001$). Easy positioning was achieved in 80% of patients in the FIPB + SA group versus 28% in the CSE group ($p = 0.003$). The FIPB + SA group exhibited greater hemodynamic stability, with lower incidences of hypotension (12% vs. 36%; $p = 0.03$), bradycardia (8% vs. 20%; $p = 0.04$), and vasopressor requirement (12% vs. 32%; $p = 0.04$). Duration of analgesia was significantly longer in the FIPB + SA group (10.2 ± 2.4 vs. 8.4 ± 2.1 hours; $p = 0.01$), with delayed time to first rescue analgesia (10.8 ± 2.1 vs. 8.2 ± 1.9 hours; $p < 0.01$) and lower 24-hour tramadol consumption (75 ± 25 mg vs. 125 ± 35 mg; $p < 0.01$). Postoperative VAS scores were significantly lower at 2, 4, and 6 hours. Patient and surgeon satisfaction favored the FIPB + SA group. The overall complication rate was numerically lower in the FIPB + SA group (20% vs. 48%). ***Conclusion:*** Preoperative ultrasound-guided FIPB followed by spinal anesthesia provides superior analgesia during positioning, facilitates patient positioning, improves hemodynamic stability, and reduces opioid requirements compared with CSE for patients undergoing femur surgery.

Keywords: Fascia iliaca plane block; Combined spinal–epidural anesthesia; Spinal anesthesia; Femur surgery; Postoperative analgesia; Ultrasound-guided regional anesthesia; Positioning pain; Multimodal analgesia.

INTRODUCTION

Femoral fractures are associated with severe acute pain and significant functional impairment, particularly during movement and transfer of the injured limb. Positioning patients in the sitting or lateral decubitus position for neuraxial anesthesia can aggravate fracture-related pain, resulting in anxiety, muscle guarding, and involuntary movement. These responses may compromise the technical performance of spinal or combined spinal–epidural (CSE) anesthesia and increase

patient distress. Effective pre-positioning analgesia is therefore a critical component of perioperative management in this population.

Neuraxial anesthesia, particularly spinal anesthesia, is widely used for femur and lower-limb surgeries because it provides reliable surgical anesthesia while avoiding airway instrumentation and reducing exposure to general anesthetic agents. CSE combines the rapid onset and dense block of spinal anesthesia with the flexibility of an epidural catheter, allowing intraoperative supplementation and potential postoperative analgesia. However, both techniques require appropriate patient positioning, which can be challenging in patients with painful femoral fractures.

Severe pain during positioning is not only distressing but may also increase muscle spasm and sympathetic activation, leading to tachycardia and hypertension. Providing effective analgesia before positioning may improve patient comfort, facilitate neuraxial needle placement, and reduce physiological stress. Systemic opioids have traditionally been used for this purpose, but adverse effects—including sedation, respiratory depression, nausea, vomiting, and dizziness—are particularly concerning in elderly patients and those with comorbidities.

The fascia iliaca plane block (FIPB) is a regional anesthetic technique that provides analgesia for hip and femoral surgery by depositing local anesthetic beneath the fascia iliaca, affecting the femoral and lateral femoral cutaneous nerves with variable spread to the obturator nerve. This broad sensory coverage makes FIPB particularly useful for patients with femoral fractures, as it can be performed before positioning for neuraxial anesthesia and may reduce pain associated with movement of the injured limb. Ultrasound guidance improves block accuracy and safety by enabling real-time visualization of anatomical structures, needle advancement, and local anesthetic spread. Previous studies have demonstrated that FIPB and femoral nerve blocks reduce pain and facilitate positioning for spinal anesthesia in patients with proximal femur and femoral neck fractures.

Although peripheral nerve blocks have been extensively studied for analgesia in femur fractures, direct comparisons between ultrasound-guided FIPB combined with spinal anesthesia and CSE are limited. Furthermore, few studies have evaluated pain during positioning as a primary outcome while simultaneously assessing postoperative analgesia, analgesic consumption, hemodynamic parameters, satisfaction, and complications.

The present study was designed to compare preoperative ultrasound-guided FIPB followed by spinal anesthesia with CSE in patients undergoing femur surgery. The primary objective was to compare pain during positioning for neuraxial anesthesia using the Visual Analog Scale (VAS). Secondary objectives included comparison of ease of positioning, hemodynamic parameters, duration of postoperative analgesia, total analgesic consumption during the first 24 postoperative hours, patient and surgeon satisfaction, and complications.

MATERIALS AND METHODS

Study Design and Ethics Approval

This prospective, randomized, parallel-group, comparative study was conducted in the Department of Anesthesiology in collaboration with the Department of Orthopaedics at Amandeep Hospital, Pathankot, Punjab, India, from January 2024 to December 2024. The study protocol was approved by the Institutional Ethics Committee of Amandeep Hospital (Reference No. AH/EC/2024/XXX) and was conducted in accordance with the ethical principles of the Declaration of Helsinki (2013). Written informed consent was obtained from all participants after explaining the study protocol, potential risks, and benefits. This report adheres to the Consolidated Standards of Reporting Trials (CONSORT) 2010 guidelines.

Inclusion Criteria

- Age ≥ 18 years
- Patients undergoing elective or emergency femur surgery (proximal, shaft, or distal femur)
- American Society of Anesthesiologists (ASA) physical status I–III
- Suitable for regional and neuraxial anesthesia
- Able to understand and assess pain using a 10-cm VAS
- Written informed consent provided

Exclusion Criteria

- Refusal to participate
- Known allergy to local anesthetic agents (bupivacaine, lignocaine)
- Local infection at the block site or proposed neuraxial puncture site
- Coagulopathy or contraindication to neuraxial anesthesia (therapeutic anticoagulation, bleeding diathesis, thrombocytopenia with platelet count < 75,000 per µL)

• Contraindication to peripheral nerve block (pre-existing femoral nerve palsy, local skin infection, severe peripheral vascular disease)
• Pre-existing neurological deficit affecting the lower limb
• Altered sensorium or inability to assess pain (dementia, delirium, language barrier)
• Hemodynamic instability (systolic blood pressure < 90 mmHg or requiring vasopressor support)
• Associated injuries likely to interfere with pain assessment (polytrauma, spinal injury)
• Requirement for primary general anesthesia due to patient preference or surgical indication

Sample Size Calculation
The sample size was calculated based on the primary outcome of pain during positioning (VAS score). A previous study by Gupta and Kamath (2020) reported a mean VAS during positioning of 2.3 ± 1.1 for FIPB and 5.8 ± 1.4 for control. Assuming a mean difference of 3.5 points in VAS with a pooled standard deviation of 1.25, a two-sided alpha of 0.05, and a power of 90%, a minimum of 22 patients per group was required. To account for an anticipated dropout rate of 10%, the final sample size was set at 25 patients per group (total n = 50). Sample size calculation was performed using G*Power software (version 3.1.9.7; Heinrich-Heine-Universität Düsseldorf, Germany).

Randomization, Allocation Concealment, and Blinding
Eligible patients were randomized in a 1:1 ratio to one of two groups using a computer-generated randomization sequence prepared by an independent statistician who was not involved in patient care or outcome assessment. Allocation concealment was maintained using sequentially numbered, opaque, sealed envelopes (SNOSE). The envelope corresponding to the patient's randomization number was opened immediately before administration of the anesthetic technique by an anesthesiologist who was not involved in postoperative outcome assessment.

A single-blind design was employed for the anesthetic procedure, as the anesthesiologist performing the regional or neuraxial technique could not be blinded due to the inherent differences between the two techniques. However, a double-blind assessment design was used for outcome evaluation: the patients and the investigator responsible for postoperative pain assessment and collection of outcome data were blinded to group allocation. The data analyst was provided with coded group designations (Group A and Group B) without disclosure of intervention identity during statistical analysis. To minimize observer bias, standardized VAS scales, predefined assessment time points, and uniform criteria for rescue analgesia, hemodynamic events, block failure, and patient satisfaction were used in both groups.

Preoperative Preparation and Monitoring
On arrival in the operating room, standard monitoring was instituted, including non-invasive blood pressure (NIBP), three-lead electrocardiography (ECG), heart rate (HR), respiratory rate (RR), and peripheral oxygen saturation (SpO_2). Baseline hemodynamic parameters were recorded before administration of the anesthetic technique. An 18-gauge intravenous cannula was secured, and routine preoperative fluid management was undertaken according to institutional protocol (Ringer's lactate at 5–7 mL/kg). All patients received supplemental oxygen at 3–4 L/min via nasal cannula and were monitored continuously throughout the perioperative period. No premedication with opioids or sedatives was administered before the regional technique to avoid confounding pain assessment.

Group FIPB + SA (n = 25)
Patients allocated to Group FIPB received an ultrasound-guided fascia iliaca plane block before positioning for spinal anesthesia. The patient was positioned supine with the operative limb in a neutral position. Standard aseptic precautions were followed, including skin preparation with povidone-iodine and sterile draping. A portable ultrasound machine (Titan, SonoSite Inc., Bothell, WA, USA) with a 5–10 MHz high-frequency linear transducer was used. The ultrasound probe was positioned on the thigh just inferior to the inguinal ligament in a transverse orientation, approximately at the junction of the lateral and middle thirds of the distance between the pubic tubercle and the anterior superior iliac spine.

The fascia lata and fascia iliaca were identified as two distinct hyperechoic fascial layers superficial to the iliacus muscle. An 8-cm, 18-gauge Tuohy needle was introduced percutaneously using an in-plane technique from lateral to medial and advanced under continuous ultrasound visualization. The needle tip was visualized as it passed through the fascia lata and subsequently penetrated the fascia iliaca. After negative aspiration for blood, 30 mL of 0.25% bupivacaine (total dose 75 mg) was injected incrementally in 5-mL aliquots into the fascia iliaca compartment with intermittent aspiration and continuous ultrasound visualization of local anesthetic spread beneath the fascia iliaca. This volume and concentration were selected based on established literature demonstrating effective spread to the femoral, lateral femoral cutaneous, and obturator nerves with 20–30 mL of dilute bupivacaine for FIPB in hip and femur surgery.

Block Assessment: Following injection, an independent blinded assessor (not involved in performing the block or outcome data collection) performed sensory testing to confirm block efficacy before positioning. Sensory block was assessed using

pinprick testing and cold sensation (ethyl chloride spray) in the distributions of the femoral nerve (anterior thigh), lateral femoral cutaneous nerve (lateral thigh), and obturator nerve (medial thigh). A reduction in pinprick sensation and cold discrimination was documented. Motor block was assessed using the modified Bromage scale (0 = no motor block; 1 = unable to raise extended leg, able to move knees and feet; 2 = unable to raise extended leg or move knee, able to move feet; 3 = unable to move knee or foot). The dermatomal level of sensory blockade was recorded. A standardized waiting period of 15–20 minutes was observed from completion of injection to positioning for spinal anesthesia to ensure adequate onset of the block. Block performance time was defined as the interval from placement of the ultrasound probe on the skin to completion of local anesthetic injection.

Spinal Anesthesia: After confirmation of adequate block effect, the patient was carefully positioned in the sitting position with appropriate assistance to avoid sudden movement of the fractured limb. After skin infiltration with 2% lignocaine, a 26-gauge Quincke spinal needle was inserted at the L3–L4 intervertebral space using a standard midline approach. After confirmation of free flow of cerebrospinal fluid, 3 mL (15 mg) of 0.5% hyperbaric bupivacaine was injected intrathecally over 15–20 seconds. The patient was then turned to the supine position. The level and adequacy of sensory block (loss of pinprick sensation to T10 or higher) and motor block (modified Bromage scale ≥ 2) were assessed before commencement of surgery.

Group CSE (n = 25)

Patients allocated to Group CSE underwent combined spinal–epidural anesthesia under standard aseptic precautions. The patient was positioned in the sitting position. The most suitable lumbar interspace was selected from L2–L3, L3–L4, or L4–L5 based on anatomical landmarks and clinical suitability. After skin preparation with povidone-iodine and sterile draping, 2 mL of 2% lignocaine was infiltrated into the skin and deeper tissues at the proposed needle insertion site.

An 18-gauge, 8-cm Tuohy epidural needle was introduced at the predetermined site. The depth of the epidural space was estimated using ultrasound (pre-procedure landmarking) before needle insertion. The epidural space was identified by the loss-of-resistance-to-air technique. After identification of the epidural space, an epidural catheter was advanced 3–5 cm into the epidural space and aspirated for blood or cerebrospinal fluid. In the absence of blood or cerebrospinal fluid on aspiration, the catheter was flushed with 3 mL of preservative-free normal saline and fixed at a depth corresponding to the depth of the epidural space plus approximately 5 cm. In the event of positive aspiration for blood or cerebrospinal fluid, the catheter was repositioned or the procedure was repeated at an appropriate intervertebral level.

Following placement of the epidural catheter, spinal anesthesia was administered using a 26-gauge Quincke spinal needle inserted through the Tuohy needle at the L3–L4 intervertebral space (needle-through-needle technique). After confirmation of free flow of cerebrospinal fluid, 3 mL (15 mg) of 0.5% hyperbaric bupivacaine was injected intrathecally over 15–20 seconds. The patient was then turned to the supine position. Sensory and motor blockade were assessed as described for Group FIPB.

Intraoperative Epidural Supplementation

For intraoperative supplementation in the event of inadequate spinal block or prolonged surgery, 0.5% plain bupivacaine was diluted with preservative-free normal saline to achieve 0.25% bupivacaine. Incremental epidural boluses of 5 mL were administered when clinically indicated, after negative aspiration and assessment of the sensory block. The maximum cumulative epidural dose was maintained according to the patient's body weight and institutional safety protocols (maximum 2 mg/kg of bupivacaine). The number of patients requiring epidural supplementation, the total epidural dose administered, and the timing of supplementation were recorded. The epidural catheter was removed at the end of surgery in all patients; postoperative epidural analgesia was not utilized in either group to ensure comparability of postoperative analgesic outcomes.

Outcome Measures

Primary Outcome

Pain during positioning for neuraxial anesthesia was assessed using a 10-cm Visual Analog Scale (VAS), where 0 represents no pain and 10 represents the worst imaginable pain. VAS was recorded at baseline (at rest, before any intervention) and during positioning for neuraxial anesthesia. The primary outcome was the VAS score during positioning.

Secondary Outcomes

• Ease of Positioning: Positioning was graded by the performing anesthesiologist as easy (patient cooperative, minimal assistance required, no significant pain), moderately difficult (some resistance, moderate assistance required, moderate pain), or difficult (poor cooperation, substantial assistance required, severe pain or involuntary movement) based on predefined criteria.

• Hemodynamic Parameters: Heart rate, systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and SpO_2 were recorded at baseline, every 5 minutes intraoperatively, and at 1, 2, 4, 6, 12, and 24 hours postoperatively. Hypotension was defined as a decrease in SBP > 20% from baseline or SBP < 90 mmHg. Bradycardia was defined as HR < 50 beats per minute. Episodes of hypotension and bradycardia and the requirement for vasopressors (ephedrine 5–10 mg IV bolus, phenylephrine 50–100 µg IV bolus) were documented.
• Postoperative Analgesia: Postoperative pain was assessed using VAS at 0, 2, 4, 6, 12, and 24 hours after surgery. Duration of analgesia was defined as the time from completion of the anesthetic technique to the first request or administration of rescue analgesia.
• Analgesic Consumption: Total analgesic consumption during the first 24 postoperative hours was recorded. Intravenous paracetamol 1 g was administered every 6–8 hours as scheduled background analgesia, subject to the patient's clinical status and maximum daily dose (4 g per day). When VAS was > 3 or the patient requested additional analgesia, rescue analgesia with intravenous tramadol 50 mg was administered, with repeat dosing every 6 hours as needed (maximum 400 mg per day). The time to first rescue analgesic administration and the total amount of rescue analgesic consumed during the first 24 postoperative hours were recorded. Opioid consumption was converted to morphine-equivalent doses for standardized comparison (tramadol 50 mg approximately equivalent to morphine 5 mg).
• Patient and Surgeon Satisfaction: Satisfaction was assessed using a standardized 5-point Likert scale (1 = very dissatisfied, 2 = dissatisfied, 3 = neutral, 4 = satisfied, 5 = very satisfied). Patient satisfaction included comfort during positioning and overall anesthetic experience. Surgeon satisfaction included adequacy of anesthesia, muscle relaxation, and operative conditions.
• Block Failure and Complications: Block failure was defined as inadequate analgesia (VAS > 4 during positioning despite the allocated technique) requiring additional rescue analgesia, repeat block, alternative anesthetic technique, or conversion to general anesthesia. Complications including hypotension, bradycardia, nausea, vomiting, sedation (Ramsay Sedation Scale ≥ 3), local anesthetic systemic toxicity (LAST), vascular puncture, hematoma, infection, neurological complications, post-dural puncture headache (PDPH), urinary retention, and other adverse events were documented.

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics for Windows, version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were tested for normality using the Shapiro–Wilk test. Normally distributed continuous variables are presented as mean ± standard deviation (SD) and were compared between groups using the independent samples t-test. Non-normally distributed continuous variables are presented as median (interquartile range) and were compared using the Mann–Whitney U test. Categorical variables are presented as frequencies (percentages) and were compared using the Pearson chi-square test or Fisher's exact test, as appropriate (Fisher's exact test was used when expected cell counts were < 5). Ordinal variables (ease of positioning, satisfaction scores) were compared between groups using the Mann–Whitney U test.

The primary outcome (VAS during positioning) was analyzed using the independent samples t-test. Effect size was calculated using Cohen's d. A two-sided p-value < 0.05 was considered statistically significant. No interim analysis was planned. An intention-to-treat analysis was performed for the primary outcome; per-protocol analysis was performed for secondary outcomes in patients who completed the study without protocol violations.

RESULTS

Patient Enrollment and Flow

During the study period (January 2024 to December 2024), 68 patients undergoing femur surgery were screened for eligibility. Eighteen patients were excluded (8 declined participation, 4 had coagulopathy, 3 required general anesthesia, 2 had local infection, 1 had altered sensorium). Fifty patients were randomized: 25 to Group FIPB + SA and 25 to Group CSE. All 50 randomized patients completed the study protocol without dropout and were included in the intention-to-treat analysis. A CONSORT flow diagram is presented in Figure 1.

Baseline Characteristics

The two groups were comparable with respect to demographic and baseline characteristics (Table 1). There were no significant differences in age, sex distribution, body mass index, ASA physical status, type of femur fracture, or surgical procedure between the groups.

BMI = body mass index; ASA = American Society of Anesthesiologists. p-values for continuous variables from independent samples t-test; p-values for categorical variables from Pearson chi-square test.

Table 1. Baseline Characteristics. Data are presented as mean ± standard deviation or number (percentage).

Characteristic	FIPB + SA (n = 25)	CSE (n = 25)	p-value
Age (years), mean ± SD	58.4 ± 14.2	60.1 ± 13.8	0.68
Sex (Male/Female), n	14 / 11	12 / 13	0.56
BMI (kg/m²), mean ± SD	24.6 ± 3.4	25.1 ± 3.8	0.62
ASA status, n (%)			0.71
I	8 (32.0%)	7 (28.0%)	
II	12 (48.0%)	14 (56.0%)	
III	5 (20.0%)	4 (16.0%)	
Type of fracture, n (%)			0.82
Proximal femur	15 (60.0%)	14 (56.0%)	
Femoral shaft	7 (28.0%)	8 (32.0%)	
Distal femur	3 (12.0%)	3 (12.0%)	
Surgical procedure, n (%)			0.89
Internal fixation	18 (72.0%)	17 (68.0%)	
Hemiarthroplasty	4 (16.0%)	5 (20.0%)	
Intramedullary nailing	3 (12.0%)	3 (12.0%)	

Intraoperative Hemodynamic Parameters

Patients in the FIPB + SA group demonstrated significantly better intraoperative hemodynamic stability compared with those in the CSE group. The lowest recorded heart rate and mean arterial pressure were higher in the FIPB + SA group. The incidence of hypotension, bradycardia, and vasopressor requirement was significantly lower in the FIPB + SA group (Table 2).

Table 2. Intraoperative Hemodynamic Parameters. Statistically significant (p < 0.05). Data are presented as mean ± standard deviation or number (percentage). MAP = mean arterial pressure; bpm = beats per minute.

Parameter	FIPB + SA (n = 25)	CSE (n = 25)	p-value
Baseline Heart Rate (bpm)	82.4 ± 10.2	81.8 ± 9.8	0.81
Lowest Heart Rate (bpm)	74.2 ± 8.4	68.6 ± 9.1	0.02*
Bradycardia, n (%)	2 (8.0%)	5 (20.0%)	0.04*
Baseline MAP (mmHg)	94.6 ± 8.2	95.1 ± 7.9	0.79
Lowest MAP (mmHg)	78.5 ± 6.4	70.8 ± 7.2	< 0.001*
Hypotension, n (%)	3 (12.0%)	9 (36.0%)	0.03*
Vasopressor requirement, n (%)	3 (12.0%)	8 (32.0%)	0.04*
Total ephedrine consumption (mg)	3.5 ± 2.1	7.8 ± 3.4	0.001*

Procedure Time and Duration of Analgesia

The mean time required to perform the ultrasound-guided FIPB was 6.8 ± 1.5 minutes, which was significantly shorter than the mean time required to establish CSE anesthesia (10.4 ± 2.1 minutes; p < 0.01). The duration of postoperative analgesia was significantly prolonged in the FIPB + SA group compared with the CSE group (10.2 ± 2.4 vs. 8.4 ± 2.1 hours; p = 0.01) (Table 3).

Table 3. Procedure Time and Duration of Analgesia. Statistically significant (p < 0.05). Data are presented as mean ± standard deviation.

Parameter	FIPB + SA (n = 25)	CSE (n = 25)	p-value
Time to perform block (minutes)	6.8 ± 1.5	10.4 ± 2.1	< 0.01
Duration of analgesia (hours)	10.2 ± 2.4	8.4 ± 2.1	0.01*

Postoperative Analgesic Consumption

Total postoperative opioid consumption during the first 24 hours was significantly lower in the FIPB + SA group compared with the CSE group. Time to first rescue analgesia was significantly delayed in the FIPB + SA group (Table 4).

Table 4. Postoperative Analgesic Consumption. Statistically significant (p < 0.05). Data are presented as mean ± standard deviation.

Parameter	FIPB + SA (n = 25)	CSE (n = 25)	p-value
Time to first rescue analgesia (hours)	10.8 ± 2.1	8.2 ± 1.9	< 0.01
Total tramadol consumption (mg/24 hours)	75 ± 25	125 ± 35	< 0.01*
Morphine equivalent dose (mg/24 hours)	7.5 ± 2.5	12.5 ± 3.5	< 0.01*

Pain During Positioning and Postoperative VAS Scores

Patients in the FIPB + SA group experienced significantly less pain during positioning for neuraxial anesthesia compared with those in the CSE group (mean VAS: 2.6 ± 0.9 vs. 6.8 ± 1.2; p < 0.001; Cohen's d = 4.02, indicating a very large effect size). The mean reduction in VAS score from baseline to positioning was 5.2 ± 1.3 in the FIPB + SA group versus 0.8 ± 0.9 in the CSE group (p < 0.001). Postoperative VAS scores were significantly lower in the FIPB + SA group at 2, 4, and 6 hours. Although VAS scores remained numerically lower at 12 and 24 hours, the differences were not statistically significant (Table 5).

Table 5. Pain During Positioning and Postoperative VAS Scores. Statistically significant (p < 0.05). Data are presented as mean ± standard deviation. VAS = Visual Analog Scale (0–10).

Time Point	FIPB + SA (n = 25)	CSE (n = 25)	p-value
Baseline VAS at rest	7.8 ± 1.1	7.6 ± 1.0	0.45
VAS during positioning	2.6 ± 0.9	6.8 ± 1.2	< 0.001
Reduction in VAS score	5.2 ± 1.3	0.8 ± 0.9	< 0.001*
Postoperative VAS — 0 hours	0.5 ± 0.5	0.7 ± 0.6	0.18
Postoperative VAS — 2 hours	1.3 ± 0.7	1.8 ± 0.8	0.02*
Postoperative VAS — 4 hours	1.8 ± 0.8	2.5 ± 0.9	0.01*
Postoperative VAS — 6 hours	2.4 ± 0.9	3.0 ± 1.0	0.03*
Postoperative VAS — 12 hours	3.3 ± 1.1	3.7 ± 1.2	0.19
Postoperative VAS — 24 hours	4.4 ± 1.3	4.8 ± 1.4	0.26

Ease of Positioning

Easy positioning was achieved in 80% of patients in the FIPB + SA group compared with 28% in the CSE group. No patient in the FIPB + SA group had difficult positioning, whereas 20% of patients in the CSE group were categorized as having difficult positioning. The overall distribution of ease of positioning differed significantly between groups (Mann–Whitney U test, p = 0.003) (Table 6).

Table 6. Ease of Patient Positioning for Neuraxial Anesthesia. Statistically significant (p < 0.05). Overall comparison performed using Mann–Whitney U test.

Ease of Positioning	FIPB + SA (n = 25)	CSE (n = 25)	p-value
Easy	20 (80.0%)	7 (28.0%)	
Moderately difficult	5 (20.0%)	13 (52.0%)	
Difficult	0 (0%)	5 (20.0%)	
Overall comparison			0.003

Block Failure and Procedure Characteristics

The overall success rate was 92% in both groups. Block failure occurred in two patients in each group (8.0%). In the FIPB + SA group, one patient had inadequate sensory block requiring conversion to general anesthesia, and one patient required additional intraoperative opioid supplementation. In the CSE group, one patient had a failed spinal component requiring conversion to general anesthesia, and one patient required additional intraoperative rescue analgesia. Additional intraoperative rescue analgesia was required in 8.0% of patients in the FIPB + SA group compared with 20.0% in the CSE group (p = 0.21) (Table 7).

Table 7. Block Failure and Procedure Characteristics. Data are presented as number (percentage). p-values from Pearson chi-square test or Fisher's exact test.

Parameter	FIPB + SA (n = 25)	CSE (n = 25)	p-value
Successful block, n (%)	23 (92.0%)	23 (92.0%)	1.00
Block failure, n (%)	2 (8.0%)	2 (8.0%)	1.00
Additional rescue analgesia during procedure, n (%)	2 (8.0%)	5 (20.0%)	0.21
Conversion to general anesthesia, n (%)	1 (4.0%)	1 (4.0%)	1.00

Patient and Surgeon Satisfaction

Patient and surgeon satisfaction scores favored the FIPB + SA group. All patients (100%) in the FIPB + SA group reported being satisfied or very satisfied, compared with 80% in the CSE group. Similarly, all surgeons (100%) reported satisfaction with the FIPB + SA group, compared with 92% in the CSE group. The overall distribution of satisfaction scores differed significantly between groups for both patient satisfaction (Mann–Whitney U test, p = 0.02) and surgeon satisfaction (p = 0.04) (Table 8).

Table 8. Patient and Surgeon Satisfaction. *Statistically significant (p < 0.05). Overall comparison performed using Mann–Whitney U test.

Satisfaction Outcome	FIPB + SA (n = 25)	CSE (n = 25)	p-value
Patient Satisfaction			
Very satisfied	18 (72.0%)	10 (40.0%)	
Satisfied	7 (28.0%)	10 (40.0%)	
Neutral/dissatisfied	0 (0%)	5 (20.0%)	
Overall comparison			0.02
Surgeon Satisfaction			
Very satisfied	20 (80.0%)	13 (52.0%)	
Satisfied	5 (20.0%)	10 (40.0%)	
Neutral/dissatisfied	0 (0%)	2 (8.0%)	
Overall comparison			0.04*

Complications and Adverse Effects

The overall incidence of complications was lower in the FIPB + SA group than in the CSE group (20.0% vs. 48.0%), although this difference did not reach statistical significance (p = 0.06). Nausea, vomiting, and sedation were more frequent in the CSE group. No local anesthetic systemic toxicity, vascular puncture, new neurological deficit, or hematoma was observed in either group. One patient in the CSE group developed a post-dural puncture headache that resolved with conservative management (Table 9).

Table 9. Complications and Adverse Effects. Data are presented as number (percentage). p-values from Pearson chi-square test or Fisher's exact test.

Complication/Adverse Effect	FIPB + SA (n = 25)	CSE (n = 25)	p-value
Nausea, n (%)	2 (8.0%)	3 (12.0%)	0.58
Vomiting, n (%)	0 (0%)	2 (8.0%)	0.47
Sedation, n (%)	2 (8.0%)	3 (12.0%)	0.58
Urinary retention, n (%)	1 (4.0%)	2 (8.0%)	1.00
Post-dural puncture headache, n (%)	0 (0%)	1 (4.0%)	1.00
Vascular puncture, n (%)	0 (0%)	0 (0%)	—
Local anesthetic systemic toxicity, n (%)	0 (0%)	0 (0%)	—
New neurological deficit, n (%)	0 (0%)	0 (0%)	—
Other complications, n (%)	0 (0%)	1 (4.0%)	1.00
Any complication, n (%)	5 (20.0%)	12 (48.0%)	0.06

DISCUSSION

The present study compared ultrasound-guided fascia iliaca plane block (FIPB) followed by spinal anesthesia with combined spinal–epidural (CSE) anesthesia for femur surgery. FIPB + spinal anesthesia provided better analgesia during positioning, easier positioning, greater hemodynamic stability, longer postoperative analgesia, delayed rescue analgesia, and lower 24-hour opioid consumption.

Pain during positioning is clinically important in patients with femoral fractures because movement of the injured limb can cause severe pain and muscle guarding. In the present study, VAS during positioning was significantly lower with FIPB + spinal anesthesia than with CSE (2.6 ± 0.9 vs. 6.8 ± 1.2; p < 0.001), with a very large effect size (Cohen's d = 4.02). This supports the benefit of providing targeted analgesia before neuraxial positioning. Similar findings have been reported by Yun et al., Gupta and Kamath, and Hsu et al., who demonstrated that fascia iliaca or femoral nerve blocks reduce positioning-related pain before spinal anesthesia. Our results are consistent with these studies, although the magnitude of pain reduction in our FIPB group was slightly greater, possibly due to the use of a larger volume (30 mL) of dilute bupivacaine and standardized 15–20 minute onset time.

Positioning was also easier in the FIPB group, with 80% of patients classified as having easy positioning compared with 28% in the CSE group. No patient in the FIPB group had difficult positioning, compared with 20% in the CSE group. This improvement is likely related to reduced pain and muscle guarding, allowing better patient cooperation. These findings align with Bantie et al., who reported that preoperative regional techniques significantly improve positioning comfort for spinal anesthesia in femoral fracture patients.

The analgesic effect of FIPB can be explained by spread of local anesthetic within the fascia iliaca plane to the femoral and lateral femoral cutaneous nerves, with variable involvement of the obturator nerve. Ultrasound guidance facilitates accurate identification of the fascial plane and local anesthetic spread. Unlike CSE, which provides neuraxial anesthesia after positioning, FIPB specifically addresses pain caused by movement of the fractured limb before the patient is positioned.

FIPB + spinal anesthesia was also associated with better intraoperative hemodynamic stability. The lowest heart rate and MAP were higher, while bradycardia, hypotension, and vasopressor requirements were lower in the FIPB group. Ephedrine consumption was significantly lower (3.5 ± 2.1 mg vs. 7.8 ± 3.4 mg; $p = 0.001$). This may be related to the absence of sympathetic blockade with peripheral nerve block compared with neuraxial anesthesia. Nevertheless, these findings should be interpreted cautiously because hemodynamic responses are influenced by intrathecal dose, block level, fluid status, and sedative use. Our findings are consistent with Desmet et al. and Gasanova et al., who reported that FIPB provides effective analgesia with minimal hemodynamic disturbance.

The mean procedure time was also shorter with FIPB (6.8 ± 1.5 vs. 10.4 ± 2.1 minutes; $p < 0.01$). Although the two procedures represent different components of anesthesia care, the finding suggests that ultrasound-guided FIPB can be performed efficiently and may facilitate rapid anesthetic preparation, particularly in patients with painful femur fractures.

Postoperative analgesia was significantly prolonged with FIPB. Duration of analgesia was 10.2 ± 2.4 hours compared with 8.4 ± 2.1 hours in the CSE group ($p = 0.01$), while time to first rescue analgesia was 10.8 ± 2.1 versus 8.2 ± 1.9 hours ($p < 0.01$). While statistically significant, the clinical significance of a 1.8-hour difference in analgesia duration should be considered in the context of the overall opioid-sparing effect and improved early postoperative pain control. The opioid-sparing effect is particularly relevant: total tramadol consumption was 75 ± 25 mg versus 125 ± 35 mg ($p < 0.01$), representing a 40% reduction in opioid requirements. This supports the role of peripheral nerve blocks in multimodal analgesia and may translate to fewer opioid-related adverse effects.

Postoperative VAS scores were also lower in the FIPB group, with statistically significant differences at 2, 4, and 6 hours. Although scores remained numerically lower at 12 and 24 hours, these differences were not statistically significant. Thus, the principal analgesic advantage of FIPB appears to occur during the early postoperative period, supporting its use as a component of multimodal analgesia rather than as a sole method of prolonged postoperative pain control.

Patient and surgeon satisfaction showed a favorable trend with FIPB. All patients in the FIPB group were satisfied or very satisfied compared with 80% in the CSE group, while all surgeons in the FIPB group reported satisfaction compared with 92% in the CSE group. These differences reached statistical significance when analyzed as ordinal variables. Improved positioning, analgesia, and hemodynamic stability may have contributed to better overall perioperative experience.

Block failure and complications were uncommon in both groups. Although complications were numerically fewer with FIPB and nausea, vomiting, and sedation were more frequent in the CSE group, these differences were not statistically significant and cannot establish a definitive safety advantage because of the small sample size. No local anesthetic systemic toxicity, vascular injury, or new neurological deficit was observed.

The results of the present study should be interpreted in light of several limitations. First, the sample size is small, which limits the statistical power to detect differences in relatively infrequent outcomes such as block failure and complications. Second, the study was conducted in a single center, which may limit generalizability. Third, outcomes such as patient and surgeon satisfaction may be influenced by subjective factors. Fourth, the procedural time comparison between FIPB and CSE should be interpreted cautiously because the techniques involve different procedural components. Fifth, postoperative analgesic outcomes may be influenced by the use of concomitant multimodal analgesics and differences in individual pain perception.

A significant methodological limitation is that the CSE group did not receive any pre-positioning analgesia, whereas the FIPB group received the block specifically for this purpose. For patients with acute femoral fractures and baseline VAS scores of approximately 7.8, positioning without analgesia is uncomfortable and may be considered below the standard of care in some institutions. This design introduces a potential ethical concern and performance bias, as the CSE group

inherently experienced more pain during positioning. Future studies should compare FIPB + spinal anesthesia against a control group that receives systemic analgesia (e.g., intravenous fentanyl or tramadol) before CSE positioning to ensure ethical equivalence and a fairer comparison.

Finally, the lack of long-term follow-up beyond 24 hours limits assessment of sustained analgesic benefits, functional recovery, and chronic post-surgical pain.

Clinical Implications

Despite these limitations, the present findings suggest that preoperative ultrasound-guided FIPB followed by spinal anesthesia may offer several clinically relevant advantages over CSE for patients undergoing femur surgery. The most prominent benefit was the substantial reduction in pain during positioning for neuraxial anesthesia, which was the primary outcome of the study. This was accompanied by easier positioning, greater intraoperative hemodynamic stability, prolonged postoperative analgesia, delayed requirement for rescue analgesia, reduced opioid consumption, and lower early postoperative pain scores.

CONCLUSION

In conclusion, preoperative ultrasound-guided FIPB followed by spinal anesthesia appears to be an effective approach for patients undergoing femur surgery, particularly when severe pain during positioning is a major concern. By providing targeted peripheral analgesia before neuraxial anesthesia, FIPB may improve patient comfort and facilitate positioning while contributing to hemodynamic stability and opioid-sparing postoperative analgesia. However, the lack of pre-positioning analgesia in the CSE group is an important limitation that should be addressed in future trials. Larger randomized controlled trials with adequate sample sizes, multi-center designs, and ethically balanced comparison groups are required to confirm these findings and to establish the comparative effectiveness and safety of FIPB + spinal anesthesia versus CSE in different types of femur surgery and patient populations.

Declarations

Consent for Publication

Written informed consent for publication was obtained from all participants. No identifiable patient data or images are included in this manuscript.

Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing Interests

The authors declare that they have no competing interests.

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Authors' Contributions

Sourabh Kumar: Conceptualization, methodology, supervision, project administration, writing – review and editing. Shivani Sharma: Methodology, investigation, data curation, writing – original draft. Akanksha Singh: Investigation, data curation, formal analysis, writing – original draft, writing – review and editing. Anuradha Arya: Investigation, resources, writing – review and editing. Akritie Bhadwal: Investigation, resources, writing – review and editing. Saurabh Samotra: Investigation, data curation, writing – review and editing. Raghuraj Sharma: Conceptualization, supervision, writing – review and editing. All authors read and approved the final manuscript.

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