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Comparative Study of Pericapsular Nerve Group (PENG) Block vs Suprainguinal Fascia Iliaca Compartment Block (SIFICB) in Fracture Neck of Femur in Geriatric Patients

Yaşlı Hastalarda Femur Boynu Kırıklarında Perikapsüler Sinir Grubu Bloğu (PENG) ile Suprainguinal Fasya İliaka Kompartman Bloğu (SIFICB) Karşılaştırmalı Çalışması

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ABSTRACT

Objective: Fracture neck of femur represents a major clinical challenge in the geriatric population, and effective perioperative analgesia is essential for optimal recovery. Peripheral nerve blocks such as the suprainguinal fascia iliaca compartment block (SIFICB) and pericapsular nerve group (PENG) block offer promising opioid-sparing alternatives. The aim of this study was to compare quadriceps muscle strength preservation and analgesic efficacy between two blocks.

Method: This randomized study included 50 patients aged >60 years (ASA I/II) scheduled for fracture neck of femur surgery. Participants were randomly allocated into two groups (n=25 each). Group A received an ultrasound-guided PENG block (20 mL 0.25% levobupivacaine with 4 mg dexamethasone), while Group B received an ultrasound-guided SIFICB (40 mL 0.25% levobupivacaine with 4 mg dexamethasone). The primary outcome was quadriceps muscle strength at 6 hours postoperatively.

Results: Baseline demographic and clinical characteristics were comparable between the groups. At 3 hours postoperatively, Medical Research Council (MRC) grade ≥4 quadriceps muscle power was achieved in 92% of patients in the PENG group compared with 32% in the SIFICB group (p=0.0011). At 6 hours, grade 5 muscle power was observed in 72% and 32% of patients, respectively (p=0.0039). No statistically significant differences were observed in pain scores at 6, 12, or 24 hours postoperatively. Rescue analgesia was required in 32% of patients in the PENG group and 52% in the SIFICB group (p=0.15). Postoperative nausea and vomiting occurred in 4% and 12% of patients, respectively (p=0.61).

ÖZ

Amaç: Femur boyun kırığı, geriatrik popülasyonda önemli bir klinik sorun oluşturmaktadır ve optimal iyileşme için etkili perioperatif analjezi gereklidir. Suprainguinal Fasya İliaka Kompartman Bloğu (SIFICB) ve Perikapsüler Sinir Grubu (PENG) bloğu gibi periferik sinir blokları, opioid kullanımını azaltan umut verici alternatifler sunmaktadır. Bu çalışmanın amacı, iki blok arasında kuadriseps kas gücünün korunması ve analjezik etkinliğin karşılaştırılmasıdır.

Yöntem: Bu randomize çalışmaya, femur boyun kırığı nedeniyle cerrahi planlanan, 60 yaş üzeri (ASA I/II) 50 hasta dahil edildi. Katılımcılar rastgele iki gruba ayrıldı (her grupta n=25). Grup A'ya ultrason eşliğinde PENG bloğu (20 mL %0,25 levobupivakain ve 4 mg deksametazon), Grup B'ye ise ultrason eşliğinde SIFICB (40 mL %0,25 levobupivakain ve 4 mg deksametazon) uygulandı. Birincil sonuç, postoperatif 6. saatte kuadriseps kas gücüydü.

Bulgular: Başlangıç demografik ve klinik özellikleri gruplar arasında benzerdi. Postoperatif 3. saatte, PENG grubundaki hastaların %92'sinde, SIFICB grubundaki hastaların ise %32'sinde Medical Research Council (MRC) derece ≥4 kuadriseps kas gücüne ulaşıldı (p=0,0011). Altıncı saatte, hastaların sırasıyla %72'sinde ve %32'sinde derece 5 kas gücü gözlendi (p=0,0039). Postoperatif 6., 12. veya 24. saatlerdeki ağrı skorları açısından istatistiksel olarak anlamlı bir fark gözlenmedi. Kurtarıcı analjezi PENG grubundaki hastaların %32'sinde ve SIFICB grubundaki hastaların %52'sinde gerekli oldu (p=0,15). Postoperatif bulantı ve kusma sırasıyla hastaların %4'ünde ve %12'sinde görüldü (p=0,61).

Sonuç: Perikapsüler sinir grubu bloğu, erken postoperatif dönemde SIFICB'ye kıyasla kuadriseps kas gücünün anlamlı olarak daha

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Conclusion: The PENG block resulted in significantly better preservation of quadriceps muscle strength than SIFICB in the early postoperative period. However, the SIFICB group received twice the total dose of levobupivacaine compared with the PENG group, and therefore the observed difference in motor preservation cannot be attributed solely to the block technique. No significant differences were observed in postoperative pain scores or rescue analgesia.

Keywords: PENG block, suprainguinal fascia iliaca compartment block, fracture neck of femur, regional anaesthesia, quadriceps sparing, geriatric population

iyi korunmasını sağladı. Bununla birlikte, SIFICB grubuna PENG grubunun iki katı levobupivakain uygulandı. Bu nedenle, motor fonksiyonun korunmasında gözlenen fark yalnızca blok tekniğine bağlanamaz. Postoperatif ağrı skorları veya kurtarıcı analjezi gereksinimi açısından anlamlı bir fark gözlenmedi.

Anahtar sözcükler: PENG blok, suprainguinal fasya iliaka kompartman bloğu, femur boynu kırığı, bölgesel anestezi, kuadriseps kasının korunması, geriatrik popülasyon

INTRODUCTION

Fracture neck of femur in the geriatric population represents a growing challenge for healthcare systems worldwide, with an expected increase as populations age. By the year 2050, the global annual incidence is expected to rise to 6.3 million, underscoring the magnitude of this healthcare burden (1). Effective pain management in this population is crucial, facilitating early mobilisation, reducing perioperative morbidity, and improving postoperative outcomes.

Systemic opioid analgesia carries considerable risks for older adults, including respiratory depression, delirium, constipation, and delayed recovery (1). As a result, regional anaesthesia techniques have gained prominence for their efficacy in controlling pain with a more favourable adverse-effect profile. The two principal regional blocks studied for fracture neck of femur are the suprainguinal fascia iliaca compartment block (SIFICB) and the pericapsular nerve group (PENG) block (2).

The SIFICB aims to anaesthetise the femoral, obturator, and lateral femoral cutaneous nerves by depositing local anaesthetic beneath the fascia iliaca (1). The suprainguinal fascia iliaca compartment block has demonstrated efficacy in reducing pain and opioid consumption after fracture neck of femur surgery but is often associated with quadriceps weakness, which can hamper early mobilisation and rehabilitation—key priorities in geriatric fracture care (1,3).

The PENG block targets the articular branches of the femoral, obturator, and accessory obturator nerves supplying the anterior hip capsule (2,4). The anatomical basis of the PENG block is intended to provide motor-sparing effects, aiming to maximise pain relief while minimising muscle weakness and preserving quadriceps muscle strength (1,5). Several studies and meta-analyses have reported that the PENG block can achieve comparable or even superior analgesic efficacy compared with other nerve blocks, with greater preservation of quadriceps muscle strength and reduced opioid requirements (1,3,5).

Recent meta-analyses also suggest that the PENG block offers similar or superior analgesia and a higher likelihood of motor preservation compared with the SIFICB, although some studies have reported mixed findings, indicating a need for further direct comparative studies (1,3,5). Clinical trials using PENG blocks in elderly patients with fracture neck of femur have shown significant reductions in pain scores, lower opioid requirements, and higher patient satisfaction during positioning for spinal anaesthesia and postoperative recovery (4,5).

The PENG approach has also been used for phenol-mediated chemical denervation as a palliative analgesic strategy in frail older patients with hip fractures managed non-operatively (6). Importantly, both the PENG and SIFICB techniques are ultrasound-guided, which increases their precision and may potentially improve their safety profiles (1,2,5).

Recently, there has been a heightened focus on improving perioperative care for geriatric patients with femoral neck fractures, given the significant morbidity and mortality associated with this condition. As regional anaesthesia techniques have evolved, the PENG block and the SIFICB have emerged as promising strategies for effective analgesia. These techniques may also help minimise opioid-related complications. Despite their widespread use, direct comparative studies on their relative efficacy and motor-sparing effects remain limited to date, particularly in the elderly population.

The primary aim of the present study was to compare quadriceps motor preservation at 6 hours postoperatively between the PENG block and the SIFICB in geriatric patients undergoing surgery for fracture neck of femur. Secondary objectives included comparison of postoperative pain scores, rescue analgesic requirements, and adverse events.

METHODOLOGY

Study Design and Setting

This prospective, randomized clinical trial was conducted in the orthopaedic operating theatre at the study centre from

September 2024 to March 2025. The study was designed as a feasibility-based randomized clinical trial because no prior institutional data were available to permit a reliable *a priori* sample size estimation. Written informed consent was obtained from all participants before enrolment.

Participants

Patients aged >60 years of either sex who were scheduled for surgical management of fracture neck of femur and classified as American Society of Anesthesiologists (ASA) physical status I or II were eligible for inclusion. Patients were excluded if they refused participation or had ASA physical status III or IV, allergy to local anaesthetics, coagulopathy, sepsis, hepatic or renal failure, ongoing use of antiplatelet agents, neuropsychiatric disease, myopathy, or obesity (body mass index [BMI] >40 kg m^{-2}).

Patients with ASA physical status III or IV were excluded to reduce clinical heterogeneity and enhance patient safety in this feasibility-based randomized study, while minimizing the potential influence of severe systemic comorbidities on postoperative outcomes.

Details of patient enrolment and randomization are depicted in CONSORT flow diagram in Figure 1.

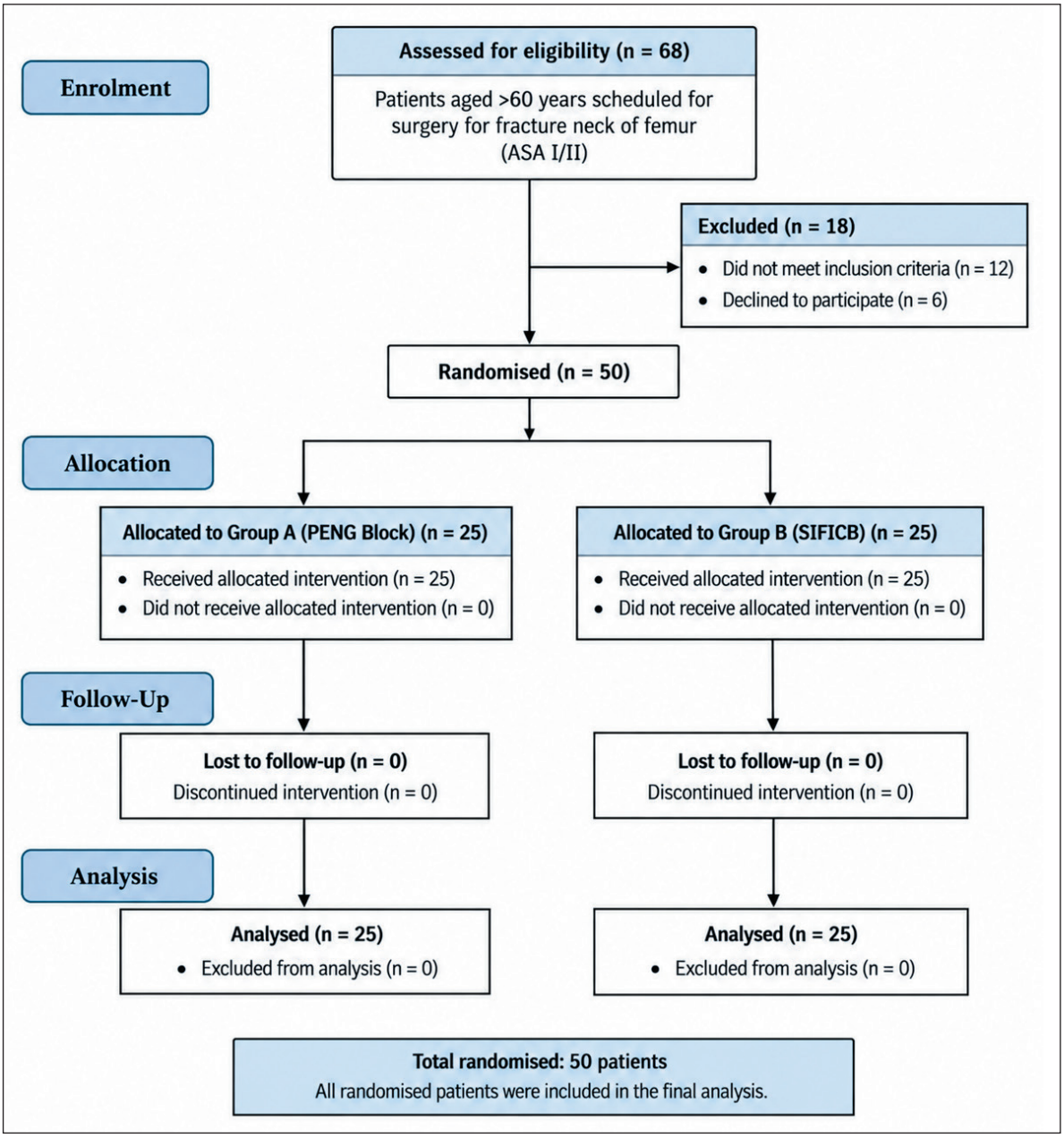


Figure 1. CONSORT flow diagram

Randomization and Allocation Concealment

A total of 50 eligible patients were enrolled and randomly assigned in a 1:1 ratio to two groups (n = 25 per group) using a computer-generated randomization table. Allocation concealment was maintained using sealed, opaque envelopes. Group allocation was performed immediately before the block procedure by an independent individual who was not involved in the study. Patients allocated to Group A received a PENG block, whereas those allocated to Group B received a SIFICB.

Interventions

In Group A (PENG block group), an ultrasound-guided PENG block was performed using 20 mL of 0.25% levobupivacaine combined with dexamethasone 4 mg. In Group B (SIFICB group), an ultrasound-guided SIFICB was performed using 40 mL of 0.25% levobupivacaine combined with dexamethasone 4 mg. Thus, the total levobupivacaine dose was 50 mg in the PENG group and 100 mg in the SIFICB group.

All nerve blocks were administered after institutionally standardized spinal anaesthesia.

Three consultant anesthesiologists, each experienced in both ultrasound-guided PENG and SIFICB techniques, performed the blocks. Anesthesiologists 1 performed 17 blocks (9 PENG and 8 SIFICB), Anesthesiologists 2 performed 17 blocks (8 PENG and 9 SIFICB), and Anesthesiologists 3 performed 16 blocks (8 PENG and 8 SIFICB). Both techniques were performed according to a standardized institutional protocol, with uniform patient positioning, ultrasound guidance, needle approach, local anaesthetic concentration, and injection technique. Before study initiation, all participating anaesthesiologists agreed upon the study protocol to promote procedural consistency and minimize inter-operator variability.

The PENG block targeted the pericapsular space near the iliopubic eminence, whereas the SIFICB was performed beneath the fascia iliaca above the pelvic brim. Following confirmation of the appropriate anatomical plane and needle position, the anaesthetic solution was injected incrementally, and spread within the intended fascial compartment was visualized. Ultrasound-confirmed spread was considered evidence of technical completion of the block and not independent confirmation of clinical block efficacy. Block failure was defined as inability to complete the planned injection or requirement for a repeat block. No technical block failures or repeat blocks occurred.

All surgical procedures were performed by the same orthopaedic unit according to standardized institutional protocols.

Spinal Anaesthesia and Motor Block Regression

Spinal anaesthesia was administered using 7.5–12.5 mg of hyperbaric bupivacaine with fentanyl 25 µg as an intrathecal adjuvant, according to the institutional protocol. The exact individual spinal dose and sensory level achieved were not prospectively recorded as study variables. Similarly, group-specific time to achievement of Modified Bromage score 0 was not separately recorded. Complete regression of spinal motor block, defined as a Modified Bromage score of 0, was confirmed in all participants within 3 hours postoperatively before assessment of quadriceps muscle strength.

There were three patients with Medical Research Council (MRC) Grade 2 quadriceps strength at 3 hours who had achieved Modified Bromage score 0 before the quadriceps assessment. Bromage score 0 was used to confirm recovery of gross lower-limb motor function from spinal anaesthesia, whereas MRC grading specifically assessed quadriceps muscle strength by active knee extension. Therefore, the presence of MRC Grade 2 quadriceps weakness despite Bromage score 0 was recorded as part of the study motor outcome and was not considered evidence of persistent global spinal motor block.

Perioperative and Postoperative Management

All patients received standard perioperative care, including prophylactic antibiotics, antiemetics, and intraoperative fluid management according to the institutional protocol. Intraoperative monitoring consisted of continuous electrocardiography, non-invasive blood pressure, pulse oximetry, and capnography, with standard haemodynamic monitoring maintained throughout surgery.

Outcome Measures

The registered primary outcome was the incidence of quadriceps motor block at 6 hours postoperatively. In the present study, quadriceps motor function was assessed at 6 hours using the MRC muscle power grading scale, with muscle power grade recorded as an ordinal outcome.

Quadriceps muscle strength was assessed by the patient's ability to perform active knee extension and was graded on the MRC scale from 0 to 5: Grade 0, no movement; Grade 1, flicker; Grade 2, movement with gravity eliminated; Grade 3, movement against gravity; Grade 4, movement against resistance; and Grade 5, normal power. Muscle strength was analysed as an ordinal variable, with higher grades indicating better preservation of quadriceps motor function.

Motor assessment was performed only after complete regression of spinal anaesthesia. Spinal motor recovery was confirmed using the Modified Bromage Scale, with a score of 0 indicating complete motor recovery.

Secondary outcomes included postoperative pain intensity measured using the Visual Analog Scale (VAS) at 6, 12, and 24 hours, requirement for rescue analgesia, and adverse events, including postoperative nausea and vomiting. The VAS was used because all enrolled patients were cognitively intact, able to understand and reliably use the scale, and had provided informed consent.

Rescue analgesia consisted of intravenous tramadol 100 mg administered as required when the VAS score was ≥6 or when the patient requested additional analgesia. Rescue analgesia requirement during the first 24 postoperative hours was recorded as a binary outcome (required/not required). Cumulative tramadol consumption was not recorded.

Cumulative opioid consumption was not a predefined outcome and was therefore not recorded. Similarly, time to mobilization, length of hospital stay, and other functional recovery outcomes were not predefined study outcomes and were not systematically recorded.

Blinding and Data Collection

Because of the differences in anatomical approach and injectate volume between the two techniques, blinding of the anesthesiologists performing the block was not feasible. Patients were aware of the procedure performed. However, postoperative outcome assessment was conducted by an independent observer who was blinded to group allocation and was not involved in block administration.

All nerve blocks were performed by consultant anaesthesiologists experienced in ultrasound-guided regional anaesthesia and familiar with both techniques. Surgical procedures were performed by the same orthopaedic unit according to standard institutional protocols. All study data were collected prospectively and recorded on pre-designed data-collection forms.

Statistical Analysis

Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages. The distribution of continuous variables was assessed using the Shapiro–Wilk test.

Continuous variables were compared between groups using the independent-samples *t*-test or Mann–Whitney *U* test, as appropriate. Ordinal quadriceps muscle power grades (MRC Grades 0–5) were compared between groups using the Mann–Whitney *U* test. Categorical variables were analysed using the chi-square test or Fisher's exact test, as appropriate. For the difference in proportions, 95% confidence intervals were calculated using the Newcombe method. A post hoc dichotomous analysis classified MRC grades ≥4 as preserved quadriceps motor function.

Statistical analyses were performed using SPSS (Statistical Package for the Social Sciences), Version 26.0. A two-sided *p* value <0.05 was considered statistically significant.

Ethics and Trial Registration

The study was approved by the Institutional Ethics Committee vide Letter No. Dean/2024/EC6938 dated 28 February 2024, before commencement of participant recruitment. The trial was registered with the Clinical Trials Registry–India under registration number CTRI/2024/06/069537 on 26 June 2024. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Written informed consent was obtained from all participants before enrolment.

RESULTS

Both groups were comparable with regard to baseline demographic and clinical characteristics, including age (66.52 ± 2.95 vs. 67.44 ± 5.44 years; p = 0.46), sex, ASA physical status, body mass index, duration of surgery, and intraoperative blood loss (all p > 0.05), indicating similar baseline characteristics between the groups (Table I).

Overall, intraoperative haemodynamic parameters remained stable in both groups, with no clinically important haemodynamic events observed.

Postoperative quadriceps muscle strength, assessed using the MRC muscle power grading scale, was significantly better preserved in the PENG group than in the SIFICB group at both 3 and 6 hours postoperatively (Mann–Whitney U test, p = 0.0011 and p = 0.0039, respectively). At 6 hours, 72% of patients in Group A achieved grade 5 muscle power compared with 32% in Group B, while grade 3 power was observed in 8% and 32% of patients, respectively (Table II). In a post hoc dichotomous analysis, MRC muscle power ≥4 was achieved by 23/25 patients (92.0%) in the PENG group compared with 17/25 patients (68.0%) in the SIFICB group. The absolute between-group difference was 24.0 percentage points (95% confidence interval (CI), 1.5–44.4).

No statistically significant differences were observed in postoperative pain scores between the two groups. However, given the feasibility-based sample size, these findings should be interpreted as exploratory rather than evidence of equivalent analgesic efficacy (Table III).

Rescue analgesia was required in 8 patients (32%) in Group A and 13 patients (52%) in Group B; however, this difference did not reach statistical significance (p = 0.15). Postoperative nausea and vomiting occurred in 1 patient (4%) in Group A and 3 patients (12%) in Group B, with no statistically significant difference between the groups (p = 0.61). No major block-related complications were observed in either group (Table IV).

Table I. Baseline Demographic and Clinical Characteristics of Study Participants

Variable	Group A (PENG) (n=25)	Group B (SIFICB) (n=25)	p-value
Age (years)	66.52 ± 2.95	67.44 ± 5.44	0.46*
BMI (kg m^{-2})	24.87 ± 2.44	25.32 ± 2.39	0.51†
Sex, n (%)			0.765‡
Male	17 (68.0)	16 (64.0)	
Female	8 (32.0)	9 (36.0)	
ASA Physical Status, n (%)			0.50§
ASA I	4 (16.0)	7 (28.0)	
ASA II	21 (84.0)	18 (72.0)	
Fracture type, n (%)			0.449‡
Subcapital	13 (52.0)	13 (52.0)	
Transcervical	9 (36.0)	6 (24.0)	
Basicervical	3 (12.0)	6 (24.0)	
Duration of surgery (min)	150.20 ± 10.60	148.28 ± 11.80	0.55†
Intraoperative blood loss (mL)	257.2 ± 42.8	254.8 ± 44.3	0.85†
Surgical procedure, n (%)			0.733‡
Bipolar hemiarthroplasty	20 (80.0)	19 (76.0)	
Total hip arthroplasty	5 (20.0)	6 (24.0)	

Data are presented as mean ± standard deviation or number (%).
* Welch's independent-samples *t*-test. † Independent-samples *t*-test. ‡ Pearson's chi-square test. § Fisher's exact test. **BMI:** Body mass index, **ASA:** American Society of Anesthesiologists, **PENG:** Pericapsular nerve group block, **SIFICB:** Suprainguinal fascia iliaca compartment block.

Table II. Comparison of Muscle Power Between Group A and Group B

Postoperative time	Muscle power grade	Group A (PENG), n (%)	Group B (SIFICB), n (%)
3 hours	Grade 2	0 (0)	3 (12)
	Grade 3	2 (8)	14 (56)
	Grade 4	20 (80)	4 (16)
	Grade 5	3 (12)	4 (16)
	Median (IQR)	4 (4–4)	3 (3–4)
	Mann–Whitney U; p-value	469.0; 0.0011	
6 hours	Grade 3	2 (8)	8 (32)
	Grade 4	5 (20)	9 (36)
	Grade 5	18 (72)	8 (32)
	Median (IQR)	5 (4–5)	4 (3–5)
	Mann–Whitney U; p-value	448.5; 0.0039	

IQR: Interquartile range, **PENG:** Pericapsular nerve group block, **SIFICB:** Suprainguinal fascia iliaca compartment block.
Note: Muscle power was assessed using the Medical Research Council (MRC) grading scale (Grade 0 = no movement; Grade 5 = normal muscle strength). Muscle power grades were analysed as an ordinal variable and compared between groups using the Mann–Whitney U test.

Table III. Comparison of VAS Scores Between Group A and Group B

VAS Score	Group A (PENG), Mean ± SD	Group B (SIFICB), Mean ± SD	Mean Difference (95% CI)	p-value
Postoperative at 6 hours	2.32 ± 0.80	2.68 ± 0.74	−0.36 (−0.80 to 0.08)	0.10
Postoperative at 12 hours	2.84 ± 0.62	2.72 ± 0.73	0.12 (−0.27 to 0.51)	0.53
Postoperative at 24 hours	3.88 ± 0.72	3.76 ± 0.43	0.12 (−0.22 to 0.46)	0.47

Data are presented as mean ± standard deviation (SD). Between-group comparisons were performed using the independent-samples t-test.
CI: Confidence interval, **VAS:** Visual Analog Scale, **PENG:** Pericapsular nerve group block, **SIFICB:** Suprainguinal fascia iliaca compartment block.

Table IV. Comparison of Rescue Analgesic Requirement and Adverse Events Between Group A and Group B

Variable	Group A (PENG) (n=25)	Group B (SIFICB) (n=25)	p-value
Rescue analgesia required, n (%)	8 (32.0)	13 (52.0)	0.15*
No rescue analgesia required, n (%)	17 (68.0)	12 (48.0)	
Postoperative nausea and vomiting, n (%)	1 (4.0)	3 (12.0)	0.61†
No postoperative nausea and vomiting, n (%)	24 (96.0)	22 (88.0)	

Data are presented as number (%).
*Chi-square test. †Fisher's exact test. **PENG:** Pericapsular nerve group block, **SIFICB:** Suprainguinal fascia iliaca compartment block.

DISCUSSION

Our study demonstrated significantly better preservation of quadriceps muscle strength with the PENG block compared with the SIFICB in older patients undergoing surgery for fracture neck of femur. The primary outcome, quadriceps muscle strength at 6 hours postoperatively, was significantly higher in the PENG group, with 72% of patients achieving grade 5 muscle power compared with 32% in the SIFICB group. A similar difference was also observed at 3 hours, which was prespecified as a secondary motor outcome. These findings suggest that PENG may provide greater preservation of quadriceps motor function during the early postoperative period in this patient population.

The analgesic findings in the present study were less definitive. No statistically significant differences were observed in VAS scores at 6, 12, or 24 hours, and the requirement for rescue analgesia was also not significantly different between groups. Because this was a feasibility-based study with a relatively small sample size and was not designed or powered to establish equivalence, the absence of statistically significant differences in analgesic outcomes should not be interpreted as evidence of equivalent analgesic efficacy. These outcomes should therefore be regarded as exploratory and hypothesis-generating.

The present analgesic findings are consistent with the heterogeneity reported in the existing literature. A recent systematic review by Dolstra et al., which evaluated PENG, fascia iliaca compartment block, and femoral nerve block for pain management in patients with hip fractures, demonstrated variability in analgesic outcomes across studies (7). This heterogeneity may reflect differences in block techniques, local anaesthetic regimens, patient populations, fracture characteristics, and outcome assessment. In addition, Senthil et al. reported no significant difference in dynamic pain scores or duration of analgesia between PENG and SIFICB, although differences in static pain scores and motor function were observed. Kalashetty et al., in a double-blinded randomized study, also provided comparative evidence regarding postoperative analgesia and motor preservation between PENG and SIFICB (8,9).

Pavithra et al. compared landmark-based PENG and SIFICB in patients undergoing surgery for hip fractures, with particular attention to preoperative positioning and postoperative analgesia (10). Their findings suggested advantages of PENG in readiness for positioning and patient comfort, while differences in postoperative analgesic duration were also observed. However, preoperative positioning comfort was not assessed in our study and therefore cannot be compared directly with these findings. Similarly, cumulative opioid consumption and time to first rescue analgesia were not systematically recorded in the present study and should not be inferred from the binary rescue-analgesia outcome.

The principal finding of our study was the preservation of quadriceps muscle strength following PENG block. This observation is clinically relevant because quadriceps weakness is an important consequence of regional techniques that involve spread to the femoral nerve and may potentially influence postoperative functional recovery. The PENG block was developed to target articular branches supplying the anterior hip capsule while attempting to reduce involvement of the major motor nerves. Comparative randomized studies have reported better preservation of motor function with PENG than with SIFICB, supporting the anatomical rationale for the present findings (8,9). The systematic review by Dolstra et al. also identified motor preservation as an important area of comparison among regional techniques for hip fracture analgesia (7).

Liang et al. further evaluated a modified PENG approach combined with lateral femoral cutaneous nerve block and compared it with SIFICB in patients undergoing total hip arthroplasty (11). Their study reported differences in postoperative functional parameters, including hip movement and ambulation. These findings are relevant to the potential clinical implications of motor preservation; however, functional recovery, time to mobilization, and ambulation were not outcomes assessed in our study. Therefore, our findings should be limited to the demonstrated preservation of quadriceps muscle strength rather than interpreted as evidence of improved postoperative mobility or rehabilitation.

Differences in ease of positioning for spinal anaesthesia have also been described in previous comparative studies. Jadon et al. specifically evaluated ease of positioning during spinal anaesthesia, while Pavithra et al. assessed preoperative positioning and patient comfort (10,12). Although these studies provide evidence regarding a potential additional benefit of regional analgesia, positioning-related outcomes were not prospectively assessed in our study and therefore cannot be used to support a similar conclusion from our data.

Both techniques were well tolerated in the present study, and no major block-related complications were observed. The low incidence of postoperative nausea and vomiting was also comparable between groups. These observations are broadly consistent with the safety findings reported in comparative studies and systematic reviews of PENG and SIFICB (7-10,13). However, the present feasibility study was not sufficiently powered to detect uncommon adverse events, and the absence of observed major complications should therefore not be interpreted as definitive evidence of superiority in safety.

An important consideration when interpreting the motor findings is the difference in local anaesthetic dose between the two study groups. The PENG group received 20 mL of 0.25% levobupivacaine, corresponding to 50 mg, whereas the SIFICB group received 40 mL of 0.25% levobupivacaine, corresponding to 100 mg. Different injection volumes are commonly used for these techniques because they involve different anatomical compartments and requirements for injectate spread. However, in our study the same concentration was used for both techniques, resulting in a two-fold difference in total levobupivacaine dose. Consequently, the observed difference in quadriceps strength cannot be attributed solely to the block technique. The higher total local anaesthetic dose in the SIFICB group may have contributed to greater motor impairment and represents an important potential confounding factor. This limitation should be considered when interpreting the superiority of PENG with respect to quadriceps preservation.

The use of three consultant anaesthesiologists is another consideration. All three were experienced in both ultrasound-guided techniques and followed a standardized institutional protocol. Their distribution of procedures was also relatively balanced between the two groups. Nevertheless, some residual inter-operator variability in needle placement, anatomical identification, and injectate spread cannot be excluded. Future multicentre studies should use highly standardized block protocols and, where feasible, assess operator-related variability.

Blinding also presents an inherent limitation. The anesthesiologists performing the block could not be blinded because the two procedures differ in anatomical approach and injectate volume, and patients were also aware of the procedure performed. Postoperative outcome assessment, however, was conducted by an independent observer who was blinded to group allocation. The absence of patient and operator blinding may have introduced performance or expectation bias, particularly for subjective outcomes such as pain assessment and rescue analgesic use. The objective motor outcome was assessed using a predefined MRC grading scale by the blinded postoperative assessor, which was intended to reduce detection bias.

The assessment of quadriceps strength was performed after documented regression of the gross spinal motor block, defined by a Modified Bromage score of 0. However, the individual intrathecal spinal dose and sensory level were not prospectively recorded. Therefore, a residual intrathecal effect cannot be completely excluded, particularly at the 3-hour assessment, and may have contributed to early postoperative quadriceps weakness. The marked recovery in quadriceps strength between 3 and 6 hours in both groups is also consistent with a possible contribution from resolving spinal effects. Although a Modified Bromage score of 0 indicated recovery of gross lower-limb motor function, it may not completely exclude subtle or muscle-specific residual effects of spinal anaesthesia.

Clinical block efficacy was not independently verified using a standardized sensory or analgesic block assessment before the primary motor outcome assessment; therefore, technical completion of the block based on ultrasound visualization cannot be considered confirmation of clinical block success.

The study was designed primarily as a feasibility-based randomized trial, and the sample size was not derived from a formal a priori power calculation because adequate institutional data were unavailable for such an estimation. The sample of 50 participants therefore provides preliminary evidence regarding the feasibility of comparing postoperative motor function between the two techniques but limits the precision of estimates for secondary outcomes. For example, rescue analgesia was required in 32% of patients in the PENG group and 52% in the SIFICB group, but this difference was not statistically significant ($p = 0.15$). This should not be interpreted as evidence that the two techniques are equivalent with respect to analgesic requirements.

Several clinically relevant outcomes were not systematically recorded and therefore were not analysed. These included cumulative opioid consumption, time to first rescue analgesia, time to mobilization, length of hospital stay, functional recovery, and patient-reported recovery measures such as Quality of Recovery-15 (QoR-15) or QoR-40. Preoperative positioning comfort, injury-to-surgery interval, and details

of preoperative analgesic use were also not systematically captured in the study database. Consequently, although PENG was associated with better preservation of quadriceps strength, our study cannot establish whether this translated into earlier mobilization, improved rehabilitation, shorter hospitalization, lower overall opioid consumption, or better quality of recovery.

The findings should also be interpreted within the context of the study population. Only patients aged >60 years with ASA physical status I or II were included, while patients with ASA III or IV status were excluded to reduce clinical heterogeneity in this feasibility study. Accordingly, the results may not be directly generalizable to frailer patients with substantial systemic comorbidity. The single-centre design and moderate sample size further limit generalizability. Larger multicentre randomized trials including broader geriatric populations would provide more definitive evidence.

Overall, the present study adds to the growing comparative literature on PENG and SIFICB by demonstrating a significant difference in an objectively assessed motor outcome at both 3 and 6 hours after surgery, with the 6-hour assessment serving as the primary endpoint. The findings suggest greater preservation of quadriceps motor function with PENG in this study. However, the unequal local anaesthetic dose between groups, limited sample size, absence of patient and operator blinding, use of multiple operators, and lack of functional and cumulative opioid outcomes require cautious interpretation. Future adequately powered multicentre randomized trials should use standardized local anaesthetic dosing, include functional recovery and mobilization outcomes, and assess cumulative opioid consumption and quality of recovery to determine the broader clinical significance of the observed motor preservation.

CONCLUSION

This feasibility-based randomized study demonstrated greater preservation of quadriceps muscle strength following PENG block compared with the SIFICB during the early postoperative period in geriatric patients undergoing surgery for fracture neck of femur. However, the two techniques used different total levobupivacaine doses, with a two-fold higher dose in the SIFICB group; therefore, the observed difference in motor preservation cannot be attributed solely to differences in block anatomy or technique. Although no statistically significant differences were observed in postoperative pain scores or rescue analgesia requirement, the study was not designed or powered to establish equivalence in analgesic efficacy, and these findings should therefore be interpreted cautiously. As mobilization, functional recovery, and length of hospital stay were not assessed, no conclusions can be drawn regarding these outcomes. Larger, adequately powered, multicentre randomized trials incorporating functional recovery measures and standardized local anaesthetic dosing are needed to confirm these preliminary findings.

AUTHOR CONTRIBUTIONS

Conception or design of the work: AB
Data collection: SKS
Data analysis and interpretation: SKS, AB, SK
Drafting the article: AB, SK, SY
Critical revision of the article: AB, SK
Other (study supervision, fundings, materials, etc): AB, SKS, SK, SY, SK, SP
The authors (SKS, AB, SK, SY, SK, SP) reviewed the results and approved the final version of the manuscript.

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